United States
Environmental Protection
Agency

National Training
and Operational
Technology Center
Cincinnati OH 45268

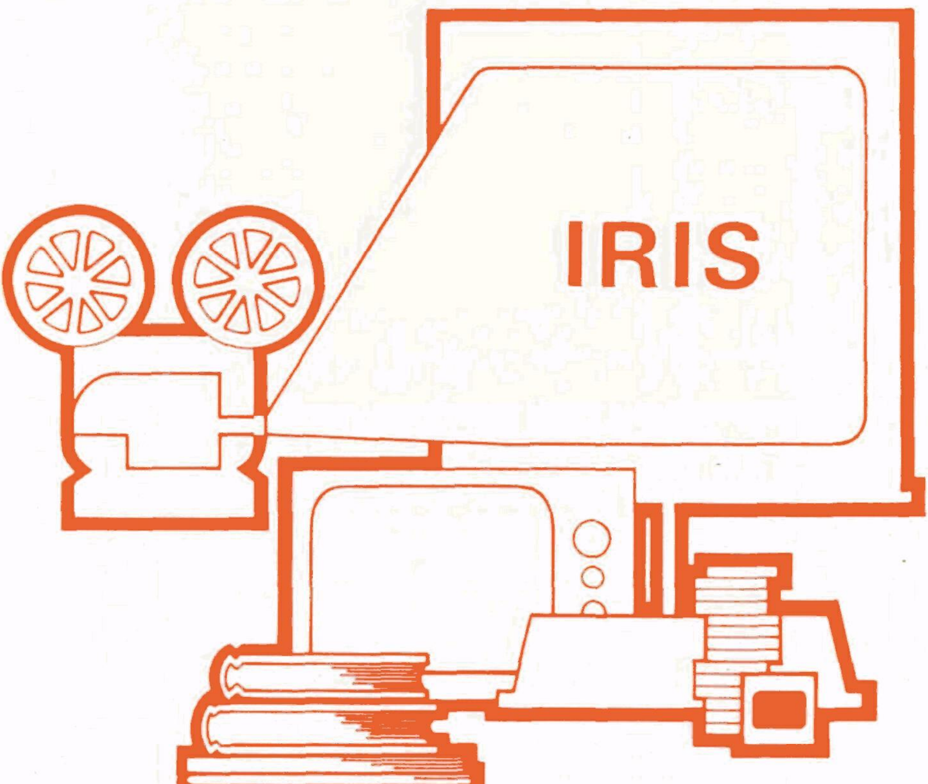
EPA-430/1-80-008
September 1980

Water

EPA

Instructional Resources Monograph Series:

Activated Sludge



July, 1980

Monograph Series:
ACTIVATED SLUDGE

Selected Instructional Activities and References

Clinton L. Shepard and James B. Walasek

Compiled by the staff of the
EPA Information Dissemination Project
SMEAC Information Reference Center
1200 Chambers Rd., 3rd Floor
Columbus, Ohio 43212

U.S. ENVIRONMENTAL PROTECTION AGENCY
Office of Water Program Operation
National Training and Operational Technology Center
Cincinnati, Ohio 45268

FOREWORD

The National Training & Operational Technology Center in cooperation with Ohio State University is offering an Instructional Resources Monograph Series. The monograph series is an extension of the information provided in the "Instructional Resources Information System" (IRIS) for water quality.

This document is one of the Instructional Resources Monograph Series. These documents will assist the professional in identifying and locating instructional and reference materials related to various technical aspects of water quality control. Emphasis is given to items useful in the development and presentation of wastewater treatment training programs.

Each monograph reviews the technical aspects of a pollution control process, provides representative examples of available instructional materials, and includes an annotated bibliography plus additional references.

Your comments and suggestions regarding these publications are invited.

Walter G. Gilbert
Director
NTOTC
Cincinnati, Ohio

ABOUT THE AUTHORS

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Clinton L. Shepard is an Assistant Professor of Environmental Education in the School of Natural Resources at The Ohio State University. Dr. Shepard teaches a course in Environmental Education Programs and has served as a Research Associate for the EPA Information Dissemination Project and the ERIC Clearinghouse for Science, Mathematics and Environmental Education at The Ohio State University.

Credits

Primary staff work for this publication was completed by Ms. Beverly Malcolm, Dr. Robert W. Howe, and Mrs. Maxine Weingarth.

PREFACE

This monograph contains a variety of selected materials related to wastewater treatment and water quality education and instruction. Part I presents a brief discussion of the activated sludge process in wastewater treatment operations. The overlying premise is that operator training is a vital part of the operation of a wastewater treatment facility. Also included in this section are procedures to illustrate how instructors and training personnel in the water quality control field can locate instructional materials to meet general or specific program requirements.

Part II, Instructional Units, are selected portions of existing programs which may be utilized in implementing a training program for the activated sludge process. Each unit has been selected for its representativeness to training level, subject area and instructional approach. A reference to the source where the unit may be found in more detail is included. (A list of additional references for those materials currently available through the Water Resources Center, ERIC, and IRIS systems is found at the end of Part II.)

It is hoped that the instructors and trainers who use these materials will recognize that the instructional units herein serve only as a guide in selecting appropriate training materials and should not be considered a fixed structure. It is recommended that instructors check for other activities appropriate for use or to adapt for use in their own particular situation.

For further information about these materials contact:

EPA Information Dissemination Project
1200 Chambers Road, 3rd Floor
Columbus, Ohio 43212

Phone: 614-422-7853

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PART I

The National Training and Operational Technology Center and Selected Information Sources

THE NATIONAL TRAINING AND OPERATIONAL TECHNOLOGY CENTER

The entire program responsibility for water pollution control training within the Environmental Protection Agency is assigned to the National Training and Operational Technology Center (NTOTC), located at EPA's Environmental Research Center in Cincinnati, Ohio.

The NTOTC is responsible for conducting training sessions, developing instructional materials and courses, providing training assistance, operating the Instructional Resources Center, and developing operational technology. The Center is also responsible for the management of the Section 104(g) operator training grant program, the academic training grant program, other training grant and contract programs, and related training activities.

As an instructional resource, NTOTC's purpose is to help regions, states, local governments, and educational institutions become knowledgeable about the Environmental Protection Agency's goals, regulations, and strategies, as well as the implications of EPA programs.

Activities encompass three categories: (1) instruction; (2) course development; and (3) information management.

Instruction

NTOTC offers a variety of training courses in water quality control. Such courses are taught at many locations, but most are presented at the Environmental Research Center in Cincinnati, Ohio. Area training centers will soon act as satellites to the NTOTC program, offering similar courses and instructional support. Select universities with broad pollution control curricula will act as area training centers within a region. As a result, more pollution control personnel will have access to needed specialized training.

Some courses are conducted at wastewater treatment plants, enabling USEPA to work directly with plant personnel to improve treatment plant effluent. While working on site at treatment plants, staff can diagnose and discuss particular problems and provide information on design and operation to many technicians within the local region.

Courses currently are offered in five general categories: wastewater treatment technology, treatment facility evaluation and inspection, water quality surveillance and monitoring, water quality analysis, and drinking water quality monitoring.

Students attend courses from all states, and from some foreign countries. The largest percentage represent federal, state, and municipal pollution control agencies. A relatively small number of college and university instructors attend these short courses which are typically one week in length. USEPA encourages more participation by the educational community so that current skills and knowledge will be transmitted to students to enable them to deal with pollution control problems as they enter environmental occupations. Community college and university instructors may attend courses free of charge by following prescribed application procedures.

Course Development

NTOTC is active in the field of course development. As new educational and training needs are identified, appropriate instructional packages are developed. Almost all such development is based on current research and agency regulations. Materials include instructor guides, student manuals and supporting audiovisual materials. If USEPA'S pollution control training programs are to be successfully implemented, college and university staff from various departments must cooperate and integrate these instructional activities within their curricula; or students will not be adequately prepared, either theoretically or practically.

Information Management

The goal of USEPA's information management system is to support, in a comprehensive and systematic manner, those involved with pollution control education and training. A central location within the NTOTC facility is designed to provide a contact point and to coordinate assistance efforts and has been designated the Instructional Resources Center (IRC).

Through the IRC, NTOTC maintains a central location to inventory, evaluate, catalog, and disseminate instructional materials in the areas of water pollution control, water supply, and pesticides. The IRC provides those involved in water quality control education and training with an information management system and acts as a primary communications link between the Environmental Protection Agency and educators at all post-secondary levels. Activities of IRC include:

IRIS

The focal point of the IRC is the Instructional Resources Information System (IRIS), a compilation of abstracts on print and non-print materials related to water quality and water resources education. Obtainable in paper, microfiche, and computer versions, the IRIS contains more than 3,000 entries from local, state, and federal government sources, as well as from private concerns and educational institutions. The system allows the user to discover what material can be utilized, the title, the author, cross references, and a brief abstract describing the content. IRIS users can also readily determine where the material can be obtained, whether it can be purchased, borrowed, or rented, and the cost. The IRIS is kept current through constant revision, adding new material as it becomes available and deleting outdated information.

IRIS can be scanned for a particular subject or author, both by hand and by computer. Any institution with appropriate computer terminals can access the search and retrieval capabilities of the system.

Audiovisual Library

The IRC facilities include an audiovisual library equipped with individual study carrels for viewing movies, videocassettes, slide/tape presentations, filmstrips, and tape programs. Before determining curriculum requirements or making purchases, educators can use the library to review water quality-oriented materials for use in training courses.

Nearly 200 of these audiovisuals are also available to instructors for free, short-term loans. Not intended as self-instructional units, these materials are meant to be used as part of a complete training program. A catalog of audiovisual units can be obtained through the IRC.

Workshops

The center also conducts a variety of water-related workshops each year. Designed for state and local agencies, as well as college and university educators, these seminars enable individuals to become familiar with USEPA developed and sponsored resources, descriptions of ongoing programs, and specific instructional techniques. Participants also assist NTOTC in determining instructional priorities.

IRC Bulletin

The IRC maintains communications with its users through the IRC Bulletin. Published approximately six times a year and mailed to interested parties at no charge, the Bulletin provides current news on IRC events. It also includes descriptions of model programs, current instructional materials available, and education strategies. Articles for the Bulletin are accepted from various organizations, education institutions, and governmental agencies.

Interested persons are invited to Cincinnati to use IRC facilities for reviewing tapes, slides, films, and other materials before deciding about purchases or curriculum development requirements. IRC staff assist visitors by determining the most appropriate ways to use the Center's resources, or in determining educational and training program requirements and available resources. During the past year, universities and state and local governments have been assisted with curriculum design, course materials selection, and audiovisual support efforts.

THE INSTRUCTIONAL RESOURCES
INFORMATION SYSTEM

General Information about Materials in IRIS

The EPA Information Dissemination Project acquires, reviews, indexes, and makes available both print and non-print materials related to water quality and water resources education and instruction.

Before materials are entered into IRIS they are reviewed by the project staff. Availability of the material is checked, and the materials are abstracted and indexed. The abstract describes the contents of the material.

When items are processed they are entered on the IRIS computer tape maintained by the EPA Information Dissemination Project at The Ohio State University. These tapes are used for producing tapes for other information systems, publications, and for computer searches conducted at The Ohio State University.

Materials entered into the IRIS collection can be located by manual search or by computer. The first compilation contains resumes of selected materials processed for the previous IRIS collection and resumes of selected materials of items added to the IRIS collection during 1979. Quarterly updates of the IRIS compilation are available by subscription on a yearly basis.

A number of the materials processed for the IRIS system are entered into the ERIC system and announced in Resources in Education (RIE). Most of the materials announced in RIE are available on microfiche at various sites throughout the United States. Users can view these materials on site at many locations to identify what they believe will be useful to them at no cost.

Description of Information in Resumes in IRIS

Two samples of resumes are provided to explain the data fields in the resumes. Sample resume #1 is a sample resume of an item not entered in ERIC. Sample resume #2 is a sample resume of an item entered into ERIC; a few additional data elements are in these resumes and are explained.

1. Sample resume of materials not entered into ERIC

a. IRIS NUMBER: EW003059
b. PUBLICATION DATE: 1978
c. TITLE: WATER POLLUTION MICROBIOLOGY, VOL. 2
d. PERSONAL AUTHOR: MITCHELL, RALPH
e. DESCRIPTOR: BIOCHEMISTRY; *COLLEGE SCIENCE; DISEASE CONTROL; ECOLOGY; *ENVIRONMENTAL INFLUENCES; *INSTRUCTIONAL MATERIALS; *MICROBIOLOGY; NATURAL RESOURCES; *POLLUTION; *PUBLIC HEALTH; *WATER POLLUTION CONTROL; WATER QUALITY
f. DESCRIPTIVE NOTE: 442P.
g. ABSTRACT: THIS VOLUME CONTAINS INFORMATION FOR ENVIRONMENTAL AND SANITARY ENGINEERS, PUBLIC HEALTH SCIENTISTS AND MICROBIOLOGISTS CONCERNED WITH WATER POLLUTION. IT EXAMINES MICROORGANISMS AS CAUSITIVE AGENTS OF ECOLOGICAL AND PUBLIC HEALTH HAZARDS IN NATURAL WATERS, AND TREATS THE USE OF MICROORGANISMS IN POLLUTION CONTROL FROM A VARIETY OF PERSPECTIVES. (CS)
h. AVAILABILITY: JOHN WILEY & SONS, ONE WILEY DR., SOMERSET NJ 08873 ($24.95)

a. IRIS NUMBER--this is the identification number sequentially assigned to materials as they are processed. Gaps in numbers mean that some items have been deleted, are being processed to add new information, or have been delayed in processing for some reason.

b. PUBLICATION DATE--date material was published according to information on the material.

c. TITLE

d. PERSONAL AUTHOR--person or persons who wrote, compiled, or edited the material. Up to two personal authors can be listed.

e. DESCRIPTOR--subject terms which characterize substantive contents and form of the materials. The major terms are preceded by an asterisk. Terms used to index all resumes in this compilation can be reviewed in the Subject Index.

f. DESCRIPTIVE NOTE--various items of information may be contained in this section. For print materials the number of pages is usually listed.

g. ABSTRACT--some early materials entered into IRIS did not have abstract information. All materials currently being entered into IRIS have an informative abstract that describes the contents of the item.

h. AVAILABILITY--information in this field indicates where the material can be obtained and the price of the material quoted the last time information was received from the source. Please note: prices of nearly all materials are subject to changes and may not be accurate at the time a person orders a specific item.

2. Sample resume of material entered into ERIC (Resources in Education)

Item entered into ERIC (Resources in Education) will have a few additional data fields.

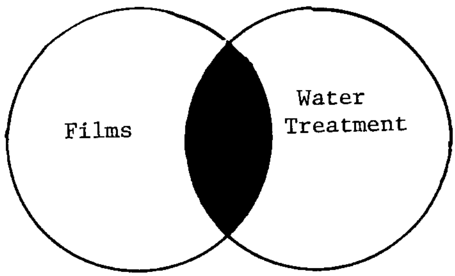
IRIS NUMBER: EW002998
a. ERIC NUMBER: ED151236
PUBLICATION DATE: SEP 77
TITLE: CHLORINATION. TRAINING MODULE 2.300.2.77.
INSTITUTION CODE: BBB08399
SPONSORING AGENCY CODE: BBB15379; FGK21436
DESCRIPTOR: *CHEMISTRY; *INSTRUCTIONAL MATERIALS; *POST SECONDARY EDUCATION; SECONDARY EDUCATION; *TEACHING GUIDES; *UNITS OF STUDY; WATER POLLUTION CONTROL; *CHLORINATION; *WASTE WATER TREATMENT; WATER TREATMENT
b. EDRS PRICE: EDRS PRICE MF-$0.83 HC-$3.50 PLUS POSTAGE
DESCRIPTIVE NOTE: 60P. FOR RELATED DOCUMENTS, SEE SE024 025-046
c. ISSUE: RIEJUL78
ABSTRACT: THIS DOCUMENT IS AN INSTRUCTIONAL MODULE PACKAGE PREPARED IN OBJECTIVE FORM FOR USE BY AN INSTRUCTOR FAMILIAR WITH CHLORINE. THE REASONS FOR CHLORINATION AND SAFE OPERATION AND MAINTENANCE OF GAS CHLORINE, DRY CALCIUM, HYPOCHLORITE AND LIQUID SODIUM HYPOCHLORITE CHLORINATION SYSTEMS FOR WATER SUPPLY AND WASTEWATER TREATMENT FACILITIES ARE GIVEN. INCLUDED ARE OBJECTIVES, INSTRUCTOR GUIDES, STUDENT HANDOUTS AND TRANSPARENCY MASTERS. THE MODULE CONSIDERS PURPOSES OF CHLORINATION, PROPERTIES OF CHLORINE, METHODS OF CHLORINATION, SAFETY, MAINTENANCE OF CHLORINATION UNITS AND INTERPRETATION OF TEST RESULTS. (AUTHOR/RH)
d. INSTITUTION NAME: KIRKWOOD COMMUNITY COLL., CEDAR RAPIDS, IOWA.
SPONSORING AGENCY NAME: DEPARTMENT OF LABOR, WASHINGTON, D.C.; IOWA STATE DEPT. OF ENVIRONMENTAL QUALITY, DES MOINES.

How to Locate Desired Materials in IRIS

Users can identify materials of interest by scanning the resume listing, or using the Subject Index, Author Index, or Institution Index in the IRIS Compilation.

The Subject Index is designed to enable the user to search for information on either a broad subject or a narrow information concern. An EW number is included for each item listed under the subject heading. The EW number refers to the abstract entry in the resume section where complete bibliographic information, an abstract of the item, and availability information can be found.

A user can also coordinate a search by checking EW numbers that appear under two or more subject headings. For example, you could check all the EW numbers under Water Treatment and all the EW numbers under Films. EW numbers included under both subject headings would include information relevant to Water Treatment that were films. EW numbers under wastewater treatment and laboratory techniques would provide a list of materials related to laboratory techniques and to wastewater treatment. Similar techniques could be used to identify other information desired.



If you desire to locate a document by the name of the author, you can use the Author Index. EW numbers are provided under the author in the Author Index as in the Subject Index. Some documents do not have a listed author. These documents are listed under the name of the institution or organization responsible for developing the document in the Institution Index. Both sources can be used to help you locate documents.

The ERIC System

Another excellent source of educational information and materials is the ERIC system. ERIC is a national information system designed and developed by the U.S. Office of Education, and now supported and operated by the National Institute of Education (NIE), for providing ready access to descriptions of exemplary programs, research, instructional materials, teaching guides, and other related information that can be used to develop effective educational programs.

There are 16 clearinghouses in the nationwide ERIC network. Each clearinghouse has responsibility for collecting and analyzing materials related to their scope.

ADULT, CAREER, AND VOCATIONAL EDUCATION
The Ohio State University
Center for Vocational Education
1960 Kenny Road
Columbus, Ohio 43210
(614) 486-3655

COUNSELING AND PERSONNEL SERVICES
University of Michigan
School of Education Building, Rm. 2108
Ann Arbor, Michigan 48109
(313) 764-9492

ELEMENTARY AND EARLY CHILDHOOD EDUCATION
University of Illinois
College of Education
805 W. Pennsylvania
Urbana, Illinois 61801
(217) 333-1386

EDUCATIONAL MANAGEMENT
University of Oregon
Eugene, Oregon 97403
(503) 686-5043

HANDICAPPED AND GIFTED CHILDREN
Council for Exceptional Children
1920 Association Drive
Reston, Virginia 22091
(703) 620-3660

HIGHER EDUCATION
George Washington University
One Dupont Circle, Suite 630
Washington, DC 20036
(202) 296-2597

INFORMATION RESOURCES
Syracuse University
School of Education
Syracuse, New York 13210
(315) 423-3640

JUNIOR COLLEGES
University of California at Los Angeles
Powell Library, Room 96
Los Angeles, California 90024
(213) 825-3931

LANGUAGES AND LINGUISTICS
3520 Prospect St., N.W.
Washington, DC 20007
(202) 298-9292

READING AND COMMUNICATION SKILLS
National Council of Teachers of English
1111 Kenyon Road
Urbana, Illinois 61801
(217) 328-3870

RURAL EDUCATION AND SMALL SCHOOLS
New Mexico State University
Box 3AP
Las Cruces, New Mexico 88003
(505) 646-2623

SCIENCE, MATHEMATICS, AND ENVIRONMENTAL EDUCATION
The Ohio State University
1200 Chambers Road, Third Floor
Columbus, Ohio 43212
(614) 422-6717

SOCIAL STUDIES/SOCIAL SCIENCE EDUCATION
855 Broadway
Boulder, Colorado 80302
(303) 492-8434

TEACHER EDUCATION
American Association of Colleges for Teacher Education
One Dupont Circle, NW, Suite 616
Washington, DC 20036
(202) 293-7280

TESTS, MEASUREMENT, AND EVALUATION
Educational Testing Services
Princeton, New Jersey 08541
(609) 921-9000, ext. 2176

URBAN EDUCATION
Box 40
Teachers College, Columbia University
525 W. 120th Street
New York, New York 10027
(212) 678-3437

PART II

INSTRUCTIONAL UNITS

Activated Sludge

Activated sludge may be defined as a biological wastewater treatment process in which a mixture of wastewater and biological floc (microorganisms) is mixed and aerated for the purpose of converting non-settlable dissolved and colloidal material to a settleable form. The biological floc is then removed from the treated wastewater by sedimentation and returned to the process as needed or wasted.

The activated sludge process compresses, in both time and space, aerobic biological reactions which occur naturally in streams. This naturally occuring process of decay may, however, take several hours or even days in a receiving water and is often accompanied by undersirable effects such as: low dissolved oxygen (DO), septicity, odors, deposition of solids, etc. By concentrating the proper microorganisms, providing an adequate oxygen supply, a settling tank to concentrate the microorganisms and provisions for returning them to the process, smaller volumes and shorter detention times may be used to complete the biological reactions.

The objective of the activated sludge process is to convert non-settleable biodegradable pollutants to settleable solids thereby producing a clarified effluent low in total suspended solids (TSS) and biochemical oxygen demand (BOD). This is accomplished by microorganisms utilizing the organic material in the wastewater for both energy and new cell mass. Microorganisms, however, can use only soluble organics which readily pass through their cell membrane. Suspended particles must first be absorbed onto the surface of the bacterium cell and then broken down by enzymes before they can be absorbed into the cell and metabolized. The biological reactions associated with metabolism stabilize the waste by conversion of biodegradable organics to new cell mass and the waste products of carbon dioxide (CO_2) and water (H_2O). Both sorption reactions require intimate contact between the wastewater and the activated sludge. Adsorption takes place quickly and is usually completed in 30 minutes or less while absorption takes place much more slowly (4 - 12 hours).

Microorganisms reproduce by a mechanism known as binary fission. If an unlimited supply of food is available and the proper amount of nutrients are available the microorganisms will reproduce at a very rapid rate. This is called the log growth phase. Several factors affect the rate at which growth occurs. Among these are: temperature, pH, type of food, nutrients present, species of microorganisms, and toxic substances. The growth rate decreases as food becomes limiting. This phase is known as the declining growth phase. In the endogenous phase the energy requirement (or that energy energy needed to maintain life functions and cell integrity) exceeds the externally available food source. When this happens the microorganism begins to break down non-essential intracellular components in an effort to maintain vital life functions.

The activated sludge system is a complex aerobic biological wastewater treatment process that requires diligent and consistent process control to maintain process equilibrium and final effluent quality. Numerous techniques and strategies for managing these systems have been proposed and used.

Activated Sludge Processes

A typical flow schematic for the conventional activated sludge process is shown in Figure 1. The aeration basin provides space for contact between the wastewater, microoganisms, and oxygen. It also provides detention time which allows the microogranisms to assimilate the organic materials in the wastewater. An air supply system (diffused or mechnical) supplies oxygen to keep the basin aerobic and also provides mixing energy to keep the microorganisms dispersed throughout the tank.

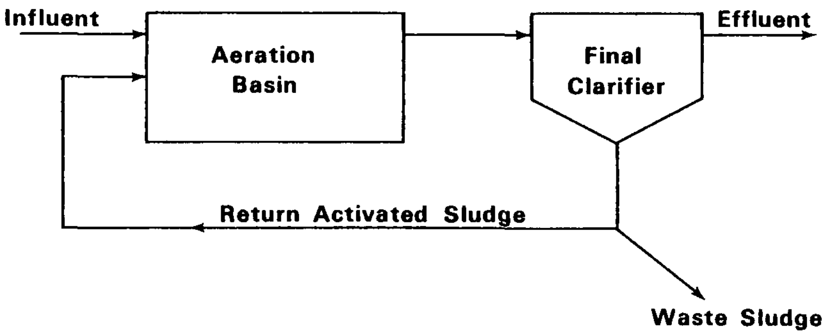


Figure 1 - **CONVENTIONAL**

The final clarifier follows the aeration tank in the conventional activated sludge process. This unit provides space, time and quiescent flow conditions to permit the suspended solids to separate from the mixed liquor to produce a clarified supernatant and a concentrated blanket of activated sludge solids. Most of the settled solids are then returned to the aeration tank. However, since the activated sludge tends to accumulate in the system a portion of the clarifier sludge must be removed from the system and "wasted" to the sludge handling system for treatment and disposal. This excess sludge is known as waste activated sludge.

Over the years, several variations of this conventional system have evolved, the most common being: tapered aeration, step-feed, contact stabilization, and complete-mix activated sludge. The tapered aeration process provides a greater amount of air at the head end of the aeration basin to help satisfy the greater oxygen demand that exists there. Less air is supplied at the outlet end of the basin where most of the oxygen demand has already been satisfied.

The principle of step-aeration is to distribute the incoming wastewater load the length of the aeration basin. Step-feed (Figure 2) would probably be a more accurate description of this process since multiple feed locations spread the oxygen demand over more of the basin resulting in a more efficient use of the oxygen.

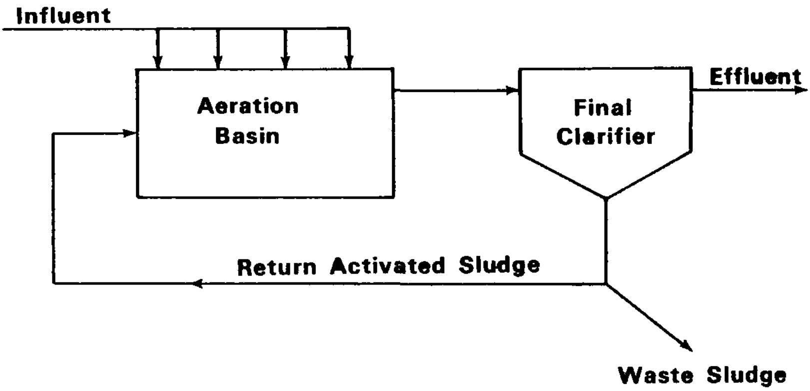


Figure 2 - **STEP AERATION**

Contact-stabilization (Figure 3) can be thought of as an extreme of the step-aeration process. In this variation only return activated sludge would be aerated most of the tank length with the wastewater being added near the end. There the wastewater is mixed briefly with the activated sludge to allow the organic waste to be adsorbed onto the biological floc.

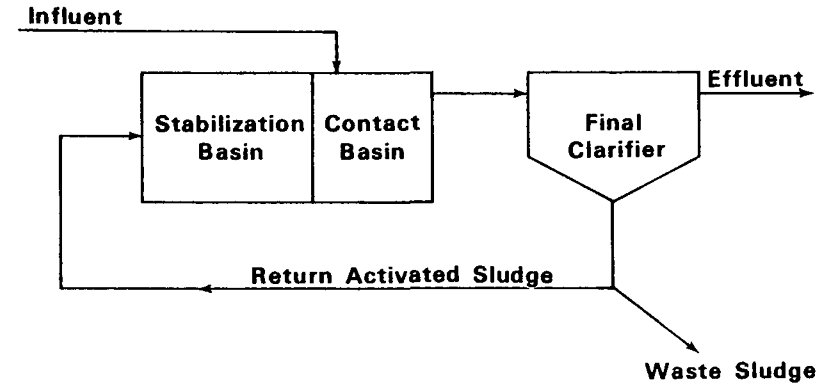


Figure 3 - **CONTACT STABILIZATION**

The sludge is settled out in the clarifier and returned to the stabilization tank where it is aerated for a longer time to permit the bacteria to break down the adsorbed organics. The contact-stabilization process offers several advantages over conventional activated sludge including reduced tank volumes, high sludge inventories and the benefits of a sludge buffer during times of hydraulic overload.

Complete mix (Figure 4) activated sludge provides some protection against shock loads by dispersing the influent load along the entire length of the aeration tank.

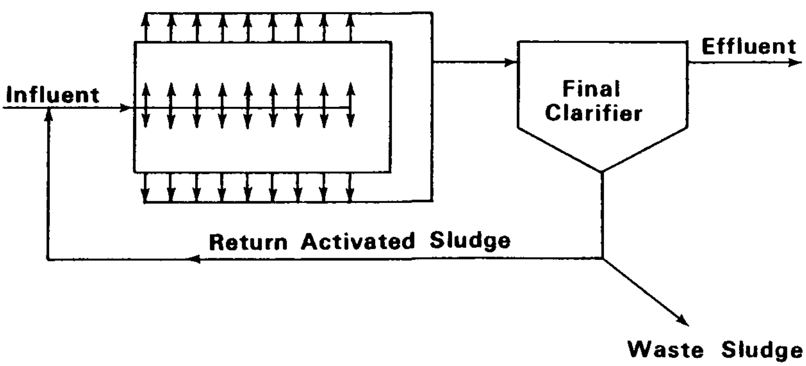


Figure 4 - **COMPLETE MIX**

The process flow diagram for extended aeration is essentially the same as that for conventional activated sludge except these plants usually have no primary treatment and the aeration basin is sized for an 18-24 hour detention period rather than the 6-8 hour period common for conventional plants. The long aeration period and high sludge age associated with these plants produces a nitrified effluent and a stable, rapidly settling, partially digested sludge.

Another variation of the activated sludge process which is gaining in popularity in the U.S. is the oxidation ditch. Originally developed in Europe it is essentially an extended aeration plant with a "race track" configuration. Surface type aerators are used to provide aeration and circulation around the ditch.

Recently, high-purity oxygen has come into widespread use as a substitute for air in the activated sludge process. To prevent the loss of oxygen to the atmosphere these aeration basins are usually covered and the oxygen recirculated through several stages. Mixing is accomplished either with surface mechanical aerators or submerged rotating spargers. Because of the enhanced oxygen transfer much smaller tanks can be designed.

The purpose of the final clarifier is to separate activated sludge solids from the liquid stream and to concentrate these solids before they are returned to the process. The final clarifier may be operated as a solids storage reservoir or with a constant solids inventory.

As discussed earlier, several factors affect the activated sludge process. Some of the more important factors are: the microorganisms, the incoming food, temperature, detention time, nutrients and toxic substances. The operator of an activated sludge facility usually has direct control of the recycle rate, the wasting rate and the air input. In addition to these controllable variables the operator also has limited control over the volume under aeration, the incoming wastewater (through sewer use control) and can use chemical additives for improved settleability.

Whatever control strategy is used, the objectives should be to: control the solids inventory, control the distribution of solids between the clariifer and the aeration basin and to control the sludge aeration time. Some of the better known control strategies are based on food to microorganism ratio (F/M), mean cell residence time (MCRT), constant-mixed liquor suspended solids, respiration rate and sludge settleability. There is no universal number for these parameters that will work for every plant. The best value to be used for process control must be determined for each plant individually. There is also no single parameter which will tell the operator the complete story. The operator must combine information from several parameters to get the complete picture necessary for accurate process control decisions.

SAMPLES OF ACTIVATED SLUDGE TRAINING MATERIALS

Training Sample 1
"Process Start-Up Procedures"
Chapter 7, Lesson 4
Operation of Wastewater Treatment Plants: A Field Study Training Program
Kerri, K. D.
Sacramento State College
Department of Civil Engineering
1970

General

Procedures for starting the activated sludge process are outlined in this lesson. An initial average daily flow of 4.0 MGD will be assumed; and the plant will be operated as a conventional activated sludge plant.

Start-up help should be available from the design engineer, vendors, nearby operators, or other specialists. During start-up the equipment manufacturers should be present to be sure that any equipment breakdowns are not caused by improper start-up procedures.

The operator may have several options in the choice of start-up procedures with regard to number of tanks used and procedures to establish a suitable working culture in the aeration tanks. The method described in this lesson is recommended because it provides the longest possible aeration time, reduced chances of solids washout, and provides the opportunity to use most of the equipment for a good test of its acceptability and workability before the end of the warranty.

First Day

First, start the air blowers and have air passing through the diffusers before primary effluent is admitted to the aeration tanks. This prevents diffuser clogging from material in the primary effluent.

Fill both aeration tanks to the normal operating water depth, thus allowing the aeration equipment to operate at maximum efficiency. Employing all of the aeration tanks will provide the longest possible aeration time. You are trying to build up a population with a minimum amount of seed organisms, and you will need all the aeration capacity available to give the organisms a chance to reach the settling stage.

When both aeration tanks have been filled, begin filling the two secondary clarifiers. Use of all the secondary clarifiers will provide the longest possible detention time to reduce washout of light solids containing rapidly growing organisms and will help enhance solids build-up.

When the secondary clarifiers are approximately three-fourths full, start the clarifier collector mechanism and return sludge pumps. Return sludge pumping rates must be adjusted to rapidly return the solids (organisms) back to the aeration tanks. The solids should never remain in the secondary clarifiers longer than 1.5 hours. Trouble also may develop if the return sludge pumping rate is too high (greater than 50% of the raw waste-water flow), because the high flows through the clarifier may not allow sufficient time for solids to settle to the bottom of the clarifier. A conventional activated sludge plant usually operates satisfactorily at return sludge rates of 20 to 30 percent of raw wastewater flow, but the rate selected should be based upon returning organisms back to the aerator where they can treat the incoming wastes. A thin sludge will require a higher return percentage than a thick one. Addition of a coagulant or coagulant aid at the end of the aeration tank will hasten solids build-up and improve effluent during start-up.

When the secondary clarifiers become full and begin to overflow, start effluent chlorination to disinfect the plant effluent.

Filling the aeration tanks and aerating the wastewater starts the activated sludge process. The aerobes in the aeration tank have food and are now being supplied with oxygen; consequently, this worker population will begin to increase.

After two or three hours of aeration you should check the dissolved oxygen (DO) of the aeration tanks, to determine if sufficient air is being supplied.

Check the DO at each end and at the middle of the aerator. Oxygen must be available for the aerobes throughout the tank. If the DO is less than 2.0 mg/l, increase the air supply. If the DO is greater than 2.0 mg/l the air supply may be decreased, but not to the point where the tank would stop mixing. There will probably be an excess amount of DO at first due to the limited number of organisms initially present to use it.

The effluent end of the aerator should have a dissolved oxygen level of 2.0 mg/l. DO in the aerator should be checked every two hours until a pattern is established. Thereafter, DO should be checked as frequently as needed to maintain the desired DO level. Daily flow variations will create different oxygen demands; and until these patterns are established, it is not known whether sufficient or excess air is being delivered to the aeration tanks. Frequently excess air is provided during early mornings when the inflow waste load is low. Air supply may be too low during the afternoon and evening hours because the waste load tends to increase during the day.

Second Day

Collect a sample from the aeration tank and run a 60-minute settleability test using a 1000 ml graduated cylinder. If possible, use a 2000 ml cylinder with a five-inch diameter in order to obtain better results. Observe the sludge settling in the sample for approximately one hour. It will probably have the same color as the primary effluent during the first few days. After a few minutes in the cylinder, very fine particles will start forming with a light buff color. The particles remain suspended, not settling, similar to fine particles of dust in a light beam. After an hour, a small amount of these particles may have settled to the bottom of the cylinder to a depth of 10 or 20 ml, but most are still in suspension. This indicates that you are making a start toward establishing a good condition in the aeration tank, but many more particles are needed for effective wastewater treatment.

Third through Fifth Days

During this period of operation the only controls applied to the system usually consist of maintaining DO concentrations in the system and maintaining proper sludge return rates. A sampling program should be started to develop and record the necessary data required for further plant control.

Aeration of wastewater to maintain DO will require some time before settling will produce a clear liquid over the settled liquids. Time is required for organisms to grow to the point where there are sufficient numbers to perform the work needed--to produce an activated sludge. Usually within 24 to 72 hours of aeration you will note that the settleable solids do not fall through the liquid quite so rapidly, but the liquid remaining above the solids is clearer.

The active solids (organisms) are light and may wash out of the clarifier to some extent. Hopefully you can retain most of them, because a rapid solids build-up will not occur unless they are retained. A good garden soil will add organisms and solids particles for start-up. Mix the soil with water and hose in the lighter slurry, but try to avoid a lot of grit. A truckload of activated sludge from a neighboring treatment plant also will help to start the process. Hopefully you will not have to treat design flows during plant start-up. More time is needed both for aeration and clarification until you have collected enough organisms in you return sludge to enable you to produce a clear effluent after a short period of mixing with the influent followed by settling.

Sixth Day

A reasonably clear effluent should be produced by the sixth day. Solids build-up in the aeration tank should be closely checked using the 60-minute settleable solids test during the first week. Results of this test indicate the flocculating, settling, and compacting characteristics of the sludge. Suspended solids build-up is very slow at first but increases as the waste removal efficiency improves. This build-up should be carefully measured and evaluated each day.

To obtain an indication of the size of the organism population in the aeration tank, the solids are measured either in mg/l or in pounds of dry solids. Suspended solids determinations for aerator mixed liquor will give the desired information in mg/l, and the total pounds of solids may be calculated on the basis of the size of the aerator.

Total Susp. Solids, lbs = Suspended Solids, mg/l x Aerator Volume, MG x 8.34 lbs/gal

The suspended solids test conducted on activated sludge plant mixed liquor is normally a grab sample obtained at the effluent end of the aerator. The sample should be collected at the same time every day, preferably during peak flows, in order to make day-to-day comparisons of the results. Collect the mixed liquor sample approximately five feet from the effluent end of the aeration tank and 1.5 to 2 feet below the water surface to insure a good sample. A return sludge sample also should be collected at this time every day to determine its concentration.

With information from the lab tests, estimates of the organism mass (weight) in the aerator can be calculated.

Information Needed:

1. Aeration Tank Dimensions

   100 ft long, 45 ft wide, and 16.5 ft deep

2. Results of Laboratory Tests

   Mixed Liquor Suspended Solids, 780 mg/l

Steps to calculate pounds of solids in aeration tank:

1. <u>Determine aeration tank volume</u>.

   Aerator Volume, cu ft = Length, ft x Width, ft x Depth, ft

   = 100 ft x 45 ft x 16.5 ft

   = 74,250 cu ft

2. Convert cu ft to gallons.

Aerator Volume, gals = 74,250 cu ft x 7.48 gals/cu ft

= 555,390 gals

or = 555,000 gals (approximately)

or = 0.55 MG

3. Calculate pounds of solids under aeration.

Formula:

Solids lbs, = Mixed Liquor Suspended Solids, mg/l x Aerator Volume, MG x 8.34 lbs/gal

$$= \frac{780 \text{ mg}}{1{,}000{,}000 \text{ mg}} \times 0.55 \text{ M Gals} \times 8.34 \text{ lbs/gal}$$

$$= \frac{780 \text{ mg}}{\text{M mg}} \times 0.55 \text{ M Gals} \times 8.34 \text{ lbs/gal}$$

= 780 x 4.6* lbs.

= 3588 lbs

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*The factor 4.6 lbs is equivalent to 0.55 x 8.34, a constant for your plant. You will use this value every day as long as you use the same aeration tank capacity. Only a change in the suspended solids concentration will cause a change in the pounds of solids in the aeration tank.

Close observation of the suspended solids build-up and results from the 60-minute settleability test will indicate the solids growth rate, condition of solids in aerator, and how much sludge should be returned to insure proper return of the organisms to the aerator. It will be necessary to return all of the sludge for 10 to 15 days or longer if the wastewater is weak.

Results from the 60-minute settleability test can be used to estimate if the return sludge rate is too high or too low. If the volume of settle sludge in the cylinder is indicative of amount of sludge settling in the secondary clarifier, the volume of return sludge should be equal to or slightly greater than the percentage of settling sludge in the cylinder multiplied by the sum of the primary effluent and the return sludge flows.

Estimate the return sludge pumping rate.

Information needed:

1. Flow to Aerator from Primary Clarifier, 4.0 MGD

2. Return Sludge Flow, 1.0 MGD

3. Volume of Mixed Liquor Solids Settled in 60 Minutes, 360 ml in 2 liters, or 18%

Example:

Flow to Aerator from Primary Clarifier	=	4.0 MGD
Return Sludge Flow to Aerator	=	1.0 MGD
Total Flow through Aerator	=	5.0 MGD

Return Sludge Rate, MGD = Aerator Flow, MGD x Settleable Solids, %

= 5.0 MGD x 0.18

= 0.9 MGD or 900,000 gals/day

Return Sludge Rate, GPM $= \frac{900,000 \text{ GPD}}{1440 \text{ min/day}}$

= 625 GPM

Therefore, the initally selected 700 GPM return sludge rate is acceptable at this time. It insures that most solids are being returned to the aeration tank. A return sludge pumping rate slightly higher than calculated is recommended to return the organisms as fast as possible to the aerator. Too high a return sludge rate must be avoided because the resulting high flows reduce the detention time in the aerator and secondary clarifier.

If the return sludge rate is too low, the following undesirable conditions may develop:

1. Insufficient organisms will be in the aerator to treat the influent waste (food) load. This normally occurs during the first week or two of start-up.
2. Too long a detention time in the secondary clarifier could allow the sludge to become septic.
3. Accumulation of sludge in the clarifier creates a deep sludge blanket which will allow solids to escape in the effluent.

Questions

1. When and where should solids samples be collected to provide the operator with a record of solids build-up in the aeration tank?
2. Determine the pounds of solids in an aeration tank with a volume of 0.25 MG and a Mixed Liquor Suspended Solids (MLSS) concentration of 640 mg/l.
3. Estimate the return sludge pumping rate (GPM) if the plant inflow is 2.0 MGD and the return sludge flow is 0.5 MGD. The results of the 60-minute settleability test indicate the volume of solids settled to be 340 ml in 2 liters, or 17%.
4. When starting a new activated sludge plant, who might the operator contact for assistance and advice?
5. When starting the activated sludge process, why should you use all of the aerators and all of the secondary clarifiers?
6. What are the essential laboratory tests for starting the activated sludge process, and why?

Training Sample 2
"Interactions of Activated Sludge with other Unit Processes."
ACTIVATED SLUDGE PROCESS CONTROL COURSE
GMP ENVIRONMENTAL ENGINEERS, INC.,
1115 Terminal Tower
Cleveland, Ohio 44113
One of several modules contained within the whole course package.

LESSON TITLE: Process Interaction
Estimated time: One hour
Prerequisites for this lesson: Initial certification as a Wastewater Treatment Plant Operator

PERFORMANCE OPJECTIVES:

Trainees will be able to:

1. Identify the unit processes contributing to the solids and BOD loading in an activated sludge plant.

2. Identify the streams that provide an exit for sludge solids to be removed from the plant.

JUSTIFICATION:

Operator awareness of the feedback effect of the sludge handling unit processes on activated sludge is important.

INSTRUCTIONAL RESOURCES:

Trainee Manual
Slides and other visuals

INSTRUCTOR ACTIVITIES:

1. Review and organize the slides and audio visuals. Point out high concentrations of BOD and SS in these streams. Assess the recycle stream contributions to plant solids and BOD loadings, compared to raw sewage using appropriate visuals.

2. Review scenarios of wasted sludge getting back to Activated Sludge. Use visuals to show the limited possibilities for sludge solids to be actually removed. If the solids can't be removed by those routes, then the inventory piles up in the plant and interferes with the Activated Sludge process.

3. Discuss guidelines to reduce the effects of recycle streams on the activated sludge process.

a. Avoid pumping thin sludges to sludge handling unit processes.

b. Improve efficiency of sludge handling unit processes.

c. Pretreat recycle streams to reduce the loadings.

d. Be sure to meter and sample the actual influent to the activated sludge process, after all recycle streams from other unit processes have been added.

TRAINEE MANUAL SECTION

Introduction

The accompanying Figure 1 shows the potential for interaction between activated sludge and other unit processes, including thickening, stabilization and dewatering. Places where sludge solids can truly be wasted in the plant are shown by arrows. Direct wasting by landfill disposal or export to another plant is possible only in a few plants. Volatile solids reduction in the stabilization process is another important exit. Dewatered and dried solids are the two best ways for sludge handling unit processed to remove solids.

If the sludge handling unit processes fail, then the solids will inevitably return to the wet stream and eventually work their way out as undesirable solids and organic loading in the final effluent. (A sample scenario is included.) But there are interactions, even when the other unit processes operate normally.

EFFECTS OF SLUDGE HANDLING UNIT PROCESSES ON ACTIVATED SLUDGE

Sludge handling unit processes can add greatly to the loading of the Activated Sludge process through recycle streams that contain high concentration or organics and high solids. Recycle streams (Table 1) of this type include the supernatants from anaerobic digestion, heat treatment or aerobic digestion; the centrate from centrifugation; the filtrate from vacuum filtration; and the supernatant from thickening. Some of these processes are run only one or two shifts per day, and not every day. So the way that the sludge handling unit processes are operated can result in shock loading for the Activated Sludge process, depending on how they spread out the loads. (Loadings that are possible with some of the more common treatment schemes are shown in the accompanying Tables.)

The ideal thing for overall plant efficiency would be to have intermediate storage, so that the loadings from the recycle streams could be programmed to even out the overall daily loading cycle for the plant influent. Some new plants provide a separate treatment for the heavily loaded recycle streams, so that they do not interfere with the activated sludge process.

WHERE SLUDGE CAN BE WASTED

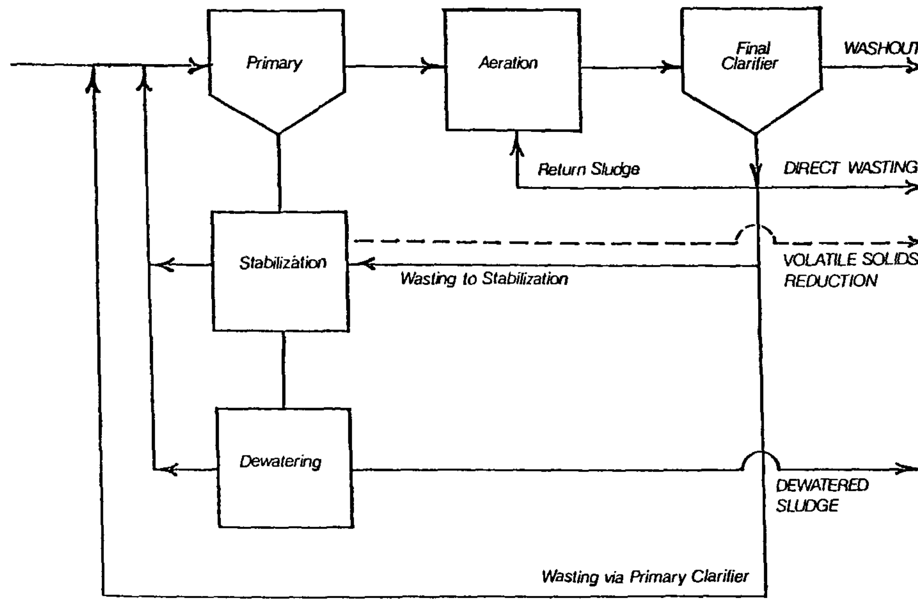


Figure 1

TABLE 1 - CHARACTERISTICS OF RECYCLE STREAMS (mg/liter)

	TS	SS	VSS	BOD	COD
Anaerobic Digestion					
low rate supernatant	4,000-5,000	2,000-3,000	650-3,000	2,000-3,500	
high rate supernatant	10,000-14,000	4,000-6,000	2,400-3,800	6,000-9,000	
Aerobic Digestion					
supernatant		50-11,500		900-1,700	230-8,100
Heat Treated Sludge					
supernatant	100-20,000			5,000-15,000	10,000-30,000
Centrate	10,000				
Filtrate		500-2,000			

Reference: "Process Design Manual for Sludge Treatment and Disposal" U.S. Environmental Protection Agency, Center for Environmental Research Information Technology Transfer, September 1979, EPA 625/1-79-011.

TABLE 2

LOADINGS OF RECYCLE STREAMS COMPARED TO RAW SEWAGE

Conventional Activated Sludge Plant
With Anaerobic Digestion

	BOD	SS	Flow
Digester Supernatant	10.1%	10.7%	continuous
Filtrate		1.7%	1-2 $\frac{\text{shifts}}{\text{day}}$
Centrate		13.0%	1-2 $\frac{\text{shifts}}{\text{day}}$

TABLE 3

LOADINGS OF RECYCLE STREAMS COMPARED TO RAW SEWAGE

Conventional Activated Sludge Plant
With Aerobic Digestion

	BOD	SS	Flow
Digester Supernatant	1.7%	9.1%	continuous
Filtrate		1.7%	1-2 $\frac{\text{shifts}}{\text{day}}$
Centrate		13.0%	1-2 $\frac{\text{shifts}}{\text{day}}$

TABLE 4

LOADINGS OF RECYCLE STREAMS COMPARED TO RAW SEWAGE

Conventional Activated Sludge Plant
With Sludge Heat Treatment

	BOD	SS	Flow
Heat Treatment Supernatant	48%	48%	continuous
Filtrate		1.2%	1-2 $\frac{\text{shifts}}{\text{day}}$
Centrate		9.5%	1-2 $\frac{\text{shifts}}{\text{day}}$

EFFECTS OF ACTIVATED SLUDGE ON OTHER UNIT PROCESSES

Wasting from the activated sludge process has a definite effect on sludge handling unit processes. If the waste sludge is too thin (low RSC), it can cause hydraulic overloading of thickening and stabilization processes. This will eventually come back to haunt the activated sludge, in the form of high solids and organic loadings in the recycle streams.

Problems in the sludge handling unit processes can limit your freedom to operate the Activated Sludge process in the best way possible. You may be forced to accumulate sludge in the activated sludge process even when it is desirable to waste, because the sludge handling unit processes are temporarily unable to take additional load. For example, a digester failure may force you to postpone scheduled wasting.

Some plants do not have sludge handling facilities on site. These plants waste directly, either to disposal by landfill or by transfer to another plant via a force main or tank truck. These plants export not only their sludge, but also the problems due to interactions of the activated sludge process with other unit processes.

SLUDGE QUALITY CONTROL

How can you account for the loading on the activated sludge process due to the recycle streams? The formulas used for sludge quality control allow you to do that. For example, AFI is the total influent to the activated sludge process, not just the primary effluent. You should monitor that stream to determine its flow rate, solids concentration and diurnal cycling.

SCENARIO FOR SOLIDS RECYCLE
OR, WHEN IS WASTING NOT REALLY WASTING?

Assume that the plant operator has determined that wasting is really the only way the plant is controlled - that everything else relates to operation, not real control. Further assume that he has established a wasting scheme consistent with loading on the plant, aeration capacity, etc. In the normal plant then, all that should remain is to monitor the flow meters and make solids analyses on the waste sludge to confirm that the desired amount has actually been "wasted." Simple enough, and accurate, provided the following example situation does not arise!

In many plants, particulary smaller plants with limited staff and limited construction funds, waste activated sludge is directed back to the head of the plant to be removed and blended with the primary sludge for subsequent processing. If plant staffing allows only 8 to 12 hours per day coverage, all operational, laboratory and maintenance tasks must be done during this time, including wasting.

Unfortunately, the wasting period coincides with the highest flow rates, with the result that solids wasted to the primary clarifiers are often carried through them with little or no removal of the waste activated sludge solids. These solids then are recycled back into the activated sludge system to be "wasted" again the next day. However, the next day's wasting will have to include this recycle plus the waste solids generated from the current day's BOD and SS removals.

Many plants are operated by wasting a constant volume of return activated sludge on a daily basis. In such a case, the excess recycle would not be wasted, and if control of MLTSS is by return sludge pumping rate, these solids will accumulate in the final clarifier. Assume, for purposes of illustration, that these recycled "wasted" solids occupy approximately one foot in the clarifier. Then for each day that wasted solids are in fact merely recycled through the system, one foot of new sludge blanket develops in the final clarifier. The return slow flow rates could be increased to remove the blanket, but in that case the MLTSS (and MCRT) will increase. Thus, two days "wasting" will produce a 2-foot blanket; a week's recycle produces a 7-foot blanket; and so on, until aerators and clarifiers are both filled with sludge. At which point, everything else being constant, the final clarifiers will "bulk."

This, of course, is not true bulking but is merely the result of the clarifier being full of solids which have no place to go other than over the final effluent weirs. The reason why a true bulking sludge is washed out over the effluent weirs is related to the inherent properties of the sludge itself, not to the fact that the tank has been filled with solids thought to have been wasted.

No amount of "blast wasting" through the primaries during high flow periods can possibly be effective in solving the problem of recycled waste activated sludge. An alternate method of disposal, perhaps as simple as wasting during periods of low flow, must be found. Once found, it must be adhered to rigorously, even after the excessive "circulating inventory" has been reduced to manageable levels.

Similar scenarios can be developed for digesters, decant tanks, mechanical dewatering devices, ash classifiers, etc. The point to be made, emphasized and clearly understood is this:

> Solids are truly wasted <u>only</u> when they or their residues have been physically removed from the plant, with no connection which would allow their being recycled back to the wet stream in any form. In simpler form: Once solids in any form have entered the plant in the raw flow, there are only two places they can go: Out the gate or into the river.

Training Sample 3
"Problems Caused by Industrial Waste"
BASIC SEWAGE TREATMENT OPERATION
Topic 5
Ministry of the Environment
Toronto, Canada
1978

SUBJECT: 1 - Sewage Treatment Operation

TOPIC: 5 - Problems Caused by Industrial Waste

OBJECTIVES: The trainee will be able to

1. List 8 features of a sewer-use by-law.

2. List 7 causes of problems at the treatment plant due to industrial wastes.

3. List 6 possible causes of problems in sewers due to industrial wastes.

PROBLEMS CAUSED BY INDUSTRIAL WASTES IN SEWERS AND SEWAGE PLANTS

General

Most sewage treatment plants have experienced the problems that can be caused by industrial wastes. In fact, life would be very simple if it were not for the occasional slugs of grease that send personnel scurrying for skimming buckets. Plant operation is easy under ideal operating conditions, but foresight and ingenuity are required to prevent problems, such as those resulting from industrial wastes, without upsetting the entire plant.

Sewer-use by-law

To control the quality of the waste flows being discharged to the sanitary system, a municipality usually enacts a sewer-use by-law, based on a model by-law published by the Ontario Ministry of the Environment. If the industries comply with this by-law, there should be no problems in the sewers or at the plant. The important features of such a by-law are that discharges must comply with certain standards for

1. Temperature

2. pH

3. Organic loading as measured by the 5-day biochemical oxygen demand (BOD-5)

4. Suspended solids

5. Toxic materials such as

   a. cyanide as HCN
   b. phenols
   c. sulphides as H_2S
   d. metals

6. Oils and greases or those substances soluble in ether

   a. of mineral origin
   b. of animal or vegetable origin

7. There must be insignificant amounts of explosive, inflammable and/or radioactive materials present.

8. Flow volumes must not result in hydraulic overloading of the system.

The effect of any one industrial discharge on the entire sewage flow will depend on their relative volumes. As most industrial wastes can be treated with domestic sewage in municipality treatment plants, it may be possible for a municipality to accept and treat wastes that do not comply with the by-law limits without upsetting the operation of the sewage treatment plant. The municipality may wish to supply this additional service at no extra charge, or they may require a special agreement with the industry and additional money for this service. Normally, there is a section in the by-law that provides for this agreement. In order that the municipality may decide how to handle any particular situation, they must know the probable effect of any waste flow on their sewers and sewage treatment plant.

An Industrial Point of View

An industry views the treatment and disposal of its wastes as a matter of economics. It expects and deserves treatment of flows within the by-law limits for the normal sewer rate charge. If the municipality will accept a higher strength waste for a sum less than that needed to pretreat the wastes to by-law limits, it is good business for the industry to use this method of disposal. Many times, the full strength waste cannot be treated at the municipal plant. It is then up to the industry to pretreat to a level which is acceptable to the municipality. It is quite often easier to remove contaminants from a waste flow at the source within the industry, and this should be done where possible.

POSSIBLE PROBLEMS

Sewers

The problems that may be anticipated in sewers from flows not in compliance with sewer-use by-laws may be outlined under the following headings:

1. Flows - Excessively fluctuating flows may overload the hydraulic capacity of a sewer and cause backing up of sewage into basements, or overflowing at pumping stations.

2. Temperature - The higher the temperature of a waste discharge, the greater the biological activity in the sewer (rate doubles for every $10^{\circ}C$ rise). Thus the oxygen supply is quickly depleted and septic conditions occur. Also, high temperatures speed up corrosion and place thermal stresses on the sewer pipes and joints.

3. Suspended Solids - May settle in the sewers and cause blockage.

4. pH - Variance beyond the acceptable limits will result in corrosion of the sewer.

5. Oils and greases will build up on the inside of the lines and reduce the sewer capacity.

6. Dissolved Salts - Certain dissolved salts may precipitate out in the sewers and lead to blockages and/or corroding conditions.

Sewage Treatment Plant

More important, however, is the effect of industrial waste discharges on the operation of the sewage treatment plant. First the symptoms must be recognized; then the type and extent of the problem diagnosed and the effect it will have, or has had, on the various processes must be assessed. Finally, and most important, quick remedial action must be taken to offset the changing conditions. Following are comments on characteristics of industrial waste discharges of concern to a sewage plant operator, and relating to the detection and effect on the (a) primary section and (b) biological processes, as well as the corrective action to be taken.

1. <u>Flow</u> - Excessive or surging flow conditions may be noted on the flow measuring devices within the plant or simply by noting the level of the flow on the walls of the channels. High flow rates tend to flush the tanks out, thus affecting the detention times and the

treatment provided. Little can be done to ease this condition at the sewage plant; it should be corrected at the industry where the flows may be equalized.

2. Temperature - The rate of biological activity increases with temperature in a waste flow and the resulting septic conditions may be noted by the smell and low dissolved oxygen content of the raw sewage at the plant. A septic sewage will cause septicity in the primary clarifiers and exert an increased oxygen demand in the secondary biological section. The action required in this case would be to pre-aerate or pre-chlorinate the raw sewage flow.

3. pH - A waste with a pH value outside of the accepted range (6.5 - 8.5), besides creating corrosive problems throughout the plant, will tend to reduce the settling and biological processes. This condition may be noted by checking the waste flow with pH paper at regular intervals. Again, little can be done at the plant. The situation should be corrected by having the industry neutralize its wastes before discharge.

4. Organic Loading (Biochemical Oxygen Demand - BOD) High strength industrial discharges will show up in the 5-day BOD test, but this does not help the operating personnel concerned with operating conditions at any given moment. These high strength wastes can usually be spotted by an unusual colour (eg. red; indicating blood, dye, etc.), smell (eg. a putrid smell because of the rapid depletion of oxygen in the sewer lines) or the inclusion of tell-tale solids (feathers, hair, etc.). If the high strength is due mainly to dissolved components, it will have little effect on the primary treatment process but will create a high oxygen demand and extreme sludge growth in the secondary biological section. If a significant amount of suspended material is included in the high strength waste, additional quantities of sludge will accumulate in the primary tanks and the digesters may be taxed beyond capacity. The action that should be taken at the plant would include carrying a higher concentration of solids and air in the aeration section and the possible addition of alkaline materials to the digesters as well as additional hauling of digested sludge so that a correct environment may be maintained for the anaerobic decomposition process.

5. Suspended Solids - This characteristic of the waste flow is one of the most recognizable. Usually a close examination with the naked eye will reveal unusual conditions which should be taken into account. The majority of the particles in suspension should settle out in the primary settling tanks. While most will be controllable by anaerobic treatment, some particles such as clay, chicken beaks, hair and bark will decompose very slowly, using additional digester capacity. Adjustment in digester operation as well as cleaning of the digesters may be required if these solids are allowed to get through the preliminary screening devices.

6. Toxic Materials - Toxic materials such as copper, chromium, phenols, etc., may be difficult to detect in the raw sewage if they are present in low concentrations. Should either the aerobic or anaerobic biological section be upset, however, laboratory analysis is required to confirm any suspicion in this regard. Higher solids could be carried in the aeration section to help in preventing an upset.

7. Oils and Greases - These ether soluble materials will usually come to the surface in the grit tanks and primary clarifiers, making their presence obvious. If they can be skimmed, either by means of the regular skimming facilities or manually, these materials should be of little concern.

Note: In most cases, sophisticated laboratory equipment is not a necessary part of good sewage plant operation. More important is the ability of the operator to adapt his thinking to the situation at hand and to take proper remedial action.

Resourceful plant personnel will not only provide good plant operation, but will also note the time and conditions of any upsets at the plant. An attempt should be made to determine the section of the sewer system from which the upsetting discharge came and to define as closely as possible the problem industry. Armed with this information, the municipal officials, after investigating conditions at the industries in the area, should be able to locate the culprit and thus be in a position to enforce their sewer-use by-law.

Training Sample 4
"Activated Sludge Process Control: Phosphorus Removal"
ACTIVATED SLUDGE PROCESS WORKSHOP MANUAL
Topic 6
Ministry of the Environment
Toronto, Canada
1978

SUBJECT: Activated Sludge Process Control

TOPIC: 6 - Phosphorus Removal

OBJECTIVES: The trainee will be able to

1. Name three chemicals suitable for phosphorus removal.

2. Recall three possible application points for chemicals used in phosphorus removal.

3. List the effects that phosphorus removal chemicals have on the raw sludge concentration and the operation of anaerobic digesters.

4. Calculate the feed rate for chemicals used in phosphorus removal.

5. Recall five means by which the operator can control the phosphorus removal process.

PHOSPHORUS REMOVAL

General

In recent years the phosphates in wastewater treatment plant effluents have been identified as a major factor in the eutrophication (rapid aging) of receiving waters. Industrial waste discharges and run-off also contribute to this problem. Excessive amounts of nutrients (phosphorus, nitrogen, etc.) can cause the rapid gowth of algae and weeds. Algae and weeds will settle to the bottom, decompose and use up the dissolved oxygen causing the destruction of the life cycle systems normally found in unpolluted lakes, rivers and streams.

Because it is a major cause of eutrofication and present technology provides a means to control it, phosphorus was the nutrient selected to be removed from plant effluents being discharged into Lake Erie, Lake Ontario, the Ottawa River system, and inland recreational aras. Phosphorus removal facilities have been installed in a number of wastewater treatment plants and future years will see an increasing number.

There are a number of ways to remove phosphorus. These include reverse osmosis, adsorption, ion exchange and chemical precipitation. Chemical precipitation using commerically available chemicals is the least costly, both from capital and operating costs, and is the system of choice in Ontario. It is the method discussed in this topic.

Source of Phosphorus

Phosphorus in the plant influent comes in many forms. It consists of organic phosphorus from food and wastes, polyphosphates from detergents, and precipitated orthophosphate from chemical reactions between metal ions in the wastewater and dissolved orthophosphates.

The concentration of the phosphorus in the wastewater is measured as:

1. Total phosphorus which includes all forms of phosphorus as mg/l P.

2. Soluble, reactive phosphates as mg/l P.

Because of the complexity of the test required to determine phosphorus in the influent or effluent, the tests are normally done by the Ministry Laboratories. The procedure is outlined in Topic 15 of this manual.

Mechanism of Removal

The mechanism of phosphorus removal is a combination of chemical and physical reactions which include the chemical precipitation of the soluble, reactive phosphates by the metal ions (Ca^{+2}, Fe^{+3}, Al^{+3}) introduced. Other important reactions are the formation of metal hydroxides which adsorb non-reactive phosphates and trap finely suspended material containing phosphates bound to organic matter. Sufficient time for flocculation and sedimentation of this combined floc is needed to produce an effluent with the desired low phosphorus concentration (<1.0 mg/l P). Good mixing at the point of chemical addition is also important. Rapid mixing followed by slow, gentle mixing before sedimentation will produce the best results. Sufficient clarifier (primary or secondary) detention time (over 2 hours) and low upflow rates (<800 gal/day/ft^2) at peak flows are also needed to achieve good clarification if chemicals are added for phosphorus removal.

Chemicals Used

Jar tests and possibly full scale pilot studies should be conducted before the best suitable chemical is selected. The following commercially available chemicals are normally used for phosphorus removal.

1. Ferric Chloride $FeCl_3$

2. Ferrous Chloride $FeCl_2$ (waste pickle liquor)

3. Ferrous Sulphate $FeSO_4$ (waste pickle liquor)

4. Alum $Al_2(SO_4)_3.14\ H_2O$

5. Hydrated Lime $Ca(OH)_2$

Of the chemicals listed above, alum, ferric chloride, and hydrated lime are most widely used although waste pickle liquor is gaining in popularity since a substantial cost saving can be realized. Waste pickle liquor should only be usedin secondary treatment plants, because the 2-valent (ferrous) iron has to be oxidized to the 3-valent (ferric) iron in order to precipitate phosphates. To provide sufficient time and oxygen for oxidation, the point of addition of waste pickle liquor should be the influent end of the aeration tank. Handling, storage, bulk delivery, etc., are similar to ferric chloride.

Ferric Chloride

Ferric chloride is normally used in the liquid form although it is available in the dry form in drums. The reddish-brown liquid is corrosive and stains concrete. With proper dilution, fairly low temperatures can be tolerated. For outside storage in Ontario, heated, fibre-glass reinforced plastic storage tanks should be used. All other equipment used (pumps, feed lines,etc.) should be heat treated and able to handle corrosive liquids since commercial ferric chloride solution (and pickle liquor) contains strong acid. The acid in solution and the acid produced when ferric chloride is added is normally neutralized by natural alkalinity in the wastewater. Additional alkalinity (lime, caustic soda) may have to be added to wastewaters with low alkalinity. The ferric chloride can be added to either raw sewage or in the secondary section. Experience indicates that the latter point of addition yields better results at lower costs. The ferric ions (Fe^{+3}) combine with the orthophosphate to produce a precipitate (iron phosphate) and with the hydroxyl ion to produce a floc (ferric hydroxide).

Alum

Alum is easier to handle than lime and is somewhat less corrosive than ferric chloride. It is usually purchased in liquid form, although it can be procured in 100 lb bags in dry form. The aluminum ions (Al^{+3}) combine with the orthophosphate to form a precipitate (aluminum phosphate) and with the hydroxyl ions in the water to form a floc (aluminum hydroxide). It also produces an acid (sulphuric acid) which may be neutralized by the alkalinity available in the sewage or by added alkalinity.

Alum is delivered and stored in liquid form and as for ferric chloride, involves a large capital outlay for storage tanks and ancillary equipment. As alum crystallizes at fairly high temperatures, heating of tanks and feed lines is also necessary.

Alum can be added to either the raw sewage for phosphorus removal in the primary clarifiers, or in the aeration tank effluent. At most Ministry of the Environment secondary treatment plants, addition is made to the secondary section of the plant in the aeration effluent.

Hydrated Lime

Lime is employed because it is comparatively inexpensive. A portion of lime reacts with the orthophosphate to form an insoluble compound. The remaining lime and the magnesium either in the sewage or introduced in the lime form a floc causing the precipitated phosphates and other suspended solids to settle quickly. Lime also reacts with the Co_2 in the wastewater to form calcium carbonate.

Bulk lime is delivered in 10 or 20 ton loads and blown into a storage hopper or slurry make-up tank. The quantity normally required makes the use of fifty pound bags impractical. Dry storage works well, although problems can result unless the lime remains dry, there are no uncalcined pebbles, and if there is sufficient and constant water pressure for slurry make-up. Slurry storage involves a large capital outlay, unloading of the bulk lime is less than clean and if the slurry is not used quickly it will lose some of its effectiveness.

Lime should normally be added to the raw sewage ahead of the primary clarifier. Dosage can be most effectively controlled by maintaining the pH of the primary effluent at about 9.5. A lower pH will probably not produce the right conditions for the reactions to proceed quickly and effectively, the phosphorus being carried over with the solids in the effluent. A high pH (>8.4) could inhibit biological growth in the mixed liquor. The primary effluent can be low in BOD because of the additional removal of organic materials by the lime.

Lime is particularly suitable from an economic point of view in waters of low alkalinity. Despite handling difficulties, lime will produce an effluent from which most of the heavy metals have been removed by precipitation as hydroxides and which has been softened to some extent. In some areas, because of a combination of factors, lime is the only viable choice. Digestion of lime sludge appears not to be a problem.

PROCESS CONTROL PROBLEMS

Those likely to be encountered with ferric chloride, pickle liquor and alum include:

1. If added to the raw sewage:

   a. increased raw sludge removal is required because of increased sludge volumes and lower sludge solids concentration. Increased raw sludge volumes could cause digester problems due to hydraulic overload.

   b. The raw sludge may be acidic (pH < 7.0) and could cause problems with anaerobic digestion. Alkalinity (lime) may have to be added to the digester.

2. If added to the aeration tank:

   a. sludge return and sludge wasting have to be increased to prevent excessive sludge accumulations in the clarifier and to prevent the formation of a non-volatile, inert mixed liquor.

   b. High dosages to the aeration tank could result in a mixed liquor with a low pH at which the precipitated phosphates may redissolve and biological growth may be retarded. Addition of alkalinity (lime, caustic soda) to the aeration tank will be necessary to counter this problem.

3. Feeding the chemicals at a constant rate (X ml/min) could lead to one or more of the aforementioned problems if extreme variations in daily flows are encountered at the plant. Pacing chemical addition according to incoming flows is therefore recommended.

4. Chemical addition for phosphorus removal usually results in increased removals of toxic heavy metals from the wastewater and this could result in high levels of heavy metals in the digested sludge and could make this sludge unsuitable for disposal on farm land.

Process control problems likely to be encounterd with lime include:

1. The sludge produced, if high magnesium lime is used, tends to be fluffy and may float above the scraper mechanism of the clarifiers if it is allowed to build up. Normally, "High Calcium" lime does not give this problem.

2. The deposition of precipitate at points of turbulence and on all surfaces generally. Clarifier weirs and channels must be cleaned often and pipes flushed to prevent clogging. Recirculation of primary sludge will reduce this problem substantially.

3. Because the amount of sludge produced is greater, sludge must be removed from the primary clarifier more often.

4. pH control in the aeration tank. A close check must be maintained to keep the pH below 8.4 to prevent destruction of biological sludge.

5. Overdosing with lime may cause digester upsets.

SUMMARY

Table 6-1 summarizes the use of lime, alum and ferric chloride in phosphorus removal.

SUMMARY

Table 6-1 summarizes the use of lime, alum and ferric chloride in phosphorus removal.

Table 6-1 CHEMICAL ADDITION FOR PHOSPHORUS REMOVAL

CHEMICAL	POINT OF ADDITION	COMMENT
Lime	Raw Sewage	Increased raw sludge concentrations and volumes, higher raw sludge pH. Primary effluent will have lower BOD, higher pH values. Maintain close check on aeration tank - pH should not go over 8.4.
Lime	Final Effluent (Tertiary System)	Additional clarifier needed. Problems with chemical sludge volumes.
Ferric Chloride Pickle Liquor Alum	Raw Sewage	Slight decrease in raw sludge concentrations possible, increased sludge volumes. Primary effluent BOD values lower.
Ferric Chloride Pickle Liquor Alum	Aeration Tank	Decrease in aeration tank volatile solids, increased activated sludge return and wasting required, resulting in changes in raw sludge concentration. Pickle liquor added to aeration influent.

DOSAGE

Control

Influent conditions cannot be used as a basis for determining the dosage required to produce the required effluent (1.0 mg/l) or 80% removal because:

1. Sewage is complex and variable mixture of organic and inorganic compounds.

2. Removal is not only a function of the completeness of chemical reactions but also of the degree of flocculation adsorption and sedimentation.

Dosage must be determined for each plant on the basis of experience gained from jar testing, full scale testing and recent operations. The procedure for phosphorus determination is described in Topic 15.

If the plant is not producing an effluent which meets the standard, the operator can control the process of phosphorus removal by employing one or more of the following:

1. Changes in dosage.

2. Sludge wasting.

3. Changes in pH by addition of lime or soda ash.

4. Investigate use of other chemicals.

5. Change point of chemical addition.

Calculations

In calculating chemical dosage, the operator must bear in mind that the active ingredient of the chemical added is only the metal ion; e.g. calcium (Ca^{+2}), aluminum (Al^{+3}), ferric (Fe^{+3}). One therefore calculates the amount of Fe^{+3} required to reduce the phosphorus and must then determine the amount of ferric chloride solution required which contains Fe^{+3}, acid and water. See Mathematics for Operators page 50.

Chemical Dosage Calculation for Phosphorus Removal

Examples:

In a plant with an average flow of 4.0 MGD ferric chloride is used at a dosage of 10 mg/l Fe^{+3} added after the aeration tanks. What ferric chloride flow rate measured in ml/min is needed?

Data: weight of ferric chloride is 14.1 lb/gallon

Ferric chloride contains 14.0% wt/wt Fe+3

Ferric chloride contains 41.0% wt/wt $FeCl_3$

1. Step by Step Calculations

$$10/\text{mg/l } Fe^{+3} = \frac{10 \text{ lb } Fe^{+3}}{100{,}000 \text{ G}} \times 4{,}000{,}000 \text{ G/D} = 400 \text{ lb/D of } Fe^{+3}$$

therefore liquid ferric chloride ($FeCl_3$) needed =

$$\frac{400 \text{ lb/D } Fe^{+3}}{0.14} = 2857 \text{ lb/D}$$

hence volume of liquid $FeCl_3$ needed =

$$2857 \text{ lb/D} \times \frac{1 \text{ G}}{14.1 \text{ lb}} = 202.6 \text{ G/D}$$

hence ml/min of liquid $FeCl_3$ =

$$202.6 \text{ G/D} \times \frac{1 \text{ day}}{24 \text{ hr}} \times \frac{1 \text{ hr}}{60 \text{ min}} \times \frac{4546 \text{ ml}}{\text{G}} = \underline{\underline{639.7 \text{ ml/min}}}$$

2. Calculation by Formula:

$$\text{ml/min} = \frac{(\text{dosage mg/l})\ (\text{plant flow MGD})}{(\%\text{ active chemical as fraction})\ (\text{weight of chemical lb/gal})} \times (31.57) =$$

$$\text{ml/min} = \frac{(10 \text{ mg/l})(4.\text{MGD})(31.57)}{(0.14)\ 14.1)} = \underline{\underline{639.7 \text{ ml/min}}}$$

Training Sample 5
"Conventional Activated Sludge - Design and Operation Parameters"
BASIC ACTIVATED SLUDGE
Kirkwood Community College
Cedar Rapids, Iowa
1977

OBJECTIVES

1. Using the "typical conventional activated sludge flow schematic," show the typical design values for:

   a. Aeration tank detention time.
   b. Final settling tank surface overflow rate
   c. Return sludge flow pump capacity

2. Given aeration tank dimensions, clarifier dimensions, flows, and appropriate plant data, calculate:

   a. Aeration tank detention time
   b. Clarifier surface settling rate
   c. Lbs. of BOD to aeration
   d. Lbs. of solids under aeration
   e. F/M

INSTRUCTIONAL AIDS

1. Transparencies
2. Handout
3. Calculator

INSTRUCTIONAL APPROACH

1. Lecture
2. Discussion
3. In class problem solution

REFERENCES

1. WPCF MOP 11
2. N.Y. Manual

TOPIC

Design and Operation Parameters

An operator should know what the generally "accepted" design parameters are for the conventional activated sludge process units. The "Recommended Standards for Sewage Works" and the "New York Manual" values are shown on Student Handout II. The operator must realize that these are the design numbers. The operator must deal with that which exists, i.e. the daily flow variation, the daily load variation, the weekend changes, the seasonal changes, the new industry, the industry that shut down and on and on.

The point is that design is probably past history to the operator. The operator faces operation or operational parameters. It then behooves the operator to routinely calculate operational parameters i.e. to document flows, loading, detention times, process performance, etc.

1. Aeration Tank Detention Time

   First notice that the design value is based on the design flow alone. This detention time will be called aeration tank detention time at flow. Understand, however, that the true hydraulic detention time must include the return sludge flow into the aeration tank. This detention time will be called aeration tank detention time at total flow.

   Figure 4 is an example problem. If time permits and a student has "real" plant dimensions and flow data, solve the problem with the real data.

2. Clarifier Surface Overflow Rate

   Notice the three flow values in this problem; clarifier influent, clarifier effluent, and clarifier sludge flow. The correct flow (clarifier effluent) must be used for this calculation.

   See Figure 5 - Overflow Rate Calculation Example

3. Clarifier Detention Time

   The critical value again is flow. The detention time is calculated from the clarifier influent. Use a mean clarifier depth of 10 feet and a clarifier influent flow of 2.8 MGD to complete the calculation.

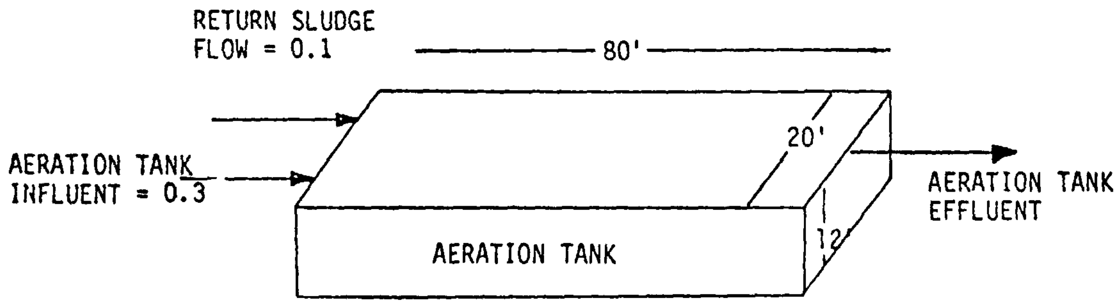
   Figure 5 - encourage use of "real" data for additonal calculation practice. The operators should be able to furnish at least approximate dimensions and flow data.

CONVENTIONAL ACTIVATED SLUDGE DESIGN PARAMETERS

	New York Manual	Recommended Standards For Sewage Works
Aeration Tank		
Detention Time *(Hrs.)	6 - 8 **	6 - 7.5
Oxygen (cu. ft. air/lb. BOD)	1,500	1,500
Organic Load (i.e. BOD/1000 cu. ft.		30 - 40
Secondary Clarifier		
Surface Overflow (Gal. sq. ft./day)	800	600 - 800
Detention Time (Hrs.)		2 - 3
Clarifier Sludge Flow (%)	20 - 30	15 - 75

*Based on design flow

**Diffused air, for mechanical aerators 9 - 12



VOLUME = LENGTH X WIDTH X DEPTH = 20 X 80 X 12

VOLUME = 19,200 CUBIC FEET X 7.48 GAL./CUBIC FEET

VOLUME = 143,616 GALLONS

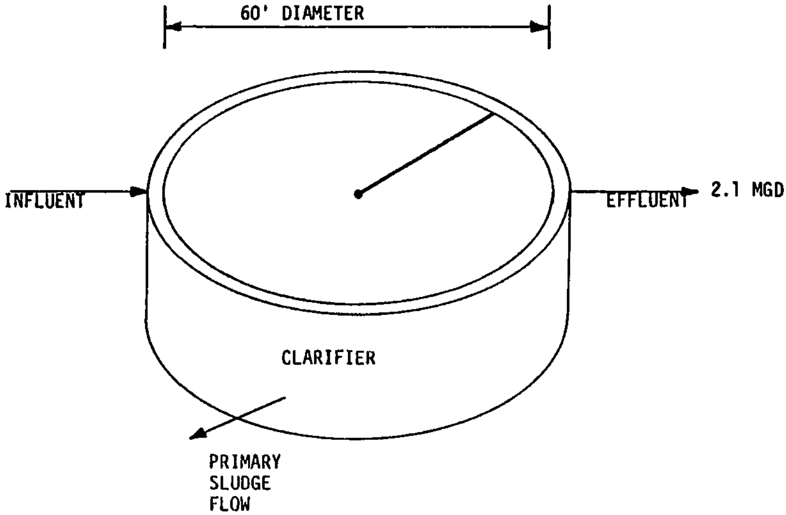
FLOW IN = .3 MGD + .1 MGD = .4 MGD

$$\text{DETENTION TIME} = \frac{\text{VOLUME}}{\text{FLOW IN}} \times 24$$

$$\text{DETENTION TIME} \doteq \frac{143{,}616}{400{,}000} \times 24$$

DETENTION TIME = 8.6 HOURS

FIGURE 4
DETENTION TIME CALCULATION EXAMPLE



SURFACE AREA - $\frac{\pi d^2}{4} = \frac{3.14 \times 60^2}{4}$ 2,826 SQ. FT.

OVERFLOW RATE - $\frac{\text{EFFLUENT}}{\text{SURFACE AREA}} = \frac{2,100,000}{2,826}$

OVERFLOW RATE = 743 GAL./SQ. FT./DAY

FIGURE 5

OVERFLOW RATE CALCULATION EXAMPLE

4. Pounds of BOD to Aeration (F)

5. Pounds of Solids Under Aeration (M)

   Some operators use mixed liquor volatile suspended solids for this calculation. That's fine - just be consistent i.e. if volatile solids are being used, always use them and make appropriate notes in the plant data and trend charts.

   See Figure 6 - Organic Load Calculation Example.

6. F/M

   Point out that this ratio is comparing the food to the organisms available to "eat" the food.

PRIMARY EFFLUENT BOD = 150 MG/L

PRIMARY EFFLUENT FLOW = 0.3 MGD

AERATION TANK VOLUME = 19,200 CUBIC FEET

AERATION TANK VOLUME = 143,616 GALLONS

MIXED LIQUOR SUSPENDED SOLIDS = 2,000 MG/L

POUNDS OF BOD/DAY = 150 X 0.4 X 8.34 = 500 LBS/DAY

$$\frac{\text{POUNDS BOD/DAY}}{\text{VOLUME (1,000 CUBIC FEET)}} = \frac{500}{19.2} = \text{26 LBS BOD/DAY/1000 CUBIC FEET}$$

POUNDS MIXED LIQUOR SOLIDS = .143616 X 2,000 X 8.34

POUNDS MIXED LIQUOR SOLIDS = 2,396 LBS

$$\frac{\text{POUNDS BOD/DAY}}{\text{POUNDS MIXED LIQUOR SOLIDS}} = \frac{500}{2396} = 0.21$$

FIGURE 6

ORGANIC LOAD CALCULATION EXAMPLE

Training Sample 6
"Control Procedures - Constant F/M Ratio"
INTERMEDIATE ACTIVATED SLUDGE
Kirkwood Community College
Cedar Rapids, Iowa
1977

OBJECTIVES

1. List the process control parameters used to maintain a constant F/M ratio control and testing. (the flows and the laboratory analysis)

2. List the usual range of "accepted" F/M ratios.

3. List three disadvantages to control by this method.

4. Given appropriate data, calculate

   a. Food (F)
   b. Micoorganisms (M)
   c. F/M

5. Given a basic conventional activated sludge schematic, label flows and concentrations, and list the mass balance equations.

6. Given appropriate data, utilizing the mass balance equation, solve for return sludge concentration needed for a given level of mixed liquor suspended solids.

7. Given appropriate data, calculate sludge weight to concentration ratio.

INSTRUCTIONAL AIDS

1. Transparencies

INSTRUCTIONAL APPROACH

1. Lecture

2. Discussion

3. In class problem solution

REFERENCES

1. WPCF MOP 11

2. PART III A - Operational Control Procedures for the Activated Sludge Process

TOPIC

Control Procedures - Constant F/M

INSTRUCTOR OUTLINE

The second control procedure to be reviewed is control to aconstant F/M ratio. In order to control by maintenance of a constant F/M ratio it is necessary to routinely determine the strength of the load (BOD, COD, TOC e.g.), the concentration of solids under aeration (MLVSS or MLSS), raw sewage flow, and calculate values for F and M in order to determine if increased or decreased waste sludge flow is in order.

It is generally accepted that values for F/M should fall within the range of 0.1 to 0.5.

The disadvantages to control by this technique include:

1. The difficulty in obtaining a timely value of F (BOD is 5 day determination).

2. MLVSS determinations are not necessarily true measures of M (paper and dead cells show up as MLVSS).

3. Inability to make instantaneous changes in aeration tank solids concentrations.

4. F/M by itself gives little assistance to operator relative to return sludge flow adjustments.

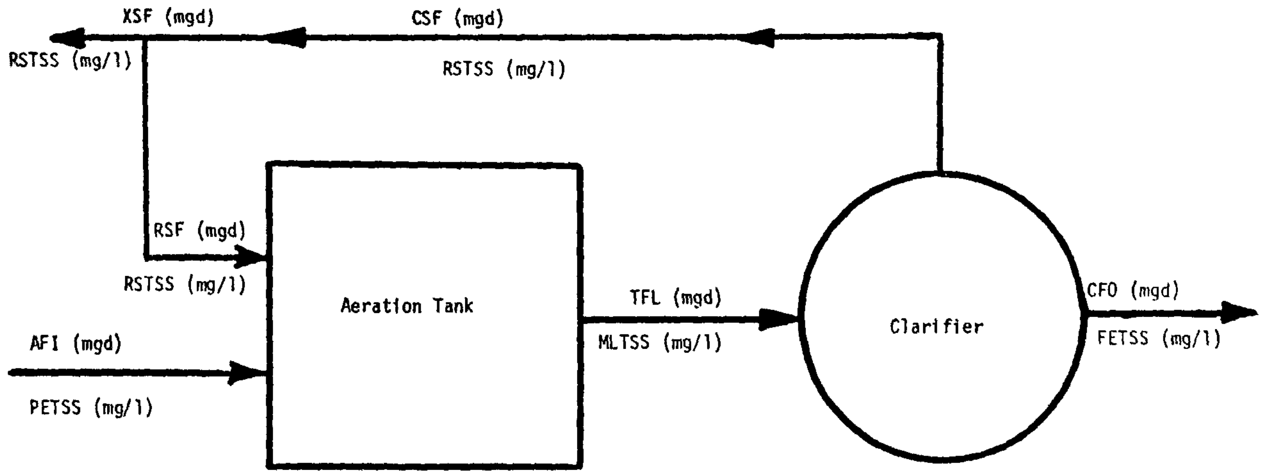
The workshop began with a problem from Student Handout 1. If there was no difficulty with the problem, proceed. If there are any questions with solving for F or M or the F/M ratio, work another problem using data from the students.

One of the most significant parts of this module deals with the "mass balance equation." The operator must come to grips with this equation if he is to rise to an improved understanding of the activated sludge process. The starting point is the process flow schematic. The second step is to label all flows and to assign symbols to these flows and the concentration of solids in each "pipe."

See Figure 1 - Conventional Activated Sludge Process Schematic.

Recall that there is an equation which has been used in this module to solve for pounds, pounds of BOD or solids. You should recognize the following equations:

1. Pounds solids = Conc. (mg/l) x Volume (mg) x 8.34



CONVENTIONAL ACTIVATED SLUDGE

PROCESS SCHEMATIC
Figure 1

2. Pounds solids per day = Conc. (mg/l) x Flow (mgd) x 8.34

The mass balance equation has as its simple premise: Mass in equals mass out.

Let's take out one step backward before moving ahead. A flow balance should be readily understood. The flow balance premise is: Flow in equals flow out. Notice the different relationships when the tanks are full. Flow balance is important in that sometimes process flow data can be calculated on occasion if some measured flow data is available. Flow balance equations should be done in your (the student's) facility. (See Figure 2 - Flow Balance)

Return now to the mass balance equation: Mass in equals mass out.

Pounds will be the units of mass for our use. The equation now becomes: Pounds in equals pounds out.

Figure 3 is identical to Figure 1 except the aeration tank and clarifier have shrunk. The mass (pound) balance relationships should now be evident. The mass balance around the clarifier results in the following:

TFL x MLTSS x 8.34 = CSF x RSTSS x 8.34 + CFO x FETSS x 8.34

First the 8.34 can be divided out resulting in:

TFL x MLTSS = CSF x RSTSS + CFO x FETSS

Next, FETSS, if final effluent quality is good, approaches zero. (At the very least it is very much smaller than either MLTSS and/or RSTSS).

The equation then becomes:

TFL x MLTSS = CSF x RSTSS

Moving around the system:

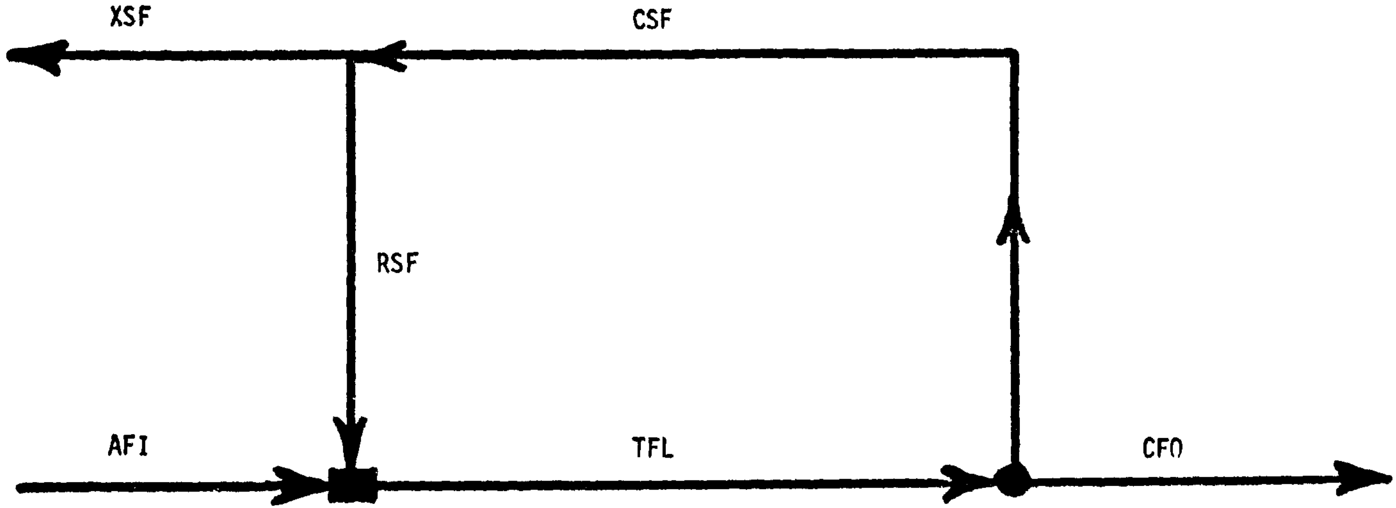
CSF x RSTSS = RSF x RSTSS + XSF x RSTSS

If there is no sludge being wasted, XSF = 0

CSF x RSTSS = RSF x RSTSS

Finally the mass balance around the aeration tank:

TFL x MLTSS = RSF x RSTSS + AFI x PETSS



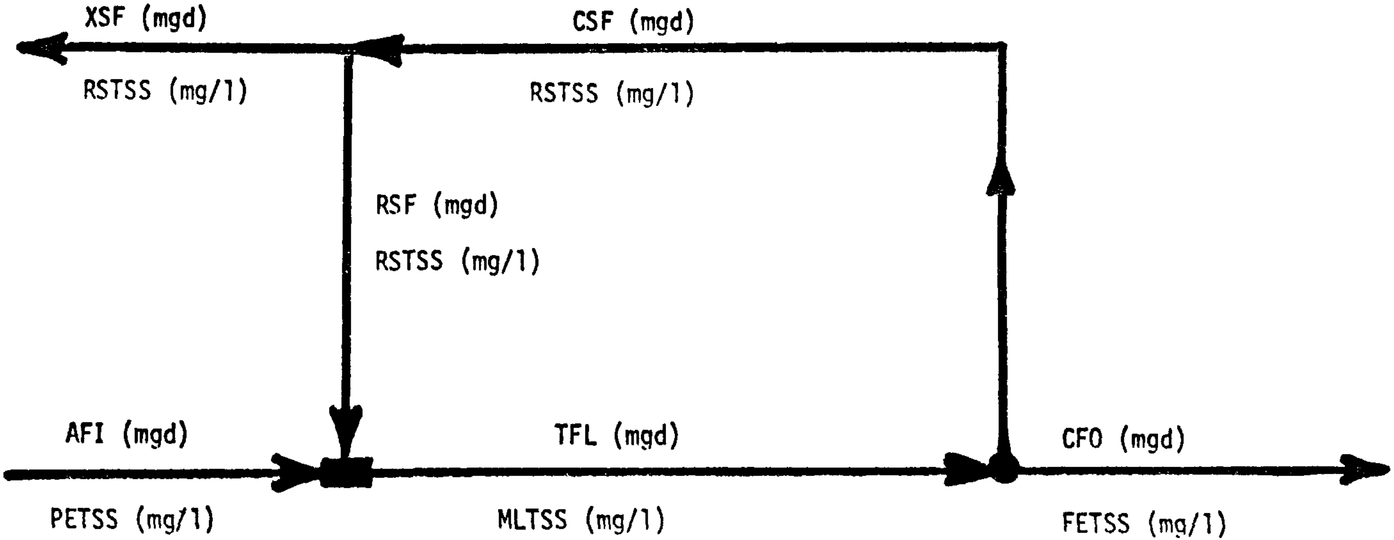
Flow in = Flow out

TFL = AFI + RSF

TFL = CFO + CSF

CSF = RSF + XSF

Figure 2 - Flow Balance



Pounds/day = Flow (mgd) x Conc. (mg/l) x 8.34

Pounds in = Pounds out

Figure 3

MASS BALANCE

These equations do have significance for the operator. The mass balance around the clarifier resulted in the following equation:

TFL x MLTSS = CSF x RSTSS

If XSF = 0

(AFI + RSF) x MLTSS = RSF x RSTSS

AFI x MLTSS + RSF x MLTSS = RSF x RSTSS

RSF x (RSTSS - MLTSS) = AFI x MLTSS

RSF = (AFI x MLTSS)/(RSTSS - MLTSS)

This relationship can be of assistance to the operator trying to control to a constant aeration tank solids concentration of F/M control. It is most important to understand that this relationship presumes no accumulation of solids in the clarifier. Other relationships can be derived and will be in subsequent topics of this module.

The centrifuge can be utilized as an operational test device and its use should be incorporated. It does not replace gravimetric solids determinations. It rather expands the operator's capability.

There are accepted, even required procedures for "self-monitoring" data. But, that does not mean that a test or analysis not in "Standard Methods" is not appropriate as a control test. Use of the centrifuge for solids concentration determinations falls into this category. Percent solids by volume can be easily determined using American Petroleum Institute (API) centrifuge tubes. Determine aeration tank concentration (ATC) and Return Sludge Concentration (RSC). The equation:

RSF = (AFI x MLTSS)/(RSTSS - MLTSS)

Becomes:

RSF = (AFI x ATC)/(RSC - ATC)

The centrifuge values can be rapidly determined and this test and equation can be made a part of control procedure.

This relationship can be manipulated to give an expression for the return sludge concentration (RSC). The expression is:

RSC = (AFI + RSF) x ATC/RSF

The expression for RSF implies that given mixed liquor and return sludge concentrations and a level of flow into the aeration tank, the return sludge flow to maintain that system in balance can be found.

The expression for RSC implies that given the flow values and mixed liquor concentration, the return sludge concentration necessary to maintain a balanced system can be found.

However, there is nothing quite so simple. First of all the activated sludge process is a biological (living) process. The mass balance presented does not take into account the growth of new sludge in the aeration tank. The second concern is that the expression does not take into account the storage of sludge on occasion in the secondary clarifier. Finally the substituion for ATC = MLTSS and RSC = RSTSS assumes an identity relationship.

In other words ATC times a constant = MLTSS and RSC times a constant = RSTSS. If such were the case, gravimetric solids determinations could be replaced with solids determination by centrifuge, which is much easier. Such is generally not true, but the relationship and its relative change is worthy of consideration. Part III A terms this the "Sludge weight-to-concentration ratio" (WCR). The key is not the exactness of the numbers shown, rather the trend. In other words a WCR of 800 does not necessarily mean that your sludge is "normal." Your centrifuge may not rotate at the identical RPM's to the one used in Part II A. The operator watches the trend of the WCR in his plant. Increasing WCR's indicate the sludge is becoming relatively "older." Decreasing WCR's indicate the sludge is becoming relatively "younger."

To solve for WCR requires only the gravimetric mixed liquor solids determination and solids by centrifuge.

WCR = MLTSS/ATC

Training Sample 7
"Review from Activated Sludge - Trend Charts"
ADVANCED ACTIVATED SLUDGE
Kirkwood Community College
Cedar Rapids, Iowa
1977

OBJECTIVES

1. Discuss settling curves

2. Discuss concentration curves

3. Discuss process flows (raw, primary sludge, return, and waste activated sludge).

4. Discuss sludge blanket levels

5. Discuss effluent quality curves

INSTRUCTIONAL AIDS

1. Transparencies (Trend Charts)

INSTRUCTIONAL APPROACH

1. Lecture

2. In-class problem solving

REFERENCES

1. Part III-A

TOPIC

Trend Charts

INSTRUCTOR OUTLINE

Process control takes on a new dimension when trend charts are a part of process control decision making. This lesson plan provides trend figures which display about 13 weeks of data opposed to true, daily maintained trend charts. They are missing the all important daily operational notes of unusual circumstances or events.

The following trend charts are included in the lesson. packet:

1. Settled sludge volume - Figure 7

2. Settled sludge concentration - Figure 8

3. Depth of sludge blanket - Figure 9

4. Turbidity, Final effluent - Figure 10

5. Aeration tank COD load - Figure 11

6. Final clarifier overflow rate - Figure 12

7. Oxygen uptake test results - Figure 13

8. Weight to concentration ratio - Figure 14

Transparencies of these figures should be made to display several of these transparencies at the same time.

Discussion of these trend charts should include but not necessarily be limited to:

1. The equation WCR = MLTSS/ATC. Notethat this ratio is most certainly not constant. Compare the improved settling characteristics to this increase in WCR.

   The COD load curve, overflow rate, and final effluent turbidity should be displayed simultaneously. Notice that hydraulic overloads do not occur, rather organic load does occur with a resultant degradation of effluent quality.

   Other combinations should generate discussion.

   Any questions on the logistics of trend charting should be resolved. It is suggested that 10 square by 10 square per inch graph paper does not lend itself to trend charts as the units of time (the horizontal scale) can be confusing. There is available graph paper graduated 12 squares per inch horizontal by 20 squares per inch vertical.

Training Sample 8
"Activated Sludge-Aeration and Sedimentation"
STANDARD OPERATING JOB PROCEDURES FOR WASTE WATER TREATMENT PLANT UNIT OPERATIONS S.O.J.P. No. 5
Charles County Community College
LaPlata, Maryland
1972

OBSERVATION

1. Observe surface of aeration tank once every 2 hours

   a. Good mixing, minimum of dead spots
   b. Color-red brown to brown
   c. Odor-like earth
   d Foam, color and amount
   e. Foam control sprays on

   TRAINING GUIDE NOTE: VI 1, 2, 3, and 4

2. Observe surface of clarifiers once every 2 hours

   a. Minimum of scum
   b. Minimum of rising sludge
   c. Minimum suspended materials

   TRAINING GUIDE NOTE: VII-1, VI-5, VI-6, VI-7

3. Check clarifier sludge blanket and record once every 2 hours

   a. Level between 1/4 - 1/2 tank depth

   TRAINING GUIDE NOTE: VI-8

4. Observe flow over clarifier weirs

   a. Even flow
   b. Weirs clean

   TRAINING GUIDE NOTE: VI-9

5. Observe return sludge flow

   a. Color brown to red-brown
   b. Odor-earthy
   c. Even smooth flow

   TRAINING GUIDE NOTE: VI-2, VI-3, III-1

EQUIPMENT CHECKING (every 4 hours)

1. Check blower and record headings

   a. Suction gauge near zero
   b. Oil temperature per mfg. specs.
   c. Oil pressure per mfg. specs.
   d. Cooling water flow at set point
   e. Ammeters per mfg. spec.
   f. Phase angle indicator greater than p.85
   g. Bearing temperature per mfg. specs.
   h. Vibration monitor within specs.

      TRAINING GUIDE NOTE: V-44, 45, 46, 47, 48, 49

2. Check return sludge pumps and record readings

   a. Bearing temperature per mfg. specs.
   b. Motor temperature per mfg. specs.
   c. Coupling quiet and smooth
   d. Record pump output from magnetic flow meter
   e. Check seal water flow
   f. Check discharge pressure

      TRAINING GUIDE NOTE: V-48, 50, 51, 52, 52, XIII-1

3. Check waste sludge pump and record readings

   a. Same as return sludge pump check

      TRAINING GUIDE NOTE: V-48, 50, 51, 52, XIII-1

4. Check Parshall Flume

   a. Clean, no obstructions
   b. Purge bubbler tume
   c. Record reading

      TRAINING GUIDE NOTE: XI-1, VI-8, XIII-1

EQUIPMENT ADJUSTMENTS

1. Adjust aeration blower output

   a. As required to maintain > 1.0 and < 3.0 mg/l D.O. throughout aeration tank (see Process Control)

   b. Adjust manual control slowly

2. Adjust return sludge flow rate

   a. As required by process demand (see Process Control

3. Adjust waste sludge pumping rate

   a. As required by process demand (see Process Control)

NOTE RECORD ALL OBSERVATIONS AND READINGS

HOUSEKEEPING

1. Clean effluent weirs

   a. Daily
   b. To maintain even overflow

   TRAINING GUIDE NOTE: V-53, XII-5

2. Clean clarifier center

   a. Daily
   b. To prevent odors and maintain free flow

   TRAINING GUIDE NOTE: V-53, XII-5

3. Clean aeration tank walls

   a. At water level
   b. Once every 2 weeks
   c. To prevent odors

   TRAINING GUIDE NOTE: V-53, XII-5

4. Clean distribution channels and Parshall Flume

   a. Every other day
   b. To maintain accurate flow measurement
   c. To prevent odors

   TRAINING GUIDE NOTE: V-53, XII-5

5. Clean clarifier walls

   a. At water level
   b. Twice a week
   c. To remove algae and grease

   TRAINING GUIDE NOTE: V-53, XII-5

6. Clean all pumps, motors and blowers

   a. Daily
   b. While shut down
   c. To maintain cleanliness and increase equipment life

   TRAINING GUIDE NOTE: V-54, XII-6

7. Clean control panel(s)

   a. Daily
   b. To maintain appearance and operation
   c. To prevent accidental starts or stops

      TRAINING GUIDE NOTE: V-55, XII-7

8. Clean structures and walkways

   a. To prevent falls
   b. Always keep clean and free of debris, hoses and tools

      TRAINING GUIDE NOTE: XII-8

9. Clean piping and valves

   a. To maintain function and top appearance

      TRAINING GUIDE NOTE: V-56

Educational Concepts - Science, Section III

1. III-1 (C-I.2.1.4), (C.1.5.3), (C-I.2.6.1)

   Examination of the aeration tank solids and the return sludge solids can be very revealing of the state of oxidation of the organisms. Examination requires only a simple microscope with reasonable resolution at 100 power. A slide should be prepared using a drop of well mixed sample with a coverslip placed over it. The floc should have crisp clean edges and a large variety of protozoa should be present. The presence of many small flagellates and strings extending out of and mixed in the floc indicates an underoxidized, young floc. If the floc is small with crisp edges and many large rotifers are present, the floc is overoxidized. The presence of a variety of types and many protozoa indicated a balance process. In many cases, the organism balance in the process will indicate problems in the process long before they actually occur.

2. III-2 (C-I.5.9.10)

   pH Control. In adding coagulant aids always monitor the aeration tank pH using a pH meter. Many coagulants are acidic or basic and any pH range outside of 6.0-8.0 will affect the microorganisms adversely and halt biological action.

Process Equipment - Section IV

1. V-38 (B.1.3.1)

   Examine all potential drainage places from aeration tanks, clarifiers, and return lines. Any unplanned lsoses could upset the process or prevent establishment of a culture.

2. V-39 (B.1.4.1)

   Start blowers as soon as spargers are covered to prevent plugging.

3. V-40 (B.1.4.2)

   Remove locks and close circuit breaker. Push start button.

4. V-41 (B.1.4.4)

   Fifty percent of rated output will bring blower output up above surge point and supply all air necessary for start-up. Reference - Mfg. Specifications.

5. V-42 (B.1.5.1)

Water just covering suction arms will reduce apparent weight of arms and make start easier. Observe arm rotation for smooth, even operation. Any roughness or stops call for immediate stopping and draining of all equipment and corrective maintenance. References - Mfg. Specifications and Plant Manual

6. V-43 (B.1.7.1) (B.1.8.1) (B.1.8.2) (B.1.8.3)

Push start button and set initially to 50% of plant flow. Make adjustments later by process demand. (See Process Control Section).

7. V-44 (C.2.1.1)

Any steady deviation on the negative side of 0 for the blower intake indicates plugging filters. These should be cleaned.

8. V-45 (C.2.1.2) (C.2.1.3) (C.2.1.4)

Generally in the 90-150 degree range oil temperature; oil pressure generally 20-30 psi on blower. Cooling water adequate to keep oil temperature within specifications. References - Mfg. Specifications and Plant Manual

9. V-46 (C.2.1.5)

Ammeters must be in normal range. If otherwise serious problems are occurring and immediate shutdown is advisable. Reference - Mfg. Specifications

10. V-47 (C.2.1.6)

A power factor greater than 0.85 is required through most of the nation. Penalties are usually attached to P.F. loadings less than this on either the lead or log side. A rheostat is usually supplied for correction.
References - Mfg. Specifications and Plant Manual

11. V-48 (C.2.3.1) (C.2.1.7) (C.2.2.1)

High bearing temperatures will usually coincide with high oil temperatures which generally means a shutdown and repair are called for. References - Mfg. Specifications and Morrow

12. V-49 (C.2.1.8)

Vibration monitoring is unusual in smaller installations but can give immediate or trend information on equipment failure or problems. Reference - Morrow

13. V-50 (C.2.2.2) (C.2.3.1)

A 40^{o}C rise motor will feel very hot to the touch and caution should be used not to burn your hands. Experience will tell you when the motor is too hot.

14. V-51 (C.2.3.1) (C.2.2.3)

A noisy coupling indicates overload or mechanical damage due to misalignment. Call maintenance.

15. V-52 (C.2.2.4) (C.2.2.6) (C.2.3.1)

Pump output (flow) and pump discharge pressure are keys to the condition of the pump and piping. Learn the normal values. Drastic, uncalled for changes can lead to early discovery of malfunction.

16. V-53 (C.4.1.2) (C.4.2.2) (C.4.3.1) (C.4.4.1) (C.4.5.1)

Cleaning of all structures at the water level is an absolute requirement on a routine basis. Failure to do so will create an unhealthy, nauseous, stinking mess, due to slime, grease and algal accumulations. Use a high pressure sprayer or high pressure hose.

17. V-54 (C.4.6.1)

Clean equipment is easier to maintain, makes malfunctions show more readily (e.g. oil leaks) and prevents equipment damage from mechanical junk getting into working parts.

18. V-55 (C.4.7.2)

A control panel with extra materials on it can make operation confusing and unsafe.

Process Flow - Characterization - Section VI

1. VI-1 (C.1.1.1)

The surface of the aeration tank should have an even roll with no dead spots. Particularly watch for plugged sprayers. A dye test may be required at first to determine whether or not a dead core may exist in a spiral flow aeration tank. If this is so, major modifications of air supply may be necessary. Reference - Activated Sludge Process Operational Control, A. West P.E., EPA, Cincinnati, Ohio

2. VI-2 (C.1.1.2) (C.1.5.1)

   The color of the sludge should be a reddish brown. Any other variations may be caused by dyes or colored compounds in the influent, underoxidation causing the sludge to get very dark or to tend toward gray.

3. VI-3 (C.1.1.3) (C.1.5.2)

   Pick up a handful of loamy earth and compare the odors. Any other odor means trouble, usually overloading and underoxidation.

4. VI-4 (C.1.1.4) (D.3.1.1) (D.4.1.1) (D.3.2.1)

   There will usually be some small amount of light brown foam. If the foam is white and abundant, the aeration solids concentration is too low. If it is heavy and dark the aeration tank solids are too heavy. These are only guidelines and adequate testing must be done before corrections are made.

5. VI-5 (C.1.2.1)

   Even ideal control will leave some scum on the clarifiers. The amount will be small and the skimming devices should clean it all on each pass.

6. VI-6 (C.1.2.2)

   There will always be some small amount of floc varying from very fine to 1mm in diameter rising in the clarifiers, even under good control. The amount should be very small and not sufficient to interfere with turbidity measurements.

7. VI-7 (C.1.2.3)

   Some suspended materials (5 mg/l or so) will be present. This should not interfere with the turbidity readings.

8. VI-8 (C.1.3.1) (C.2.4.1)

Using an air lift or light device, determine the sludge blanket depth. Anything less than 1/2 the tank depth indicates process trouble.

9. VI-9 (C.1.4.1) (C.1.4.2)

An even flow over the weirs prevents short circuiting and consequent hydraulic upsets leading to excess solids in the effluent.

10. VI-10 (D.1.2.1)

Bulking sludge. The solids concentration in the clarifier will be almost the same from the top to bottom. There will be no area of clear supernate on the clarifiers or if there is it will be minimum and the blanket will be visible just below the surface. The effluent solids will be almost equal to the aeration tank solids. This will occur even below design flows.

11. VI-11 (D.2.1.1) (D.5.1.1)

Excessive solids carry-over can be of several forms. Very small pinhead floc going over the weirs indicates over-oxidized sludge. Large chunks of light brown materials indicate nitrification and denitrification or too much air and aeration tank solids too heavy. Dark brown to black chunks indicate septicity.

Training Sample 9
"The Activated Sludge Process"
Wastewater Treatment Plant Operator Training Program
Water Pollution Control Federation
Intermediate Course, Vol. A
Part of Unit 5 has been selected as an example
(Pre/posttest and review exercises are included)

UNIT: 5 The Activated Sludge Process (Summary)
Estimated Time: 2.5 hours
Prerequisites: Successful Completion of Basic Course

PERFORMANCE OBJECTIVES

Behaviors exhibited by the student at the end of this unit include being able to:

1. Briefly define what is meant by flocculation
2. Describe the causes of poor settling
3. Describe reactions throughout an aeration tank
4. Identify variations of the activated sludge process
5. Explain the 30-minute settling test, the sludge volume index, and the mixed liquor suspended solids test
6. Explain the importance of proper DO levels.

UNIT OBJECTIVES

To provide the conceptual information that the student needs to know about activated sludge.

INSTRUCTIONAL RESOURCES

1. Handbook for Program Administrator
2. Student Workbook
3. Pre/Posttests
4. Slides/tapes and program audioscript

INSTRUCTOR ACTIVITIES

1. Have the student complete and self-check the pretest questionnaire .
2. Have the student go through the audio-visual portion of the Unit and complete review exercises.
3. Provide a discussion period to clarify student questions or problems encountered in the Unit.
4. Have the student complete the final review exercise.
5. Mark and retain the Posttest questionnaire.

DISCUSSION QUESTIONS

1. What is the purpose of the secondary clarifier? How is what happens in the secondary clarifier different than what happens in the primary clarifier?

2. What is the F/M ratio? What would you expect with a high F/M ratio, and with a low F/M ratio?

3. Why is it important that floc settle at the proper rate in the secondary clarifier?

4. What is the purpose of the 30-minute settling test, and how can you use the information you get from it?

5. What are the two variables that determine the rate of sludge return from the secondary clarifier?

6. The DO level in the aeration basin should not be less than 1 mg/l, and not more than 3 to 4 mg/l. Why?

7. Why is it important that contents of the aeration tank be well mixed?

In addition to the Pretest/posttest and review information given in the student workbook, a summary of the activated sludge process is provided to supplement the audio-visual presentation. A sample of that summary information is provided.

Summary

Usually it is primary effluent that is treated in the conventional activated sludge process, although raw wastewater from the pretreatment processes might flow directly to the activated sludge process.

Regardless of the setup, there are two main steps in the activated sludge process:

1. Changing nonsettleable organic materials into settleable sludge

2. Removing the sludge

It is important that these organic materials are not allowed to enter receiving waters. Too many organics will cause rapid growth of bacteria, and this means that the overall level of dissolved oxygen in receiving waters will be reduced. Overloading the assimilation capacity of receiving waters can result in fish kills and septic conditions in the immediate area and often for several miles downstream.

In the activated sludge process, we compress the natural treatment process in time and space. There are two main units in the activated sludge process: the aeration tank, and the secondary clarifier.

Aeration Tank: Primary effluent, or sometimes raw wastewater, goes into an aeration tank. The aeration tank uses either mechanical or diffused aeration to aerate the wastewater. A plant usually has at least two aeration tanks to allow one to be shut down for maintenance. The contents of the aeration tank are called mixed liquor. This is the mixture of raw or settled wastewater and the return activated sludge. Mixed liquor is kept in the aeration tank for about 4 to 8 hours to allow the bacteria enough time to treat the wastewater. For this treatment to happen, there have to be enough bacteria, enough dissolved oxygen, and enough contact between oxygen, bacteria and organics. A healthy activated sludge in the aeration tank is light to dark brown in color, and has a smell that is earthy and slightly musty.

Secondary clarifier: Circular clarifiers are most common, and at least two clarifiers are usually used. The secondary clarifier is used to settle activated sludge from the wastewater. This material is fluffier and harder to settle than materials settled out in the primary clarifier. This means that the overflow rate has to be lower, and that the detention time in the secondary clarifier has to be longer, usually between 2 to 4 hours.

It is important that the sludge blanket doesn't get too close to the top of the clarifier, so that floc doesn't start going out with the effluent. A good secondary clarifier effluent will look clear and sparkling. Sludge in the secondary clarifier has to be continuously removed.

The key to the activated sludge process is the return activated sludge. Sludge from the bottom of the clarifier is returned to the head of the aeration tank. It is important that you know how much sludge is being returned, and how much is being wasted. Not all of the activated sludge collected in the secondary clarifier is returned to the aeration tank. Wasting should be done at regular intervals. If some of it were not wasted, the clarifier would soon fillup with sludge. The other advantage of wasting or removing sludge is the removal of some of the older, less active microorganisms

BIOLOGICAL PRINCIPLES

Because the activated sludge process is an aerobic process, we are mainly concerned with the aerobic and facultative bacteria. The organics in the wastewater are used as food by the bacteria. The bacteria use oxygen during this process, and this is one reason for aeration in the aeration tank. The other function of aeration is to provide mixing to keep the organics, oxygen and bacteria in contact.

The rate of growth of microorganisms will depend on how much food is available. The ratio of food to the weight of the microorganisms is called the F/M ratio, and it is the F/M ratio that determines the growth rate of the microorganisms. With a high F/M ratio, there will be a lot of growth and reproduction of the bacteria. With a low F/M ratio, each microorganism will continue to need oxygen unitl it dies, and it will keep losing weight during life because cellular material is being changed to energy.

SETTLING

Some sludges do not flocculate as well as others. One of the reasons for this poor settling might be that a large number of micoorganisms in the wastewater are fungi. Because of their shape, fungi tend to hinder settling. There are other types of bacteria that grow into chain-like structures, and look like fungi. These chain-like organisms are called filamentous organisms.

One of the causes of sludge bulking is filamentous organisms. Another cause could be a high F/M ratio. The individual bacteria will be too active to stay in clusters, and will not flocculate.

Another reason for poor settling is hydraulic overloading. If there is too much flow coming through the secondary clarifier, it will cause sludge to rise and go out with the effluent.

The other major requirement for a good settling sludge is the presence of a large number of protozoa. These organisms eat the bacteria, and in doing so, produce a denser sludge which settles more readily.

FOLLOWING A PARCEL OF WASTEWATER THROUGH THE ACTIVATED SLUDGE SYSTEM

At the beginning of the aeration tank, the return activatedsludge is mixed with the wastewater. There is a high F/M ratio here. There is rapid growth of bacteria, and a high demand of oxygen.

In the middle of the aeration tank, the number of microorganisms has increased. But as this is happening, the food supply is decreasing. That is, the F/M ratio is becoming lower. At this point, fewer new cells are being produced. The amount of oxygen needed by the organisms keeps on decreasing.

At the end of the aeration tank, there is very little food that remains, and the oxygen requirements are low. The bacteria are less active and will start to form flocs unless there is too much mixing from aeration. Also, some of the bacteria may die. This mixed liquor goes on to the secondary clarifier.

The important condition in the secondary clarifier is the speed with which the floc settles. If the floc settles too fast, smaller particles will stay on the top. If the sludge does not settle fast enough, solids will escape in the effluent. The settling floc acts like a filter. As it moves down, it takes the smaller particles with it.

If the sludge has settled properly, the return activated sludge line will bring hungry microorganisms back to the head of the aeration tank, where the process starts again. Some of this activated sludge is wasted to keep the number of microorganisms at a manageable level. Also, wasting helps keep the bacteria staying in the system young and active, because some of the bacteria removed during wasting are old ones.

AERATION

Aeration is important because it supplies dissolved oxygen to the microorganisms, and because it provides mixing. This mixing keeps the organisms, organics and oxygen in constant contact.

The two main systems used to get air into the aeration tank are the diffused aeration system, and the mechanical aeration system.

In the diffused aeration system, air is forced through tubes into the mixed liquor and bubbles up through it. The amount of oxygen that will be dissolved into the mixed liquor depends on the size of the bubbles, and how long it takes the bubble to reach the surface. The farther down and the smaller the bubble size, the greater the efficiency of the aeration unit.

In the mechanical aeration system, a device like a paddle, wheel or brush is used to mix the mixed liquor and bring it into contact with the air. The device splashes water into the air, or air into the water, so that oxygen will be dissolved in the liquid.

ACTIVATED SLUDGE PROCESS VARIATIONS

Extended aeration: In the extended aeration plant, wastewater is pre-treated, and then goes on to biological treatment. There is no primary clarification of wastewater Pre-treated wastewater is aerated in an aeration tank for about a day, as compaed to 4 to 8 hours in the conventional system. Also, in the extended aeration plant the mixed liquor suspended solids concentration is usually more than twice that of a conventional plant, and the amount of sludge to be wasted is considerably reduced.

Oxidation ditch: The oxidation ditch operates on the same principle as the extended aeration plant. The differences are the shape, and the method used to aerate the wastewater. In the oxidation ditch, brush rotors provide the aeration and mixing, and move the liquor around the racetrack.

Contact stabilization: In the contact stablization plant, there is only a short period, about 30 to 60 minutes, for mixing raw wastewater and activated sludge. During this time, the organics collect on the surface of the sludge particles, and these solids are then settled out. These settled particles are aerated for another 2 to 6 hours. This allows the bacteria to complete the stabilization of the organics. The advantage of this process is that only a smaller quantity of liquid must be aerated, and this means a saving in aeration tank volume.

Tapered aeration: In the tapered aeration setup, more air is added to the head of the aeration tank, because this is where the oxygen demands are the greatest. The oxygen supply is decreased or tapered throughout the rest of the tank.

Step aeration process: In this setup, settled wastewater is introduced at several points along the aeration tank. This gets around the high initial oxygen demand if all of the wastewater enters at the head of the aeration tank.

OPERATIONAL POINTS

The effluent from the secondary clarifier should look clear and attractive. To get a good effluent, the sludge blanket should be in the lower half of the clarifier. You do not have a good effluent if it looks cloudy or if it has noticeable solids in it.

If you are to get a good effluent, then you have to monitor and control settleability, the solids level, and the dissolved oxygen level.

The following tests should be performed regularly:

1. Influent: B.O.D.; ph
2. Mixed Liquor: SS, D.O.; settling
3. Return Sludge: SS
4. Clarifier: Sludge Blanket Depth
5. Effluent: B.O.D.; SS; D.O.

Settleability: The sludge has to have good settling properties if you expect a good effluent. The sludge should be fairly dense so that enough can be pumped back to the aeration tank. The sludge blanket should be in the lower half of the tank.

In a well operated plant, the sludge volume index (SVI) can be as low as 50. But if SVI values are around 200, the sludge settling characteristics are quite poor. If it gets any worse, you can expect a lot of sludge in the plant effluent.

Another good way of finding out about the settleability of your sludge is to watch it as it settles. You might, for example, check every five minutes during the 30-minute settling test. A good sludge settles fairly rapidly during the first ten minutes. It will compact uniformly, and has a clear liquid above the sludge. After ten minutes, the settling rate drops. If a sludge acts like this, you can expect to get a reading that will give an SVI of 100 to 150.

If you have a very fast settling sludge, you will notice fast settling during the first five minutes of the 30-minute settling test, and then the settling rate drops. This kind of sludge settles so quickly that it leaves behind a pin-point floc. This pin-point floc will not settle and will end up in the effluent. A very fast settling sludge could be due to a low F/M ratio. What you might consider doing if you run into this problem is lower the MLSS level.

A slow settling sludge will settle at a very slow, constant rate during the time of the 30-minute settling test. A slow settling sludge usually has an SVI value greater than 200. The probable problem with this kind of sludge is that the F/M ratio is too high. To solve the problem, you should try for a higher MLSS level.

Another fast way of checking the settleability of the sludge is to check the depth of the sludge blanket. If the sludge is in the lower half of the clarifier, then you probably have a good settling sludge. This should be checked daily, so that you realize when there are changes in the depth. If the blanket is rising, you will have time to correct the situation before the sludge gets to the top.

The most common cause of a rising sludge blanket is hydraulic overloading. If you are overloaded and if the SVI is about 50 to 100, then you must reduce the flow through the clarifier.

Solids level: By solids level, we are referring to the amount of solids in the mixed liquor. The purpose of the mixed liquor suspended solids test is to measure the amount of active microorganisms in the aeration tank. Particularly we are concerned about the active microorganisms. The MLSS test measures a number of other things besides active microorganisms. It is more accurate to do a mixed liquor volatile suspended solids (MLVSS) test, because this test does not record the inorganic suspended solids. In any case, the MLSS concentration in the aeration tank should be kept at the same level as long as there is not great change in the strength of the wastewater.

The best mixed liquor suspended solids concentration is the one which produces a good effluent. You should experiment to find the best MLSS concentration for your plant.

Oxygen level: The D.O. level should be at least 2 mg/l. If it is any lower, protozoa will have difficulty growing, and there will be an increase in the number of filamentous organisms. Turbulence caused by trying to get the dissolved oxygen higher than 2 mg/l wastes energy and might hinder floc formation.

Usually the D.O. level will be lowest at the inlet end of the tank and highest at the outlet, with some areas of poor mixing and low D.O. Also, when influent loads are high, the D.O. will be low.

The D.O. level should be checked at the same location twice each shift. These readings will let you know if your D.O. concentration is what it should be. If the D.O. is too low, you could increase the amount of air going into the aeration tank, use extra aeration tanks, or try operating at a lower MLSS level.

Even with a good D.O. in the aeration tank, you will still need aeration so that the contents of the tank are well mixed. Poor mixing will mean low D.O. and maybe even anaerobic conditions in some part of the aeration tank. Also, there might be sludge settling out in these areas.

When you look at the tank, there should not be any "dead" areas, or areas where there is no mixing.

Training Sample 10

"A Prototype for Development of Routine Operational Procedures for the pH Determination of Wastewater and Wastewater Treatment Plant Effluents"

INSTRUCTIONAL PACKAGE WORKSHEET

National Training Center
Municipal Permits and Operations Division
Office of Water Program Operations
U.S. Environmental Protection Agency

GUIDELINES FOR INSTRUCTIONAL PACKAGE WORKSHEET

SUBJECT MATTER: pH Determination

UNIT OF INSTRUCTION: pH Determination of Wastewater and Wastewater Treatment Plant Effluents

LESSON NUMBER: 1 of 1

ESTIMATED TIME: 2 hours

JUSTIFICATION FOR THIS OBJECTIVE: The learner should know how to set up, calibrate, and use a pH meter for the pH determination of wastewater and wastewater treatemnt plant effluents.

ENTRY LEVEL BEHAVIOR:

A. Instructional Objective

1. Terminal Behavior - The learner will determine the pH of several standard solutions and typical samples of treatment plant effluents.

2. Conditions - The learner will have the use of the attached CH.pH. EMP.1.9.73 and all chemicals and equipment listed in it.

3. Accepted performance - Acceptable technique in performing the test will be determined by the instructor.

B. Instructional Resources

1. Available Media - XT-69, Slide/Tape Unit "ph Meter - Lab Operation." OT-11, Overhead Transparencies - 7.

2. Suggested Media -

C. Instructional Approach (Sequencing)

1. Discussion of the various types of available pH meters by the instructor.

2. Distribution of pre-instructional quiz to all participants.

3. Discussion of the operation of a pH meter by the instructor.

4. Showing of A/V unit XT-69 pH Determination of Wastewater and Wastewater Treatment Plant Effluents.

5. Laboratory exercise involving set up, calibration, and use of pH meter. Learner will use two prepared buffer solutions for calibration and will determine the pH of two prepared buffer solutions and three typical samples of treatment plant effluents.

6. Critique of the laboratory exercise by the instructor.

7. Distribution of post instructional quiz to all participants.

8. Review and grading of pre and post quizzes.

Training Sample 11
"Unit 11: Activated Sludge, Instructor Notebook"
TROUBLESHOOTING O & M PROBLEMS IN WASTEWATER TREATMENT FACILITIES
NTOTC
Cincinnati, Ohio 45268
December 1979

Lesson 3 of 14 lessons
Recommended Time: 25 minutes

Purpose: There are several variations of the activated sludge process. The most frequently used process var iations are conventional, contact stabilization, extended aeration and step feed activated sludge. The troubleshooter may encounter any of the variations during his/her technical assistance efforts. Hence, the troubleshooter must be familiar with the design and operating characteristics of each process variation.

Trainee Entry Level Behavior: The trainee should have achieved the learning objectives specified for Unit 11, Lesson 2, before beginning Unit 11, Lesson 3.

Trainee Learning Objectives: At the conclusion of this lesson, the trainee will be able to:

1. Using references in the Trainee Notebook, describe and compare the design and operational characteristics of the major variations of the activated sludge process and explain how a change in operating mode could be used to solve an activated sludge process control problem.

2. Cite examples from his/her experience which illustrate how mode change has been used or could have been used to solve an operational problem.

Instructional Approach: Illustrated lecture with trainee discussion.

Lesson Schedule: The 25 minutes allocated to this Lesson should be scheduled as follows:

TIME	SUBJECT
0 - 2 minutes	Introduce Lesson
2 - 20 minutes	Activated Sludge Process Variations
20 - 25 minutes	Examples of Mode Change In Process Troubleshooting

Trainee Materials Used in Lesson:

1. Trainee Notebook, page T11.3.1, "Activated Sludge Process Variations, Design and Operating Parameters."

2. Field Manual for Performance Evaluation and Troubleshooting at Municipal Wastewater Treatment Facilities, page 56-57.

Instructor Materials Used in Lesson:

1. Instructor Notebook, Unit 11, Lesson 3, pages 11.3.1-11.3.9.

2. Slides 179.2/11.3.1 - 179.2/11.3.6.

Instructor Materials Recommended for Development: The instructor should be prepared to cite one or two examples from his/her experience to illustrate the use of activated sludge mode variation as a troubleshooting or operational control tool.

Additional Instructor References:

1. Metcalf and Eddy, Inc., Wastewater Engineering Treatment Disposal Reuse, Chapters 9 and 10, McGraw-Hill Book Co., New York, NY (2nd edition, 1979).

2. Stewart, M.J., "Activated Sludge Process Variations. The Complete Spectrum," Article in 3 parts, Water and Sewage Works, 111(RN), pp. R241-R262 (November 30, 1964).

Classroom Set-Up: As specified in Unit 11, Lesson 1, page 11.1.4.

Lesson Outline

I. Introduce Lesson (2 minutes)

A. Reason for Lesson

1. Many variations to activated sludge process are used

2. Troubleshooters may encounter any of the variations

3. Troubleshooters must be familiar with design and operation of all process variations

B. Lesson Objectives

1. Review design and operational parameters for activated sludge process variations

2. Discuss use of mode change as an operational or troubleshooting tool

3. Cite examples showing use of mode change as a problem solving tool

C. Refer class to

1. Trainee Notebook, page T11.3.1 which lists parameters for activated sludge process variations

2. Field Manual for Performance Evaluation and troubleshooting at Municipal Wastewater Treatment Facilities, pages 56-57 which present schematic diagrams of process variations

Key Points & Instructor Guide

Use Slide 179.2/11.3.1
Slide 179.2/11.3.1 is a blank

II. Activated Sludge Process Variations (18 minutes)

A. Conventional Activated Sludge Process

1. Hydraulic and sludge detention times are solely dependent on influent flow rate and return sludge flow rate. Solids can accumulate only in the aeration basin or final clarifier. There is limited sludge storage capability.

2. Hence, a conventional system operating near the upper limits of the loading ranges may not be able to absorb shock loads, organic or hydraulic

3. Similarly, a conventional system which is under-loaded may produce over oxidized sludges and nitrified effluents which cause clarification problems.

Key Points & Instructor Guide

Use Slide 179.2/11.3.2
Slide 179.2/11.3.2 is a schematic flow diagram of the conventional plug flow activated sludge process

Note to Instructor: The flow schematic shows the WAS flow returned to the primary clarifier which is a common design for conventional systems. Better design practice is to avoid wasting to the primary clarifier and waste directly to the solids handling and disposal system because

1. Reduce load on primary clarifier and aeration system
2. Anoxic conditions in primary clarifier promote released of phosphorous which has been accumulated by the activated sludge and hence recycle of phosphorus through the system.

B. Contact Stablization, Two-Stage Aeration or Sludge Reaeration

1. Differentiate between contact stabilization (30 to 60 min. contact time), two-stage aeration (90 to 180 min. contact time) and conventional system with sludge reaeration (4 to 8 hr. contact time).

2. The reareation basin permits accumulation of sludge under aeration. This permits some flexibility in control of sludge aeration, permits accumulation of sludge to increase sludge inventory and reduce F/M, and provides a sludge buffer to prevent total solids washout under temporary severe hydraulic overload conditions (storm water after a storm).

3. Contact time of sludge with wastewater may limit BOD removal. System normally used where influent BOD is colloidal in nature

4. Note that many processes designed as contact stablilzation actually operate as two-stage aeration plants or as conventional plants with sludge reaeration because contact times exceed 60 minutes and stabilization times exceed eight hours. This is caused by flow rates being much less than design flow at newly constructed plants. Such underloaded plants tend to have very old, over-oxidized sludges which produce turbid effluents. Problem solution at such plants may be to convert operation to conventional or extended aeration modes by changing flow patterns.

Key Points & Instructor Guide

Use Slide 179.2/11.3.3

Slide 179.2/11.3.3 is a schematic flow diagram of a contact stabilization process

Comment on problems caused by not having a primary clarifier.

C. Extended Aeration

1. Characterized by low F/M and stable rapidly settling sludge.

2. Clarifiers are usually designed for relatively low surface loadings (200-400 gpd/ft2) resulting in fairly good clarification. Return rates are high (100% of influent flow).

3. Usually produce a fully nitrified or partially nitrified effluent. High return rate prevents denitrification in final clarifier.

4. Effluent is usually turbid because of ashing and the poor clarification achieved by rapidly settling sludges.

5. Very good BOD removals (95%+).

6. Resistant to shock loads because of large aeration volume (18-24 hour detention time).

Key Points & Instructor Guide

Use Slide 179.2/11.3.4

Slide 179.2/11.3.4 is a schematic flow diagram of an extended aeration facility

Comment on problems caused by not having a primary clarifier

D. Step Feed

1. Use step feed diagram to illustrate how mode change can be used in problem solving.

2. Step feed can be varied from conventional to contact mode. Use slide to show how this change is accomplished.

3. By increasing or decreasing the tank volume used for sludge reaeration the sludge inventory and sludge aeration time can be varied over wide ranges.

4. Conditions which might indicate mode change (assume that system is being operated in conventional mode before change is affected):

   a. Sudden increase in hydraulic load (storm water run-off) - change to contact mode to protect sludge inventory.

   b. Sludge begins to settle slowly and RR begins to increase - change to sludge reaeration mode to increase sludge inventory and sludge aeration time. Cause sludge to become more stable, settle faster and lower RR.

   c. Troubleshooter may see system as an extreme problem - very slow settling sludge spilling over weirs or severely over-oxidized sludge which has deflocculated and losing excess solids. Mode changes offer quick response to correct these conditions.

Key Points & Instructor Guide

Use Slide 179.2/11.3.5

Slide 179.2/11.3.5 is a schematic flow diagram of a step feed activated sludge plant

E. Other Variations

1. Complete Mixing

   a. Complete mixing provides some protection against "shock" or "slug" loads.

   b. Operating parameters

      1) F/M: 0.2-0.6 #BOD5/#MVLSS/day

      2) Aerator Loading: 50-120 #BOD5/1000 ft^3

      3) MLSS: 3000-6000 mg/l

      4) Detention Time: 3-5 hours

      5) MCRT: 5-15 days

      6) Return sludge flow rate: 25-100% of influent

   c. Higher loadings tend to produce a slower settling sludge than conventional processes but otherwise the operation is similar.

2. Oxidation Ditch-an extended aeration plant with an "oval doughnut" aeration basin configuration. Brush aerators are used to circulate mixed liquor around the aeration basin. Sometimes called a "Dutch Ditch" or "Race Track".

3. Tapered aeration - a conventional plug flow plant with the air application tapered from the head of the plant (high oxygen demand zone and higher aeration rate) to the effluent end of the tank (low oxygen demand zone and lower aeration rate).

<u>Key Points & Instructor Guide</u>

<u>Use Slide 179.2/11.4.5</u>
Slide 179.2/11.4.5 is a schematic diagram of the complete mixing activated sludge process

<u>Use Slide 179.2/11.3.6</u>
Slide 179.2/11.3.6 is a blank

Refer class to Field Manual for Performance Evaluation and Troubleshooting at Municipal Wastewater Treatment Facilities, page 57.

III. Examples of Mode Change for Process Trouble shooting (5 minutes)

A. Ask class to cite examples from their experience of mode changes used for process control or troubleshooting.

B. Discuss class inputs

C. Instructor should be prepared to cite examples if class does not offer examples.

Key Points & Instructor Guide

Example of Mode Change for Process Troubleshooting and Operational Control. (Example is based on the experiences of the Operational Technology Branch, National Training and Operational Technology Center, U.S. Environmental Protection Agency, Cincinnati, Ohio).

1. Plant design is about 2 MGD

2. Plant has two aeration basins which can be operated

   a. In series, plug flow

   b. In parallel

   c. One tank on-line, one tank off-line

   d. One tank as "Contact basin" and one tank as "reaeration basin"

3. Large portion of raw waste comes from a large bakery which discharges a high carbohydrate waste with high grease and oil content.

4. Plant has constant slow settling (bulking) sludge problems when aeration basins are operated in series or in parallel. Solids cannot be retained in the system.

5. By operating with one tank as a contact tank and the other as a reaeration tank, the solids could be retained and stabilized. However, prolonged operation in this mode resulted in over-oxidation of the sludge producing a fast settling sludge which left a turbid effluent which exceeded TSS standards.

6. Plant personnel were taught to monitor sludge settling characteristics and to switch the plant from the "reaeration operating mode" to an operating mode with the aeration tanks in parallel when sludge settling began to increase. As settling rates became slower, the plant was switched back to the "reaeration" mode.

7. The plant operated for over a year using mode change to control sludge quality and consistently produced a high quality effluent which exceeded NPDES permit requirements.

Training Sample 12
"Unit 11: Activated Sludge, Instructor Notebook"
TROUBLESHOOTING O & M PROBLEMS IN WASTEWATER TREATMENT FACILITIES
NTOTC
Cincinnati, Ohio 45268
December 1979

Lesson 7 of 14 lessons
Recommended Time: 90 minutes

Purpose: Four major process control decision making tools, F/M, MCRT, Sludge Settleability and RR, are used in activated sludge process control, evaluation and troubleshooting. Many operators and troubleshooters routinely use only one or two of these tools and, therefore, attempt to control the process based on limited or partial information. The problem solving exercise in this lesson requires the trainee to solve a generalized process control problem, identify the possible causes of the problem, describe how the actual problem cause would be determined and recommend corrective actions for each possible cause identified. The exercise forces the trainee to look at the interrelationships between the various process control decision making tools.

Trainee Entry Level Behavior: Trainees should have achieved the learning objectives specified for Unit 11, Lessons 1 - 6 before beginning this lesson.

Trainee Learning Objectives: At the conclusion of this lesson, the trainee will be able to:

1. Given design information about a model activated sludge treatment plant, information that a change has occurred in one of the parameters F/M, MCRT, Sludge Settleability or RR and using Trainee Notebook references and class notes, list all possible causes of the observed change in the process control parameter, describe the expected change in other process control parameters which would confirm each possible cause as the most likely cause and list the recommended process control responses to each possible cause of the observed change in the process control parameter.

2. When called upon by the instructor, report his/her findings for the given conditions and justify his/her recommendations for process control responses.

3. Using class notes and Trainee Notebook references, explain why it is necessary to consider concurrent changes in at least four parameters, F/M, MCRT, Sludge Settleability and RR, when evaluating an activated sludge system to identify problems and their probable causes.

Instructional Approach: Trainee problem solving in work groups of four trainees and discussion of trainee findings.

Lesson Schedule: The 90 minutes allocated to this lesson should be scheduled as follows:

TIME	SUBJECT
0 - 10 minutes	Instructor Introduces the Problem
10 - 45 minutes	Trainee Problem Solving
45 - 85 minutes	Trainees Report Findings
85 - 90 minutes	Instructor Summarized Lesson

Trainee Materials Used in Lesson:

1. Trainee Notebook, page T11.7.1, "Activated Sludge Process Troubleshooting, Problem Identification and Process Control Response - Problem Statement."

2. Trainee Notebook, page T11.7.4, "Activated Sludge Process Troubleshooting, Problem Identification and Process Control Response - Instructions for Completing Worksheet."

3. Trainee Notebook, page T11.7.5 - T11.7.12, "Activated Sludge Process Troubleshooting, Problem Identification and Process Control Response-Worksheets.

4. All trainee references and Trainee Notebook materials used in Unit 11, Lessons 1 - 6.

Instructor Materials Used in Lesson:

1. Instructor Notebook, Unit 11, Lesson 7, pages 11.7.1 -11.7.9.

2. Instructor Notebook, pages H11.7.1 - H11.7.37, "Activated Sludge Process Troubleshooting, Problem Identification and Process Control Response" (to be reproduced and distributed to trainees at the conclusion of the lesson.)

Instructor Materials Recommended for Development: None

Additional Instructor References: As specified in Unit 11, Lessons 1 - 6.

Classroom Set-Up:

1. Lesson Introduction: As specified in Unit 11, Lessons 1.

2. Trainee Problem Solving: One separate breakout room for each trainee workgroup so that individual work groups have a private quiet area in which to meet and discuss the work group's assigned problem.

3. Trainees Report Findings: As specified in Unit 11, Lesson 1.

Lesson Outline

I. Instructor Introduces the Problem (10 minutes)

A. Introduction

1. Have discussed several process control and evaluation tools and their significance.

a. F/M

b. MCRT

c. Sludge Settleability

d. RR

2. Now its time to apply what has been covered to activated sludge process troubleshooting.

3. Do this by developing a series of process control and troubleshooting guides.

Key Points & Instructor Guide

Refer class to Trainee Notebook, pages T11.7.1-T11.7.11 for a statement of the problem, instructions and worksheets.

B. Have class read Problem Situation

1. Refer class to Trainee Notebook, page T11.7.1-T11.7.2 for a statement of the situation. Trainee Notebook pages T11.7.1-T11.7.11 are included in the Instructor Notebook.

2. Emphasize that the situation is designed to provide a maximum of process control flexibility which is available to the operator and troubleshooter. The specifics of plant design are really immaterial to this problem.

3. The objective is to provide specific guidelines to the operator on how to correctly use the available process flexibility to achieve and maintain good effluent quality.

C. Instructions for Completing the Problem Worksheets

1. Refer class to Trainee Notebook, pages T11.7.4 - T11.7.11, "Activated Sludge Process Troubleshooting, Problem Identification and Process Control Response Worksheets" and page T11.7.3 for "Instructions for Completing Worksheets". These pages are included in the Instructor Notebook.

2. Review instructions and worksheets with the class.

<u>Key Points & Instructor Guide</u>

Instructor should refer to pages H11.7.1-H11.7.37 which are the completed worksheets to gain a better understanding of the expected trainee responses to the worksheet exercise.

D. Make Worksheet Assignments

1. Assign worksheets to trainee workgroups for completion.

   a. Trainee Group 1, page T11.7.4, F/M Increasing.

   b. Trainee Group 2, page T11.7.5, F/M Decreasing.

   c. Trainee Group 3, page T11.7.6, MCRT Increasing.

   d. Trainee Group 4, page T11.7.7, MCRT Decreasing.

   e. Trainee Group 5, page T11.7.8, MLSS RR Increasing.

   f. Trainee Group 6, page T11.7.9, MLSS RR Decreasing.

   g. Trainee Group 7, page T11.7.10, Settling Rate Increasing.

   h. Trainee Group 8, page T11.7.11, Settling Rate Decreasing.

2. Each work group should complete its assigned worksheet by working as a team. Stress the importance of discussion within the group.

3. Work groups will have about 35 minutes to complete their assigned worksheets.

4. Inform work groups that when the class reconvenes, each work group will report its findings to the class and justify its recommendations.

E. Direct Work Groups to Their Work Areas

1. Separate work areas, preferably separate rooms, should be provided for each work group so that the group may freely discuss the assigned problem and develop a group concensus solution without interfering with the work of another group.

2. Assign a work area to each group and give directions for finding the assigned work area.

F. Answer any questions about the exercise before sending groups to their work areas.

II. Trainee Problem Solving (35 minutes)

A. Circulate among work groups to monitor progress and answer questions.

B. Review each work group's product periodically and redirect their efforts as necessary.

C. If a group completes the assigned work sheet early, assign a second work sheet to the group.

D. Periodically inform groups of time remaining.

E. Reconvene groups in the main classroom at the end of the 35 minute work period.

III. Trainees Report Findings (40 minutes)

A. Reconvene class in main classroom.

B. Have work groups report their findings.

1. Call on groups sequentially, beginning with Group 1, to report findings (allocate about 8 minutes per group).

a. Group 1 - F/M Increasing

b. Group 2 - F/M Decreasing

c. Group 3 - MCRT Increasing

d. Group 4 - MCRT Decreasing

e. Group 5 - MLSS RR Increasing

f. Group 6 - MLSS RR Decreasing

g. Group 7 - Settling Rate Increasing

h. Group 8 - Settling Rate Decreasing

2. Encourage class discussion as each possible cause is presented.

3. Using the suggested solutions on pages H11.7.1-H11.7.37, challenge groups to justify their recommendations as appropriate.

4. Note that there is overlap and commonality between the correct responses for the eight observed conditions given in the worksheets, e.g., a rising F/M will cause a decreasing settling rate and an increasing MLSS RR which could be associated with a decreasing MCRT. Therefore, several groups should identify the same probable causes, confirmation observations and control responses. Use this information to draw several groups into the discussion.

5. Distribute solutions to the class after discussion is complete.

<u>Key Points & Instructor Guide</u>

School Solutions
Refer to pages H11.7.1-H11.7.7

Refer to pages H11.7.8-H11.7.13

Refer to pages H11.7.14-H11.7.15

Refer to pages H11.7.16-H11.7.19

Refer to pages H11.7.20-H11.7.23

Refer to pages H11.7.24-H11.7.28

Refer to pages H11.7.29-H11.7.33

Refer to pages H11.7-34-H11.7.37

Reproduce pages H11.7.1 - H11.7.37 in sufficient quantity to distribute to the class.

A. Using one solution sheet, page T11.7.4, the F/M increasing case, point out that there were many things which could have caused this observation. Point out that the correct process control response was different for each possible cause of the problem although several other control responses could be made to reverse the observed increase in F/M if this were the only information available to the operator and troubleshooter.

B. Point out that by looking at the four control parameters, F/M, MCRT, Sludge Settleability and MLSS RR, together it is fairly easy to eliminate several possible causes and narrow the list to the one most likely cause.

C. After identifying the cause of the problem, a correct process control response decision can be made.

D. Emphasize the importance of looking at all available information about the process before making a process control decision and changing process control variables. Incorrect control responses can be made if only one parameter is considered. This may cause more problems that it solves.

E. Recommend that routine monitoring of F/M, MCRT, Sludge Settleability and process respiration rates be considered for all activated sludge plants. If it is practical (personnel and dollar resources available) to institute a comprehensive process control management system, the process can be controlled to produce good effluents consistently.

Training Sample 13
"Unit 11: Activated Sludge, Trainee Notebook"
TROUBLESHOOTING O & M PROBLEMS IN WASTEWATER TREATMENT FACILITIES
NTOTC
Cincinnati, Ohio 45268
December 1979

Trainee Notebook Contents

Activated Sludge Process Troubleshooting

Problem Identification and Process Control Response

Problem Statement

While attending a local operator association meeting, you are introduced to John Schmitt, superintendent at a new 10 MGD step feed activated sludge plant. John has heard that you are an expert in activated sludge process control and asks you to help him solve recurrent process control problems which have occurred at the new plant. The plant has been in operation about a year but has never consistently produced a good effluent.

John informs you that he was superintendent at the city's old trickling filter plant which was replaced by the new activated sludge plant about a year ago. John confesses that he knows very little about activated sludge treatment and process control. Everything he knows about process control in the plant he got from the O & M manual which was prepared by the design firm as the new plant was constructed. Because he knows little about activated sludge, John has mechanically followed the process control procedure outlined in the O & M manual but has never been able to get the plant to perform properly.

The plant design flow is 10 MGD. There are separate storm water and sewage collection systems. The raw sewage is pumped to the plant headworks from a large lift station which is equipped with one variable speed 5000 gpm, one constant speed 5000 gpm and one constant speed 3000 gpm raw sewage pumps activated by level controllers in the wet well. Preliminary treatment consists of bar screening, comminution, grit removal and flow measurment. The pretreated waste is fed to two circular primary clarifiers. The primary effluent from the two tanks discharges to a common channel which feeds the aeration basin. The aeration basin has step feed capability at the quadrant points in the four pass plug flow aeration tank. Mixed liquor is distributed to two circular final clarifiers. The final clarifier effluent is chlorinated before discharging to the river. The underflow from the two clarifiers discharges to a common return sludge wet well. There are two variable speed 5000 gpm return sludge pumps. All return sludge discharges to the first quadrant of the aeration basin. Return sludge flow is metered, and the return sludge flow can be varied from 1400 to 10,000 gpm. Waste activated sludge is pumped from the return sludge wet well to the primary clarifiers. The waste sludge pump is a 1500 gpm constant speed pump activated by a time clock mechanism. There have been no problems in solids handling.

John informs you that there are several industries in town which discharge to the plant and sometimes cause relatively large variations in hydraulic and organic load to the plant. The average daily flow to the plant is 9.0 MGD.

John always operates the plant in the conventional treatment mode with all influent wastewater and return sludge entering the first quadrant of the aeration basin. John normally operates with a constant return sludge flow rate of about 6 MGD and only varies the return rate if the sludge blanket in the final clarifier begins to fall or rise. A constant volume of sludge is wasted each day because the waste rate has not been changed from the wasting rate set by the engineer during plant start-up.

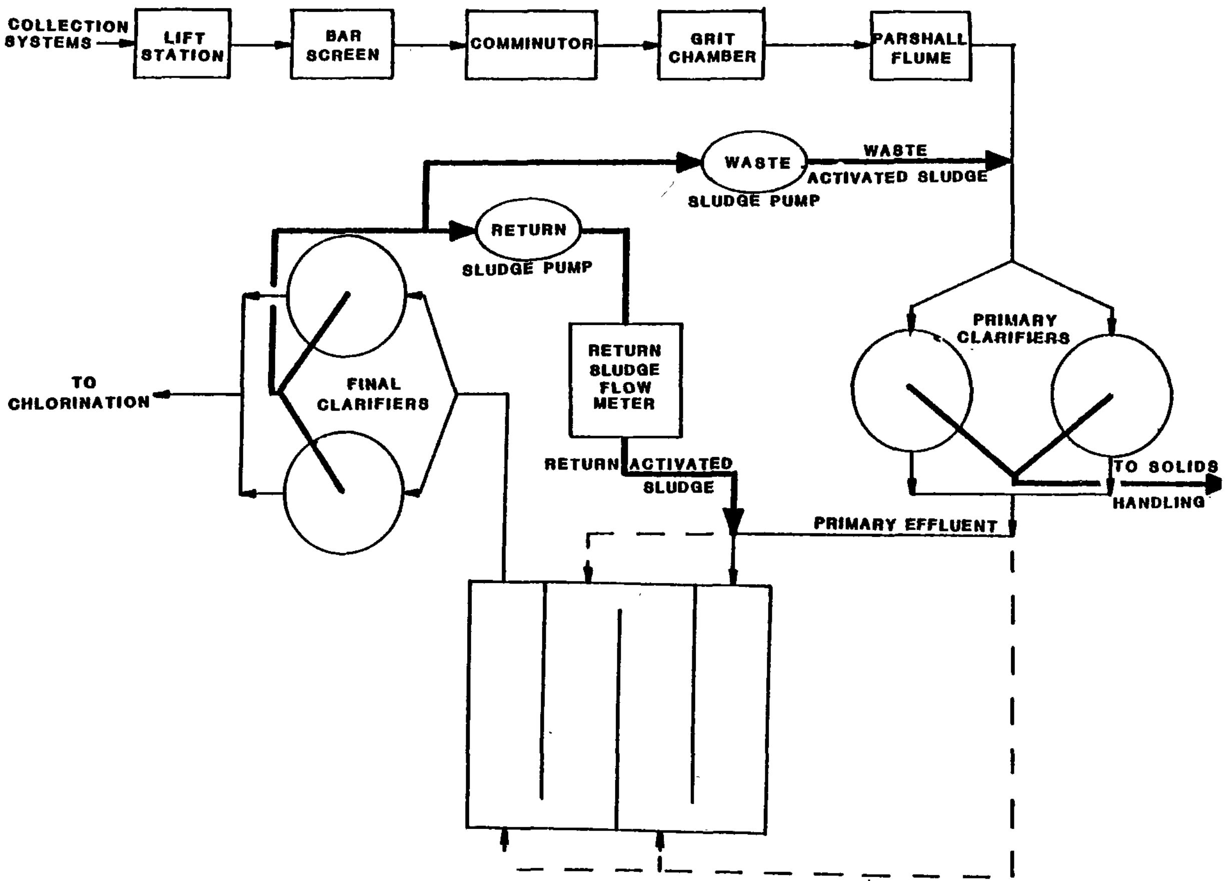
John tells you that plant performance is erratic. Sometimes the sludge bulks and washes out of the final clarifiers. Sometimes the sludge separates very well in the final clarifiers but leaves a turbid ashy type effluent. Sometimes the plant produces a good effluent but not very often. John is upset because he had been told that this plant would produce an excellent effluent and consistently meet his discharge permit requirement of 20 mg/l BOD and 20 mg/l TSS. But he can't seem to make the thing work.

John tells you that he has a well equipped laboratory and a good lab technician who's running all the tests specified in the O & M manual and the permit. John knows that these test results should be used in controlling the plant but he doesn't know what the test results mean or how to use them.

John wants you to teach him how to make the plant work. You decide to accept the job.

To accomplish the task, you decide to develop a series of process control and troubleshooting charts as work aids which John can use to help him interpret his process control laboratory data.

You will use the attached worksheets, pages T11.7.5 - T11.7.12 to develop the process control and troubleshooting charts. You and the members of your workgroup will be assigned one worksheet to complete. After you have completed your assigned worksheet, you will present the information from your worksheet to the class.



FLOW SCHEMATIC FOR USE IN PROBLEM SOLVING

Activated Sludge Process Troubleshooting

Problem Identification and Process Control Response

Instructions for Completing Worksheet

1. Prepare the worksheet in the context of the problem statement, i.e., a very flexible plant design which can accommodate many different process control adjustments in response to observed process conditions.

2. A change is observed in one process control parameter as specified at the top of the worksheet.

3. Possible Causes of Observed Condition. Possible Cause: List all things which could have occurred in the system to cause the change observed in the monitored parameter. Be as specific as possible. For example, if one possible cause for the observed condition is a change in applied load, specify the ways in which the load change could occur. Applied BOD load could increase because (a) the influent BOD concentration increases with flow remaining constant (b) the influent flow rate increases with the BOD concentration remaining constant, (c) both flow rate and BOD concentration increase, (d) an internal plant recycle stream is returned to the aeration basin, etc.

   Observations and Data to Confirm Cause: What additional observations and tests would you perform to confirm this as the cause of the problem and what result would you expect to see? For each possible cause, include the expected change in F/M, MCRT, Sludge Settleability and MLSS RR as your minimum entry in this column.

4. Process Control Response to Observed Condition. For each possible cause of the observed condition, enter the correct process control response. Process control responses should be considered as immediate or temporary (things to do right now to solve an immediate problem) and long term (things to be done which will correct the problem and prevent possible recurrence of the problem). For example, suppose the sludge settling rate decreases because of organic overload and the final clarifier sludge blanket becomes very high and solids wash-out from the clarifier is imminent. Then an immediate response may be to lower the sludge blanket by increasing return rate temporarily to prevent solids wash-out, but the long term solution to correct the problem may be to reduce return sludge rate and increase solids inventory. Be as exact and complete as possible in listing process control responses.

Activated Sludge Process Troubleshooting

Problem Identification and Process Control Response

<u>Worksheet</u>

PARAMETER MONITORED: F/M

CONDITION OBSERVED: F/M Increasing

POSSIBLE CAUSES OF OBSERVED CONDITION:

Possible Cause	Observations and Data to Confirm Cause
1.	
2.	
3.	
4.	
5.	

PROCESS CONTROL RESPONSE TO OBSERVED CONDITION:

Possible Cause	Immediate or Temporary Response	Long Term Corrective Action
1		
2		
3		
4		
5		

Training Sample 14
"Unit 11: Activated Sludge, Instructor Handout"
TROUBLESHOOTING O & M PROBLEMS IN WASTEWATER TREATMENT FACILITIES
NTOTC
Cincinnati, Ohio 45268
December 1979

Instructor Handout Contents

Activated Sludge Process Troubleshooting

Problem Identification and Process Control Response

PARAMETER MONITORED: F/M
OBSERVED CONDITION: F/M Increasing

POSSIBLE CAUSES OF OBSERVED CONDITION:

Observations and Data to Confirm Cause

1. Settling rate - decreasing
   MLSS RR - increasing
   MCRT - constant or slowly increasing
   Solids Inventory - constant or slowly increasing
   Fed Sludge RR - increasing
   Influent Flow Rate - about the same
   Aeration Basin D.O. - decreasing

   Possible Causes - Increased organic load caused by increased influent BOD concentration with little change in influent flow rate

2. Settling rate - decreasing or no change
   MLSS RR - increasing or no change
   MCRT - constant or slowly increasing
   Solids Inventory - constant or slowly increasing
   Fed Sludge RR - increasing
   Influent Flow Rate - decreasing
   Aeration Basin D.O. - decreasing or about the same

   Possible Causes - Increased organic load caused by increased influent BOD concentration with a decrease in influent flow rate

3. Settling Rate - usually decreasing
   MLSS RR - increasing
   MCRT - constant or slowly increasing
   Solids Inventory - constant or slowly increasing
   Fed Sludge RR - about the same
   Influent Flow Rate - increasing
   Aeration Basin D.O. - decreasing

   Possible Causes - Increased organic load caused by increase in influent flow rate with little change in influent BOD concentration

4. Settling Rate - decreasing or no change
MLSS RR - increasing or no change
MCRT - Constant or slowly increasing
Solids Inventory - constant or slowly increasing
Fed Sludge RR - decreasing
Influent Flow Rate - increasing
Aeration Basin D.O. - decreasing or about the same

Possible Causes - Increased organic load caused by increase in influent flow rate with a decrease in influent BOD concentration

5. Settling Rate - Decreasing
MLSS RR - increasing
MCRT - constant or slowly increasing
Solids Inventory - constant or slowly increasing
Fed Sludge RR - increasing
Influent Flow Rate - increasing
Aeration Basin D.O. - decreasing

Possible Causes - Increased organic load caused by increase in both influent BOD and influent flow rate

6. Settling Rate - decreasing
MLSS RR - increasing
MCRT - constant or slowly increasing
Solids Inventory - constant or slowly increasing
Fed Sludge RR - about the same if sample collected before recycle stream enters the aeration system
- increasing if sample collected after recycle stream enters the aeration system
Influent Flow Rate - about the same
Aeration Basin D.O. - decreasing

Possible Causes - Increased organic load caused by internal plant recycles

7. Settling Rate - decreasing
MLSS RR - increasing
MCRT - decreasing
Solids Inventory - decreasing
Fed Sludge RR - about the same
Aeration Basin D.O. - increasing or about the same

Possible Causes - Decrease in solids inventory caused by excessive deliberate wasting

8. Settling Rate - decreasing
   MLSS RR - increasing
   MCRT - decreasing
   Solids Inventory - decreasing
   Fed Sludge RR - about the same
   Influent Flow Rate - about the same
   Aeration Basin D.O. - increasing or about the same

   Possible Causes - Decrease in solids inventory caused by excessive effluent suspended solids

9. Settling Rate - no change
   MLSS RR - no change
   MCRT - no change
   Solids Inventory - no change
   Fed Sludge RR - no change or increasing
   Influent Flow Rate - about the same
   Aeration Basin D.O. - about the same

   Possible Causes - Nitrification occurring in BOD test used to measure applied load

PROCESS CONTROL RESPONSE TO OBSERVED CONDITIONS:

<u>Possible Cause 1</u>

1. Immediate or Temporary Response

   a. Check final clarifier sludge blanket depth.

      1. If the blanket is rising rapidly with possibility of solids washout, then temporarily increase return rate or waste rate to lower sludge blanket. Reduce return or waste rate as soon as blanket can be retained in final clarifier. <u>CAUTION</u>: Increased hydraulic load on clarifier may cause solids washout. This action may cause slow sludge settling problem to get worse before long range corrective actions affect process. This temporary response is a calculated risk!

      2. If the sludge blanket is not out of control, implement long term corrective actions.

   b. Check aeration basin D.O. If D.O. is less than 1 mg/l, increase air supply.

2. Long Term Corrective Action

   a. When sludge blanket can be retained in final clarifier, reduce return sludge flow rate-concentrates return sludge and increases aeration detention time.

   b. Reduce deliberate wasting to increase solids inventory and sludge aeration time. Continue to monitor F/M, sludge settleability and MLSS RR and balance system to new conditions of solids inventory and MCRT to treat increased load.

   c. If a and b don't work, then

      1. Increase aeration detention time by placing additional aeration basins into service.

      2. Increase sludge detention time by converting to sludge reaeration operating mode.

Possible Cause 2

1. Immediate or Temporary Response

   (Same as possible cause 1 responses)

2. Long Term Corrective Action

   a. If settling rate and MLSS RR are not changing, continue current operating practices but monitor settleability and MLSS RR frequently and respond to any changes which occur because of increased organic load.

   b. If settling rate is decreasing and MLSS RR is increasing, then implement corrective actions listed for possible cause 1.

Possible Cause 3

1. Immediate or Temporary Response

   (Same as possible cause 1 responses)

2. Long Term Corrective Actions

   (Same as possible cause 1 responses)

Possible Cause 4

1. Immediate or Temporary Response
   (Same as possible cause 1 responses)

2. Long Term Corrective Actions

   (Same as possible cause 2 reponses)

Possible Cause 5

1. Immediate or Temporary Response

   (Same as possible cause 1 responses)

2. Long Term Corrective Actions

   Same as possible cause 1 responses. Need to use additional aeration volume or sludge reaeration to handle new load is more likely for these influent load conditions.

Possible Cause 6

1. Immediate or Temporary Response
   a. Same as possible cause 1 responses

   b. Identify source of internal recycle and modify operations creating the internal recycle to eliminate or reduce the recycle, if possible

2. Long Term Corrective Actions

   a. Same as possible cause 1 responses

   b. If internal recycles cause serious problems which interfere with treatment of influent wastewater, the recycles cannot be eliminated and the aeration system cannot be controlled by responses in a, then

      1. Pre-treat recycle streams before returning to aeration system;

      2. Provide means to equalize recycle loads and bleed them into aeration system;

      3. Pre-aerate recycle streams before returning to aeration system;

      4. Consider and evaluate use of chemical additives such as coagulants and coagulant aids in aeration system to maintain process integrity.

Possible Cause 7

1. Immediate or Temporary Response

   (Same as possible cause 1 reponses)

2. Long Term Corrective Actions

   a. Decrease waste activated sludge to increase solids inventory. Monitor F/M and MCRT and readjust wasting rate when parameters are in optimum range.

   b. Decrease return activated sludge flow rate to concentrate return and increase aeration basin detention time

   c. If a and b are not effective

      1. Increase aeration volume in use

      2. Use sludge reaeration mode of operation

Possible Cause 8

1. Immediate or Temporary Response

   a. Same as possible cause 1 responses

   b. Check and evaluate final clarifier operation and design for possible problems

      1. Sludge collection, return or wasting systems not operating properly

         a. Rake or collector drive mechanism broken or shut off because of torque overload

         b. Broken chains

         c. Missing flights or scrappers

         d. Plugged collectors or pumps

         e. Pumps not operating

      2. Hydraulic overload

      3. Solids overload

      4. Improperly maintained clarifier weirs

5. Unequal load distribution to multiple clarifiers

6. Improperly designed clarifier

   a. High velocity currents at weirs

   b. Short circuiting

2. Long Term Corrective Action

   a. Same as possible cause 7 responses

   b. Correct final clarifier deficiencies
      1. Sludge collection, return or wasting systems not operating properly

         a. Repair or reset

         b. Repair or replace

         c. Repair

         d. Unplug collectors or pumps

         e. Repair or reset pumps

      2. Hydraulic overload

         a. Put additional clarifiers in service, if possible

         b. Reduce hydraulic load to clarifier, if possible

      3. Solids overload

         a. Put additional clarifiers in service

         b. Reduce solids load to clarifier, if possible

         c. Take actions to produce faster settling solids (possible cause 7 responses)

      4. Improperly maintained clarifier weirs

         (Check weirs for level and level if necessary)

5. Unequal load distribution to multiple clarifiers

    a. Check weirs to verify that all clarifiers have same weir elevation. Adjust as needed.

    b. Check inlet and effluent structures for obstructions - remove obstructions

    c. Check and adjust flow distribution system

6. Improperly designed clarifier

    a. High velocity currents at weirs
        1. Check adequacy of total weir length. Add weirs if needed

        2. Block excess weirs which may cause localized velocity currents

        3. If velocity currents caused by weir placement too close to wall, move weirs away from wall

    b. Short circuiting

        1. Check and adjust weirs

        2. Check adequacy of inlet target baffles and skirts. Correct target baffles and skirt deficiencies.

        3. If inlet velocities are excessive, provide mechanism to dampen inlet velocities

        4. Check for thermal stratification in clarifier. Eliminate cause of thermal stratification.

<u>Possible Cause 9</u>

1. Immediate or Temporary Response

    (None)

2. Long Term Corrective Action

    a. Continue operation using current practices if process is performing well and there are no other problems

b. Check, evaluate and correct BOD test procedure. Most likely cause is high nitrifier population in seed organisms used in BOD test

   1. Change seed

   2. Inhibit nitrification in BOD test using alternate procedure

   NOTE: This problem frequently occurs in effluent BOD determination also

c. Nitrification in influent BOD test may be desirable, and hence, this is not a problem.

PART III

Abstracted Reference Materials

TITLE	ACTIVATED SLUDGE.
AUTHOR	SCHROEDER, E. D.
CORP AUTH	CALIFORNIA UNIV., DAVIS.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 47 NO 6, P 1261-1269, JUNE, 1975. 101 REF.
KEYWORDS	*REVIEWS, *BIBLIOGRAPHIES, *ACTIVATED SLUDGE, *WASTE WATER TREATMENT, INDUSTRIAL WASTES, PHOSPHORUS, NITROGEN, NUTRIENT REMOVAL, DESIGN, OPERATIONS, MATHEMATICAL MODELS, AERATION, WASTE TREATMENT, WATER POLLUTION CONTROL, PULP WASTES, CONTROL, HEAVY METALS, BIOCHEMISTRY, MICROBIOLOGY, TOXINS, SLUDGE TREATMENT, SLUDGE DISPOSAL, ECONOMICS, COSTS.
ABSTRACT	THE 1974 LITERATURE ON THE TREATMENT OF WASTE WATERS BY THE ACTIVATED SLUDGE PROCESS IS REVIEWED. TOPICS DISCUSSED INCLUDE: PROCESS MODELS, CONTROL, AND DESIGN AND OPERATION OF ACTIVATED SLUDGE PLANTS; MICROBIOLOGY AND BIOCHEMISTRY OF THE PROCESS; REMOVAL OF HEAVY METALS AND EFFECTS OF TOXICANTS; INDUSTRIAL WASTE WATER TREATMENT; AERATION; NITROGEN AND PHOPHORUS REMOVAL; SLUDGE THICKENING AND DISPOSAL; AND COSTS OF ACTIVATED SLUDGE PLANTS. REFINERY, PULP AND PAPER, AND DISTILLERY WASTES ARE CITED AS EXAMPLES OF SOME OF THE WASTE MATERIALS THAT ARE BEING TREATED BY THE ACTIVATED SLUDGE PROCESS. (WITT-IPC)

TITLE	ACTIVATED SLUDGE BASIC DESIGN CONCEPTS.
AUTHOR	MCKINNEY, ROSS E.; OFERIEN, WALTER J.
CORP AUTH	KANSAS UNIV., LAWRENCE.
AVAIL	JOURNAL OF WATER POLLUTION CONTROL FEDERATION, VOL 40, NO 11, PART 1, P 1831-1834, NOV 1968. 16 REF.
IDEN	SCREENING, PRIMARY SEDIMENTATION, SECONDARY SEDIMENTATION.
KEYWORDS	*ACTIVATED SLUDGE, *AERATION, *DESIGN, *WASTE WATER TREATMENT, HISTORY, MIXING, SETTLING BASINS, SLUDGE DISPOSAL.
ABSTRACT	THE DESIGN OF ACTIVATED SLUDGE SYSTEMS HAS EVOLVED SLOWLY AND PROGRESS HAS BEEN MADE LARGELY ON AN EMPIRICAL BASIS. THIS PAPER PRESENTS THE BASIC DESIGN CONCEPTS FOR A MODERN ACTIVATED SLUDGE SYSTEM INCLUDING THE FOUNDATIONS ON WHICH THESE CONCEPTS WERE DEVELOPED. DESIGN PARAMETERS DEVELOPED FOR CONVENTIONAL AND COMPLETELY MIXED SYSTEMS INDICATE THAT AERATION WILL BE FROM 3 TO 8 HOURS. TOTAL MLSS WILL RANGE FROM 1500 TO 4000 MG/L, ORGANIC LOADS OF 0.5 TO 0.7 LB BOD/LB

MICROBIAL SOLIDS WILL YIELD GOOD OPERATIONS, AND DIFFUSED AERATION OF 1000 CUBIC OF AIR PER POUND OF BOD REMOVED IS A SOUND PARAMETER. ALL ASPECTS OF ACTIVATED SLUDGE SCHEMES ARE DISCUSSED WITH DESIGN PARAMETERS GIVEN. (HANCUFF-TEXAS)

TITLE	ACTIVATED SLUDGE PROCESS WORKSHOP MANUAL
PUB DATE	JUL 76
AVAIL	PUBLICATIONS CENTRE, ONTARIO MINISTRY OF GOVERNMENT SERVICES, 880 BAY STREET, 5TH FLOOR, TORONTO, ONTARIO, CANADA M7A 1N8 ($2.00; ORDERS MUST BE ACCOMPANIED BY CHECK OR MONEY ORDER PAYABLE TO "THE TREASURER OF ONTARIO")
DESC	*BEHAVIORAL OBJECTIVES, *CHEMISTRY, *ENVIRONMENTAL EDUCATION, ENVIRONMENTAL TECHNICIANS, JOB SKILLS, *POLLUTION, WASTE DISPOSAL, *WATER POLLUTION CONTROL, *WORKSHOPS, ACTIVATED SLUDGE, ONTARIO
ERIC NO.	ED155033
EDRS PRICE	EDRS PRICE MF-$0.83 PLUS POSTAGE. HC NOT AVAILABLE FROM EDRS
DESC NOTE	242P.; FOR RELATED DOCUMENT, SEE SE 024 226-233; NOT AVAILABLE IN HARD COPY DUE TO COPYRIGHT RESTRICTIONS; CONTAINS COLORED PAGES WHICH MAY NOT REPRODUCE WELL
ISSUE	RIEOCT78
ABSTRACT	THIS MANUAL WAS DEVELOPED FOR USE AT WORKSHOPS DESIGNED TO UPGRADE THE KNOWLEDGE OF EXPERIENCED WASTEWATER TREATMENT PLANT OPERATORS. EACH OF THE LESSONS IN THIS DOCUMENT HAS CLEARLY STATED BEHAVIORAL OBJECTIVES TO TELL THE TRAINEE WHAT HE SHOULD KNOW OR DO AFTER COMPLETING THAT TOPIC. AREAS COVERED IN THIS MANUAL INCLUDE: TYPES AND FACTORS AFFECTING ACTIVATED SLUDGE PROCESSES, IDENTIFICATION AND SOLUTION OF OPERATING PROBLEMS, SELECTED TESTS AND MEASUREMENT, AND CHEMICAL DETERMINATIONS. A GLOSSARY OF TERMS IS INCLUDED FOR REFERENCE. (CS)

TITLE	ACTIVATED SLUDGE. TRAINING MODULE 2.117.4.77.
PUB DATE	SEP 77
DESC	*INSTRUCTIONAL MATERIALS, *POST SECONDARY EDUCATION, SECONDARY EDUCATION, *TEACHING GUIDES, *UNITS OF STUDY, *WATER POLLUTION CONTROL, *ACTIVATED SLUDGE, OPERATIONS (WASTEWATER), *WASTEWATER TREATMENT
ERIC NO.	ED151222
EDRS PRICE	EDRS PRICE MF-$0.83 HC-$6.01 PLUS POSTAGE

DESC NOTE — 11P.: FOR RELATED DOCUMENTS, SEE SE 024-025-447; CONTAINS SMALL TYPE IN FIGURES

ISSUE — RIEJUL78

ABSTRACT — THIS DOCUMENT IS AN INSTRUCTIONAL MODULE PACKAGE PREPARED IN OBJECTIVE FORM FOR USE BY AN INSTRUCTOR FAMILIAR WITH OPERATION OF ACTIVATED SLUDGE WASTEWATER TREATMENT PLANTS. INCLUDED ARE OBJECTIVES, INSTRUCTOR GUIDES, STUDENT HANDOUTS, AND TRANSPARENCY MASTERS. THIS IS THE THIRD LEVEL OF A THREE MODULE SERIES AND CONSIDERS DESIGN AND OPERATION PARAMETERS, PROCESS CONTROL PROCEDURES, INTERPRETATION OF TREND CHART DATA AND THE OXYGEN UPTAKE TEST. (AUTHOR/RH)

TITLE — ACTIVATED SLUDGE-UNIFIED SYSTEM DESIGN AND OPERATION

AUTHOR — KEINATH, T. M.; RYCKMAN, M. D.; DANA, C. H.; HOFER, D. A.

CORP AUTH — CLEMSON UNIV., SC. DEPT. OF ENVIRONMENTAL SYSTEMS ENGINEERING.

PUB DESC — JOURNAL OF THE ENVIRONMENTAL ENGINEERING DIVISION, PROCEEDINGS OF ASCE, VOL 013, NO EE5, P 829-849, OCTOBER, 1977. 11 FIG, 2 TAB, 19 REF, 1 APPEND

DESC — *ACTIVATED SLUDGE, *ANALYTICAL TECHNIQUES, *SEDIMENTATION RATES, *TREATMENT FACILITIES, *DESIGN, BIOLOGICAL TREATMENT, OPERATION AND MAINTENANCE, EVALUATION, AERATION, WASTE WATER TREATMENT

ABSTRACT — THE SETTLING FLUX APPROACH CAN BE ADAPTED FOR EVALUATING ECONOMIC TRADEOFFS BETWEEN ALTERNATIVE DESIGNS FOR WASTE WATER TREATMENT SYSTEMS. THE DESIGN BASIS FOR THE AERATOR INCORPORATES SOLIDS RESIDENCE TIME AND HYDRAULIC RESIDENCE TIME. THE DESIGN BASIS FOR THE CLARIFIER INCORPORATES THE CLARIFICATION CONSTRAINT, AND A RECYCLE RATE CONSTRAINT. THIS METHODOLOGY CAN BE USED FOR EVALUATING THE ECONOMIC ASPECTS OF AN ACTIVATED SLUDGE SYSTEM CONSISTING OF AN AERATION BASIN, CLARIFIER, AND SLUDGE PROCESSING EQUIPMENT. THE SETTLING-FLUX APPROACH CAN ALSO BE USED IN OPERATIONS MONITORING OF AN ACTIVTED SLUDGE SYSTEM. THIS APPROACH INDICATES THAT INCREASED HYDRAULIC FLOW RATES WOULD ONLY CAUSE SOLIDS TO ENTER THE EFFLUENT AT CERTAIN CRITICALLY LOCATED POINTS NEAR THE SETTLING FLUX CURVE. FOR DECREASED HYDRAULIC FLOW RATES, THE RECYCLE RATE COULD BE REDUCED TO THE POINT OF CRITICAL LOADING. THE SETTLING FLUX APPROACH INDICATES THAT THE FLOW PROPORTIONAL RECYCLE CONTROLS CAN ESTIMATE THE

REQUIRED FLOW FAIRLY ACCURATELY. IT DOES NOT, HOWEVER, PROVIDE THE PRECISE RECYCLE RATE REQUIRED TO MAINTAIN THE CLARIFIER IN A CRITICALLY LOADED CONDITION. THIS APPROACH CAN ALSO ESTABLISH THE HYDRAULIC SURGE THAT A SYSTEM COULD ACCOMMODATE WITHOUT INDISCRIMINATE SOLIDS WASTING. THIS APPROACH CAN ONLY BE USED FOR OPERATIONS MONITORING AND CONTROL IF CURRENT SETTLING FLUX CURVES ARE AVAILABLE. CHANGES IN THE OPERATIONAL SET-POINT OF SOLIDS RESIDENCE TIME CAN BE ACCOMMODATED BY CHANGES IN THE SOLIDS WASTING PROGRAM. (SNYDER-FIRL)

TITLE AERATION: PROPER SIZING IS CRITICAL.
AUTHOR SHERRARD, J. H.
CORP AUTH VIRGINIA POLYTECHNIC INST. AND STATE UNIV., BLACKSBURG. DEPT. OF CIVIL ENGINEERING.
AVAIL WATER AND WASTES ENGINEERING, VOL 14, NO 4, P 62, 66-67, 71, APRIL, 1977. 4 FIG, 4 TAB, 6 REF.
IDEN MECHANICAL AERATORS
KEYWORDS *AERATION, *TREATMENT FACILITIES, *DESIGN, PERFORMANCE, ACTIVATED SLUDGE, MECHANICAL EQUIPMENT, OXYGEN, TEMPERATURE, MICROORGANISMS, OPERATIONS, BIOCHEMICAL OXYGEN DEMAND, NITROGEN, NITRIFICATION, *WASTE WATER TREATMENT
ABSTRACT THE SELECTION OF LOW SPEED MECHANICAL AERATORS WAS CONSIDERED. ANY AERATION METHOD MUST PRODUCE ENOUGH MIXING TO MAINTAIN ACTIVATED SLUDGE FLOC IN SUSPENSION AND SUPPLY SUFFICIENT OXYGEN TRANSER TO MEET THE DEMANDS OF MICROBIAL GROWTH. EQUATIONS WERE PROVIDED TO HELP JUDGE A GIVEN AERATOR'S PERFORMANCE. MECHANICAL AERATORS MUST MEET TWO STANDARDS: POWER, AND SUFFICIENT OXYGEN FOR MICROBIAL METABOLISM. THE FIRST DEPEND UPON THE TYPE OF AERATOR AND THE GEOMETRY OF THE BASIN. THE LATTER INVOLVES OXYGEN FOR ORGANIC REMOVAL AND NITRIFICATION, AND DEPENDS ON PLANT OPERATION AND THE BOD5/ORG-N + NH(+4) - N RATIO. BIOKINETIC COEFFICIENTS SHOULD BE ESTABLISHED TO MAKE QUALITY AND OXYGEN NEEDS PREDICTABLE AS A FUNCTION OF TREATMENT PROCESS OPERATING CONDITIONS. SEVERAL EXAMPLES OF TYPICAL SOLUTIONS WERE PRESENTED. IT WAS CONCLUDED THAT THE USE OF A RATIO OF 1 MG/LITER OF OXYGEN TO 1 MG/LITER OF BOD5 COULD BE MISLEADING AND RESULT IN A FAULTY SELECTION. NITROGENOUS OXYGEN DEMAND FROM NITRIFICATION SHOULD BE USED FOR AERATOR SELECTION IF HIGHER MEAN CELL RESIDENCE TIME VALUES ARE USED. OXYGEN TRANSFER REQUIREMENTS CAN BE MET IN SOME INSTANCES

BY LOWERING PROCESS MEAN CELL RESIDENCE TIME TO DECREASE OXYGEN NEEDS. (COLLINS-FIRL)

TITLE AN AUTOMATED SPECTROPHOTOMETRIC SUSPENDED SOLIDS ANALYSIS FOR ACTIVATED SLUDGE.
AUTHOR FINGER, R. E.; STRUTYNSKI, B. J.
CORP AUTH MUNICIPALITY OF METROPOLITAN SEATTLE, RENTON, WASH. RENTON TREATMENT PLANT
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 47, NO 5, P 1043-1054, MAY, 1975. 11 FIG, 4 TAB, 15 REF.
IDEN *SLUDGE VOLUME INDEX
KEYWORDS *ACTIVATED SLUDGE, *BIOLOGICAL TREATMENT, *SUSPENDED SOLIDS, *WASTE WATER TREATMENT, COLORIMETRY, AUTOMATION, SAMPLING, MEASUREMENT, ANALYTICAL TECHNIQUES, *POLLUTANT IDENTIFICATION, *SPECTROPHOTOMETRY
ABSTRACT THE MEASUREMENT OF SUSPENDED SOLIDS (SS) CONCENTRATION IN BIOLOGICAL WASTE TREATMENT IS USED AS A PRIMARY CONTROL, FOR PROCESS ADJUSTMENT. THE SS MEASUREMENT IS NECESSARY FOR CALCULATION OF CELL RESIDENCE TIME, ORGANIC LOADING, AND SLUDGE VOLUME INDEXES, THE DETERMINATION OF TYPES OF POLYSACCHARIDES ASSOCIATED WITH ACTIVATED SLUDGE AND THEIR EFFECTS ON THE PHYSICAL CHARACTERISTICS OF SLUDGE HAVE BEEN INVESTIGATED BY A SIMPLE COLORIMETRIC TEST. THE PURPOSE OF THIS STUDY WAS TO CONSIDER THE POSSIBILITY OF ADAPTING THIS TEST TO AN AUTOMATED PROCEDURE. A MANUAL COLORIMETRIC PROCEDURES WHICH TAKES TWO OR THREE HOURS WAS FIRST TESTED AND IT PROVED TO EFFECTIVELY MEASURE MIXED LIQUOR SUSPENDED SOLIDS AND VSS. THE AUTOMATED SPECTROPHOTOMETRIC SS TEST TAKES ONLY FIFTEEN MINUTES AND WAS DEMONSTRATED TO BE PRACTICAL FOR USE ON A CONTINUOUS BASIS. THE MAJOR PROBLEM WITH THE TECHNIQUE IS SAMPLING, WHICH MAY BE IMPROVED BY THE INSTALLATION OF A HOMOGENIZATION SYSTEM. (PRAGUE-FIRL)

TITLE BASIC ACTIVATED SLUDGE. TRAINING MODULE 2.115.2.77.
PUB DATE SEP 77
DESC *INSTRUCTIONAL MATERIALS, *POST SECONDARY EDUCATION, SECONDARY EDUCATION, *TEACHING GUIDES, *UNITS OF STUDY, *WATER POLLUTION CONTROL, *ACTIVATED SLUDGE, OPERATIONS (WASTEWATER); *WASTEWATER TREATMENT
ERIC NO. ED151220

EDRS PRICE	EDRS PRICE MF-$0.83 HC $4.67 PLUS POSTAGE
DESC NOTE	93P.; FOR RELATED DOCUMENTS, SEE SE 024 025-047; CONTAINS OCCASIONAL LIGHT AN DBROKEN TYPE.
ISSUE	RIEJUL78
ABSTRACT	THIS DOCUMENT IS AN INSTRUCTIONAL MODULE PACKAGE PREPARED IN OBJECTIVE FORM FOR USE BY AN INSTRUCTOR FAMILIAR WITH OPERATION OF ACTIVATED SLUDGE WASTEWATER TREATMENT PLANTS. INCLUDED ARE OBJECTIVES, INSTRUCTOR GUIDES, STUDENT HANDOUTS, AND TRANSPARENCY MASTERS. THIS IS THE FIRST OF A THREE MODULE SERIES AND CONSIDERS, DEFINITION OF TERMS, DESIGN AND OPERATION PARAMETERS, PROCESS OBSERVATIONS, BASIC PROCESS CONTROLS AND CONTROL TESTS. (AUTHOR/RH)
INSTITUTION NAME	KIRKWOOD COMMUNITY COLL., CEDAR RAPIDS, IOWA.

TITLE	BASIC LABORATORY SKILLS. TRAINING MODULE 5.300.2.77.
PUB DATE	SEP 77
DESC	*BIOLOGY, *CHEMISTRY, *INSTRUCTIONAL MATERIALS, *LABORATORY PROCEDURES, *LABORATORY TECHNIQUES, POST SECONDARY EDUCATION, SECONDARY EDUCATION, UNITS OF STUDY, WATER POLLUTION CONTROL, WATER RESOURCES, *WASTEWATER TREATMENT, *WATER TREATMENT
ERIC NO.	ED153866
EDRS PRICE	EDRS PRICE MF-$0.83 HC-$10.03 PLUS POSTAGE
DESC NOTE	195P.; FOR RELATED DOCUMENTS, SEE SE 024 249-254
ISSUE	RIESEP78
ABSTRACT	THIS DOCUMENT IS AN INSTRUCTIONAL MODULE PACKAGE PREPARED IN OBJECTIVE FORM FOR USE BY AN INSTRUCTOR FAMILIAR WITH THE BASIC CHEMICAL AND MICROBIOLOGICAL LABORARORY EQUIPMENT AND PROCEDURES USED IN WATER AND WASTEWATER TREATMENT PLANT LABORATORIES. INCLUDED ARE OBJECTIVES, INSTRUCTOR GUIDES, STUDENT HANDOUTS AND TRANSPARENCY MASTERS. THIS MODULE CONSIDERS LAB SAFETY, BENCH SHEETS, LABELING, SAMPLING, SOLUTIONS, DILUTION TECHNIQUES, INCUBATORS, BALANCES, GLASSWARE, STANDARDIZATION, STANDARD CURVES, EQUIPMENT PACKAGING, AUTOCLAVES, MICROSCOPES AND ASEPTIC TECHNIQUES. (AUTHOR/RH)
INSTITUTION NAME	KIRKWOOD COMMUNITY COLL., CEDAR RAPIDS, IOWA.

TITLE	BASIC SEWAGE TREATMENT OPERATION.
PUB DATE	NOV 76
AVAIL	PUBLICATIONS CENTRE, ONTARIO MINISTRY OF GOVERNMENT SERVICES, 880 BAY STREET, 5TH FLOOR, TORONTO, ONTARIO, CANADA M7A 1N8 ($2.00; ORDERS MUST BE ACCOMPANIED BY CHECK OR MONEY ORDER PAYABLE TO "THE TREASURER OF ONTARIO")
DESC	*BEHAVIORAL OBJECTIVES, *ENVIRONMENTAL EDUCATION, ENVIRONMENTAL TECHNICIANS, JOB SKILLS, *POLLUTION, SAFETY, SAMPLING, WASTE DISPOSAL, *WATER POLLUTION CONTROL, *WORKSHOPS, ONTARIO
ERIC NO.	ED155001
EDRS PRICE	EDRS PRICE MF-$0.83 PLUS POSTAGE. HC NOT AVAILABLE FROM EDRS.
DESC NOTE	247P.; FOR RELATED DOCUMENTS, SEE SE 024 227-233; NOT AVAILABLE IN HARD COPY DUE TO COPYRIGHT RESTRICTIONS; CONTAINS COLORED PAGES WHICH MAY NOT REPRODUCE WELL.
ISSUE	RIEOCT78
ABSTRACT	THIS MANUAL WAS DEVELOPED FOR USE AT WORKSHOPS DESIGNED TO INTRODUCE OPERATORS TO THE FUNDAMENTALS OF SEWAGE PLANT OPERATION. THE COURSE CONSISTS OF LECTURE-DISCUSSIONS AND HANDS-ON ACTIVITIES. EACH OF THE LESSONS HAS CLEARLY STATED BEHAVIORAL OBJECTIVES TO TELL THE TRAINEE WHAT HE SHOULD KNOW OR DO AFTER COMPLETING THAT TOPIC. AREAS COVERED IN THIS MANUAL INCLUDE: INTRODUCTION TO SEWAGE TREATMENT, BACTERIOLOGY, PRIMARY TREATMENT, ACTIVATED SLUDGE PROCESS, SAMPLING, AND RECORD KEEPING, SAFETY, AND SELECTED TESTS. A GLOSSARY OF TERMS IN INCLUDED FOR REFERENCE. (CS)

TITLE	BIOLOGICAL AND CHEMICAL WASTE TREATMENT EXPERIMENTS IN FAR NORTHERN SWEDEN
AUTHOR	BALMER, P.
AVAIL	IN: INTERNATIONAL SYMPOSIUM ON WATER POLLUTION CONTROL IN COLD CLIMATES, JULY 22-24, 1970, UNIVERSITY OF ALASKA, COLLEGE, P 252-262, 6 FIG, 6 TAB, 5 REF.
IDEN	*KIRUNA (SWEDEN), *CHEMICAL TREATMENT

KEYWORDS	*BIOLOGICAL TREATMENT, *WASTE WATER TREATMENT, *ACTIVATED SLUDGE, TEMPERATURE, BACTERIA, *AERATION, FLOCCULATION, COSTS, COLD REGIONS, CHEMICAL PRECIPITATION, PHOSPHORUS, SUSPENDED SOLIDS, SLUDGE, PILOT PLANTS, SEWAGE, RECIRCULATED WATER, SETTLING BASINS, HYDROGEN ION CONCENTRATION, EFFLUENTS
ABSTRACT	LABORATORY DATA SHOW THAT THE METABOLIZING ACTIVITY OF ACTIVATED SLUDGE IS SERIOUSLY HAMPERED AT LOW TEMPERATURES, AND BOD REDUCTION DATA IN ACTIVATED SLUDGE SYSTEMS AT LOW TEMPERATURES ARE PARTLY CONTRADICTORY. PILOT PLANT EXPERIMENTS WERE CONDUCTED WITH ACTIVATED SLUDGE AND CHEMICAL TREATMENT. THE ACTIVATED SLUDGE TREATMENT PROVED THAT BIOLOGICAL TREATMENT IS POSSIBLE EVEN AT VERY LOW SEWAGE TEMPERATURES. AS THE METABOLIZING ACTIVITY OF THE ACTIVATED SLUDGE BACTERIA IS CONSIDERABLY REDUCED, LONG AERATION PERIODS, 4-5 HOURS, AND LARGE AERATION BASINS, ARE REQUIRED. CHEMICAL TREATMENT IS MUCH LESS SENSITIVE TO LOW TEMPERATURES AND REQUIRES ONLY ABOUT 0.5 HOUR DETENTION TIME IN FLOCCULATION TANKS. DIFFERENCE IN INVESTMENT COSTS WILL IN MANY INSTANCES BE SO LARGE THAT THE INCREASED RUNNING COSTS ARE JUSTIFIED. IF A COMMUNITY HAS AN EXISTING PRIMARY TREATMENT PLANT WITH A LONG DETENTION TIME (MORE THAN 2 HOURS), IT MAY BE POSSIBLE TO ACHIEVE A SUBSTANTIAL INCREASE IN TREATMENT EFFICIENCY SIMPLY ADDING FLOCCULATING CHEMICALS TO THE INFLUENT. BOD REMOVAL WITH CHEMICAL TREATMENT IS SOMEWHAT INFERIOR TO WHAT CAN BE ACHIEVED WITH BIOLOGICAL TREATMENT. THIS DRAWBACK, HOWEVER, IS COMPENSATED BY SUPERIOR PHOSPHORUS REMOVAL. (SEE ALSO W72-12548) (JONES-WISCONSIN)
TITLE	BIOMASS DETERMINATION - A NEW TECHNIQUE FOR ACTIVATED SLUDGE CONTROL.
CORP AUTH	BIOSPHERICS INC., ROCKVILLE, MD.
AVAIL	COPY AVAILABLE FROM GPO SUP DOC EPA 17050 EOY 01/72, $1.25; MICROFICHE FROM NTIS AS PB-211 127, $0.95. ENVIRONMENTAL PROTECTION AGENCY, WATER POLLUTION CONTROL RESEARCH SERIES, NO 17050 EOY. JANUARY 1972, 116 P, 53 FIG, 22 TAB, 18 REF, EPA PROGRAM 17050 EOY 01/72.

IDEN *ATP, *PROCESS CONTROL, *ADENOSINE TRIPHOSPHATE

KEYWORDS *ACTIVATED SLUDGE, *ANALYTICAL TECHNIQUES, *WATER QUALITY, *CONTROL, MONITORING, SUSPENDED SOLIDS, *BIOMASS, SEPARATION TECHNIQUES, LABORATORY TESTS, PILOT PLANTS, ON-SITE INVESTIGATIONS, *WASTE WATER TREATMENT

ABSTRACT RESEARCH WAS CONDUCTED TO DETERMINE THE FEASIBILITY OF USING ADENOSINE TRIPHOSPHATE (ATP) AS A MEASURE OF VIABLE BIOMASS IN ACTIVATED SLUDGE. METHODS WERE DEVELOPED FOR THE EXTRACTION OF ATP FROM SLUDGE AND MIXED LIQUOR, AND FOR THE DETERMINATION OF ATP USING THE FIREFLY BIOLUMINESCENT PROCEDURE. MEASUREMENTS OF ATP WERE CONDUCTED ON VARIOUS PURE CULTURES, PILOT PLANT AND FULL-SCALE ACTIVATED SLUDGE TREATMENT PLANTS. ADDITIONAL PARAMETERS INCLUDING BOD, TOC, OXYGEN UPTAKE RATE, AND SUSPENDED SOLIDS WERE MEASUREED TO PROVIDE COMPARATIVE AND SUPPORTIVE INFORMATION. PRELIMINARY TESTS IN WHICH ATP MEASUREMENTS OF BIOMASS WERE USED TO CONTROL THE PERCENT SLUDGE RETURN WERE CONDUCTED AT TWO FULL-SCALE MUNICIPAL SEWAGE TREATMENT PLANTS. LOWERED RETURN SLUDGE RATES WERE FOUND TO PRODUCE EFFECTIVE TREATMENT AND INCREASE THE BIOLOGICAL ACTIVITY OF THE SLUDGE. CHANGES IN THE RATE OF RETURN SLUDGE RESULTED IN CHANGES IN ATP CONCENTRATION OF MIXED LIQUOR WHICH PRECEDED CHANGES IN SUSPENDED SOLIDS BY AS MUCH AS 24 HOURS. THE ASSAY WAS FOUND TO BE REPRODUCIBLE AND RAPID, RESULTS CAN BE OBTAINED WITHIN APPROXIMATELY TEN MINUTES. (LOWRY-TEXAS)

TITLE COMPARATIVE EVALUATION OF SEQUENCING BATCH REACTORS

AUTHOR IRVINE, R. L.; RICHTER, R. O.
CORP AUTH NOTRE DAME UNIV., IN. DEPT OF CIVIL ENGINEERING

PUB DESC JOURNAL OF THE ENVIRONMENTAL ENGINEERING DIVISION, VOL 104, NO EE3, PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, P 503-514, JUNE 1978. 3 FIG, 4 TAB, 15 REF.

KEYWORDS *ACTIVATED SLUDGE, *BATCH REACTORS, *SEQUENCING, *SEWAGE TREATMENT, *COMPUTER MODELS, *SIMULATION ANALYSIS, WASTE WATER (POLLUTION), MASS BALANCE EQUATIONS, FLOW, DESIGN, PERIODIC VARIATIONS, OPERATIONS RESEARCH

ABSTRACT THE PERFORMANCE OF MANY PROCESSES AND OPERATIONS CAN BE IMPROVED APPRECIABLY BY THE CONTROLLED UNSTEADY OPERATIONS THAT ARE PROVIDED BY SEQUENCING BATCH (FILL AND DRAW) BIOLOGICAL REACTORS. THE LACK OF DESIGN AND OPERATION EXPERIENCE IN BATCH TREATMENT HAS RESULTED IN AN EXPERIENCE VOID THAT HAS FOSTERED THE SELECTION OF CONTINUOUS FLOW RATHER THAN BATCH TREATMENT SCHEMES. SYSTEM SELECTION SHOULD DEPEND INSTEAD UPON SUITABILITY OF THE SYSTEM, RELIABILITY, EFFICIENCY, CONSISTENCY, AND ECONOMIC. BENCH, PILOT, AND FULL-SCALE INVESTIGATIONS, AND DESK TOP AND COMPUTER ANALYSES MUST SUPPLEMENT EXISTING BENCH SCALE STUDIES IF THE EXPERIENCE VOID IS TO BE FILLED. SEVERAL HYPOTHETICAL EXAMPLES ARE USED TO PARTIALLY FILL THE VOID BY COMPARING VOLUMES FOR BOTH THE BATCH AND CONTINUOUS FLOW SYSTEMS. IN THE EXAMPLES, SEQUENCING BATCH TREATMENT PROVIDES THE POTENTIAL FOR ACHIEVING EFFLUENT LIMITATIONS IN A TOTAL VOLUME NOTABLY LESS THAN THAT FOR A CONVENTIONAL CONTINUOUS FLOW SYSTEM. THIS ADDS TO PREVIOUSLY RECOGNIZED ADVANTAGES THAT INCLUDE HOLDING A WASTE UNTIL A PROPER TREATMENT IS ACHIEVED. THE COMPUTER SIMULATIONS HEREIN HAVE SHOWN HOW THE DESIGN VOLUME FOR A SEQUENCING BATCH SYSTEM DIFFERED AS A FUNCTION OF THE RELATIVE VARIABILITY OF THE MASS FLOW RATE EVEN THOUGH THE AVERAGE MASS FLOW RATE WAS THE SAME FOR ALL CASES INVESTIGATED. (GRAF-CORNELL)

TITLE CONTACT STABILIZATION IN SMALL PACKAGE PLANTS

AUTHOR DAGUE, R. R.; ELBERT, G. F.; ROCKWELL, M. D.

CORP AUTH IOWA UNIV., IOWA CITY.

AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 44, NO 2, FEBRUARY 1972, P 255-264, 11 FIG, 3 TAB, 6 REF.

IDEN *CONTACT STABILIZATION, *PACKAGE PLANTS

KEYWORDS *ACTIVATED SLUDGE, *DESIGN CRITERIA, *ON-SITE INVESTIGATIONS, AERATION, RESPIRATION, ABSORPTION, ADSORPTION, MIXING, BIODEGRADATION, ORGANIC LOADING, BIOCHEMICAL OXYGEN DEMAND, SUSPENDED SOLIDS, WASTE WATER TREATMENT

ABSTRACT INVESTIGATION WITH CONTACT STABILIZATION PACKAGE TREATMENT PLANTS AS CURRENTLY DESIGNED HAS DEMONSTRATED THAT SUCH FACILITIES ARE UNSTABLE UNDER CONDITIONS OTHER THAN 24 HOUR OPERATION. TWO CONTACT STABILIZATION PLANTS CURRENTLY HAVING OPERATIONAL DIFFICULTIES WERE MODIFIED, ONE TO THE CONVENTIONAL ACTIVATED SLUDGE PROCESS AND THE

OTHER TO COMPLETE MIX OPERATION. THE DIFFICULTIES ENCOUNTERED BY THE CONTACT STABILIZATION STEMMED MAINLY FROM FLOW VARIATIONS, AND THE FACT THAT MOST PLANTS ARE DESIGNED FOR A 3-HOUR CONTACT TIME RATHER THAN THE 15 TO 30 MIN. CONTACT TIME ORIGINALLY DEVELOPED. THE WIDE VARIABILITY OF THE MUNICIPAL WASTE FLOW FOR THE FIRST SYSTEM EVALUATED CAUSED THE WASTES IN THE CONTACT ZONE TO HAVE A RETENTION TIME VARYING FROM 2 TO 8 HOURS. EACH OF THE OTHER PLANT OPERATIONS WAS SIMILARLY AFFECTED. THE TROUBLE WHICH AROSE THEN, WAS MAINLY IN SEPARATING THE SOLIDS FROM THE EFFLUENT, WHICH BECAME NEARLY IMPOSSIBLE. AFTER MODIFICATION, THE TWO PLANTS FUNCTIONED EXTREMELY WELL, PRODUCING EFFLUENTS OF 13 MG/L OR LESS OF BOD AND 12 MG/L OR LESS OF SUSPENDED SOLIDS. (LOWRY-TEXAS)

TITLE	THE DESIGN, CONSTRUCTION, AND OPERATION OF EXTENDED-AERATION PLANTS.
AUTHOR	STORCH, B.
CORP AUTH	PETERS, G. D. (ENGINEERING) LTD.
AVAIL	WATER POLLUTION CONTROL, VOL 68, NO 1, P 40-50, JAN-FEB 1969, 4 REF.
IDEN	*EXTENDED AERATION, AEROBIC DIGESTION
KEYWORDS	*ACTIVATED SLUDGE, *OPERATION AND MAINTENANCE, *DESIGN, *CONSTRUCTION, AERATION, WASTE WATER TREATMENT, AEROBIC CONDITIONS
ABSTRACT	THE DESIGN OF AN EXTENDED AERATION PLANT IS DISCUSSED INCLUDING: INLET, AERATION TANK, AERATION TO SETTLING TRANSFER, INLET TO SETTLING TANKS, SETTLING TANK, SLUDGE RETURN, SURFACE SKIMMING, EFFLUENT WITHDRAWAL, AND EXCESS SLUDGE HANDLING. EXCESS SLUDGE HANDLING IS TREATED AT LENGTH INCLUDING AEROBIC DIGESTION. PHYSICAL DESCRIPTIONS AND RECOMMENDED DIMENSIONS FOR VARIOUS COMPONENTS AND EQUATIONS FOR SEVERAL CALCULATIONS ARE GIVEN. RECOMMENDATIONS ARE MADE FOR MATERIALS TO BE USED, POSITIONING OF EQUIPMENT AND OTHER FACETS OF CONSTRUCTION. PLANT START-UP IS DESCRIBED AND A CHECKLIST FOR OPERATION AND MAINTENANCE IS GIVEN. (DIFILIPPO-TEXAS)

TITLE	DESIGN PROCEDURES FOR DISSOLVED OXYGEN CONTROL OF ACTIVATED SLUDGE PROCESSES
AUTHOR	FLANAGAN, M. J.; BRACKEN, B. D.
CORP AUTH	BROWN AND CALDWELL, WALNUT CREEK, CA
PUB DESC	AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-270 960, IN

	PAPER COPY, IN MICROFICHE, REPORT NO. EPA-600/2-77-032, JUNE, 1977. 217 P, 86 FIG, 31 TAB, 47 REF, 1 APPEND. 68-2130.
KEYWORDS	*DISSOLVED OXYGEN, *ACTIVATED SLUDGE, *SLUDGE TREATMENT, *AERATION, *AUTOMATION, *COST ANALYSIS, ECONOMICS, COSTS, OPERATING COSTS, CAPITAL COSTS, MAINTENANCE COSTS, MANUAL CONTROL, AUTOMATIC CONTROL, CONTROL SYSTEMS, EQUIPMENT, PERFORMANCE, OPERATIONS, DESIGN, MAINTENANCE, APPLICATION METHODS, WASTE WATER TREATMENT, WASTE TREATMENT, SEWAGE TREATMENT, WATER PURIFICATION, INSTRUMENTATION, *AERATION EQUIPMENT, *ACTIVATED SLUDGE TREATMENT PLANTS, *COST EFFECTIVENESS, ECONOMIC ANALYSIS, MANUAL DISSOLVED OXYGEN CONTROL, AUTOMATIC DISSOLVED OXYGEN CONTROL, CONTROL EQUIPMENT.
ABSTRACT	DESIGN PROCEDURES AND GUIDELINES FOR THE SELECTION OF AERATION EQUIPMENT AND DISSOLVED OXYGEN (DO) CONTROL SYSTEMS FOR ACTIVATED SLUDGE TREATMENT PLANTS ARE PRESENTED. PROCESS CONFIGURATIONS AND DESIGN PARAMETERS ARE REVIEWED TO ESTABLISH SYSTEM REQUIREMENTS. AERATION METHODS, EQUIPMENT AND APPLICATION TECHNIQUES, DESIGN SYSTEMS, AND CONTROL SYSTEM SELECTION PROCEDURES ARE EXAMINED. RECOMMENDATIONS FOR SYSTEM APPLICATIONS TO VARIOUS AERATION EQUIPMENT TYPES AND PROCESS CONFIGURATIONS ARE DESCRIBED. PERFORMANCE, OPERATIONAL AND MAINTENANCE DATA FOR AERATION EQUIPMENT AND DO CONTROL SYSTEMS FOR 12 ACTIVATED SLUDGE PLANTS ARE PRESENTED IN THE APPENDIX. AUTOMATIC DO CONTROL SYSTEMS FOR VARIOUS SIZE HYPOTHETICAL ACTIVATED SLUDGE SYSTEM CONFIGURATIONS ARE PRESENTED TO DEVELOP AN ECONOMIC ANALYSIS MANUAL AND AUTOMATIC DO CONTROL. CONCLUSIONS INDICATE THAT CAPITAL AND OPERATING COSTS OF AUTOMATIC DO CONTROL SYSTEMS ARE JUSTIFIED FOR ACTIVATED SLUDGE PLANTS LARGER THAN 1 MGD (44 DM3/S) ONLY IF EQUIPMENT IS SELECTED AND APPLIED IN ACCORDANCE WITH GUIDELINES OF THE DESIGN MANUAL AND A POWER COST IS APPLICABLE WHICH IS EQUAL TO OR GREATER THAN THE NATIONAL AVERAGE POWER RATE. AREAS IN WHICH FURTHER RESEARCH IS INDICATED ARE DISCUSSED. (SEIP-IPA)
TITLE	DISSOLVED OXYGEN ANALYSIS - ACTIVATED SLUDGE CONTROL TESTING (XT-43).
AUTHOR	LUDZACK, F. J.
PUB DATE	JUN 71

DESC *AUDIOVISUAL AIDS, *CHEMICAL ANALYSIS, *CHEMISTRY, *INSTRUCTIONAL MATERIALS, *LABORATORY PROCEDURES, POLLUTION, *POST SECONDARY EDUCATION, SCIENCE EDUCATION, WATER POLLUTION CONTROL, *OXYGEN, WASTEWATER TREATMENT, DISSOLVED OXYGEN, *ACTIVATED SLUDGE

DESC NOTE INCLUDED IS A 34 MINUTE TAPE, 72 SLIDES, AND A SCRIPT. AVAILABLE ON LOAN FROM NTOTC, 26 W ST. CLAIR, CINCINNATI, OHIO 45268

ABSTRACT THIS MODULE IS DESIGNED FOR ADVANCED WASTEWATER TREATMENT PLANT OPERATORS OR PLANT CONTROL SUPERVISORS. RAPID AND VALID TECHNIQUES ARE DESCRIBED FOR CONTROL OF THE ACTIVATED SLUDGE TREATMENT PROCESS USING ELECTRONIC MEASUREMENT OF DO AND DO CHANGES. SAMPLE DATA ARE DISCUSSED FOR INTERPRETATION OF SLUDGE CONDITION IN RESPONSE TO STABILIZATION, FEED, LOAD RATIO OR CONDITIONS. INFORMATION OBTAINABLE WITHIN 20 MINUTES PROVIDES SUGGESTED CORRECTIVE ACTION IN TIME TO UPGRADE EFFLUENT QUALITY. (AUTHOR/JK)

TITLE DYNAMIC MODELING AND CONTROL STRATEGIES FOR THE ACTIVATED SLUDGE PROCESS.

AUTHOR BUSBY, J. B.; ANDREWS, J. F.

CORP AUTH CLEMSON UNIV., S.C. DEPT. OF ENVIRONMENTAL SYSTEMS ENGINEERING; AND ENVIRONMENTAL DYNAMICS, INC.,GR.

AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 47, NO 5, P 1055-1080, MAY 1975. 22 FIG, 3 TAB, 23 EQU, 45 REF.

IDEN *PROCESS CONTROL, DYNAMIC MODELS, FEEDING, STEP-FEED PROCESS, RATIO CONTROL.

KEYWORDS *ACTIVATED SLUDGE, *WASTE WATER TREATMENT, *WATER QUALITY, *SIMULATION ANALYSIS, BIOLOGICAL TREATMENT, WASTES, COMPUTERS, SUSPENDED SOLIDS, SYSTEMS ANALYSIS, MATHEMATICAL MODELS, RECYCLING.

ABSTRACT CONVENTIONAL ACTIVATED SLUDGE PROCESSES MAY BE CONTROLLED BY SLUDGE RECYCLE RATE, WASTE SLUDGE FLOW RATE, AND AERATION RATE. IN A MULTISTAGE REACTOR SYSTEM SUCH AS THE STEP-FEED PROCESS, VARIATIONS IN WASTEWATER FEED PATTERNS ARE ANOTHER CONTROL TECHNIQUE. A WIDE-SPECTRUM ACTIVATED SLUDGE PROCESS MODEL WAS DEVELOPED THAT CONSIDERS THE STORAGE CAPABILITY OF THE SLUDGE, INCORPORATES THE ACTIVE AND INERT FRACTIONS OF THE MIXED LIQUOR VOLATILE SUSPENDED SOLIDS IN SEPARATE MASS BALANCES, AND IS COUPLED WITH A DYNAMIC MODEL OF THE FINAL CLARIFIER. CONTROL STRATEGIES INVESTIGATED INCLUDE VARIOUS SLUDGE WASTING AND RECYCLE CONTROL TECHNIQUES AND HYDRAULIC METHODS.

COMPUTER SIMULATION RESULTS INDICATE THAT THE MODEL SATISFACTORILY DESCRIBES THE DIFFERENT PROCESS VERSIONS AND THAT DYNAMIC VARIATIONS IN WASTEWATER FEED PATTERN ARE VALUABLE FOR CONTROL. (BELL-CORNELL)

TITLE	EFFECTS OF FLOW EQUALIZATION ON THE OPERATION AND PERFORMANCE OF AN ACTIVATED SLUDGE PLANT.
AUTHOR	FOESS, G. W.; AND OTHERS
PUB DATE	AUG 77
AVAIL	NTIS, 5285 PORT ROYAL RD., SPRINGFIELD, VA 22161 ($6.50)
DESC	*ACTIVATED SLUDGE, CHEMICAL OXYGEN DEMAND, *FLOW MEASUREMENT, RESEARCH REPORTS, SEWAGE, *SLUDGE, *WASTEWATER TREATMENT, *COST EFFECTIVENESS, *OPERATIONS (WASTEWATER)
DESC NOTE	110P ORDER NO. PB 272 657
ABSTRACT	A PLANT-SCALE RESEARCH PROGRAM WAS CARRIED OUT OVER A YEAR TO EVALUATE THE IMPACT OF FLOW EQUALIZATION OF THE 14,000 CU.M/DAY (3.7 MGD) UPGRADED ACTIVATED SLUDGE PLANT AT YPSILANTI TOWNSHIP, MICHIGAN. PROCESS STEAMS WERE CHARACTERIZED UNDER BOTH EQUALIZED AND UNEQUALIZED FLOW CONDITIONS WITH RESPECT TO BOD, COD, TSS AND FORMS OF NITROGEN AND PHOSPHORUS. THE EQUALIZATION SYSTEM WAS EFFECTIVE IN ITS ABILITY TO DAMPEN VARIATIONS IN WASTEWATER CONCENTRATION AND MASS FLUX. SOME BIOCHEMICAL ACTION APPARENTLY OCCURRED IN THE EQUALIZATION BASIN, ALTHOUGH BOD REMOVAL WAS MARGINAL AND INCONSISTENT. ANALYSIS OF SECONDARY EFFLUENT INDICATED THAT PLANT PERFORMANCE WAS SIMILAR WITH AND WITHOUT EQUALIZED FLOW, SUGGESTING THAT THE THEORETICAL ADVANTAGES OF FLOW EQUALIZATION MAY NOT BE ACHIEVED IN MANUALLY CONTROLLED PLANTS. AN EXAMINATION OF THEORETICAL POWER COSTS FOR EQUALIZED AND UNEQUALIZED FLOW CONDITIONS INDICATED THAT USE OF FLOW EQUALIZATION DID NOT RESULT IN POWER COST ECONOMIES. (BB)

TITLE	EFFLUENT MONITORING PROCEDURES: BASIC PARAMETERS FOR MUNICIPAL EFFLUENTS. STAFF GUIDE.
PUB DATE	77
DESC	CHEMISTRY, COURSE DESCRIPTIONS, *EDUCATIONAL PROGRAMS, ENVIRONMENTAL EDUCATION, *INSTRUCTIONAL MATERIALS, *LABORATORY TECHNIQUES, MICROBIOLOGY, *POLLUTION, POST SECONDARY EDUCATION, SKILL DEVELOPMENT, *WATER POLLUTION CONTROL, *WASTEWATER TREATMENT, *EFFLUENTS, *MONITORING

ERIC NO. ED147194

EDRS PRICE EDRS PRICE MF-$0.83 HC-$16.73 PLUS POSTAGE.

DESC NOTE 315P.; FOR RELATED DOCUMENTS, SEE SE 023 377-383; AS NOTED IN THE TABLE OF CONTENTS, SECTIONS 18 AND 27 ARE NOT INCLUDED IN THE PAGINATION

ISSUE RIEAPR78

ABSTRACT THIS IS ONE OF SEVERAL SHORT-TERM COURSES DEVELOPED TO ASSIST IN THE TRAINING OF WASTE WATER TREATMENT PLANT OPERATIONAL PERSONNEL IN THE TESTS, MEASUREMENTS, AND REPORT PREPARATION REQUIRED FOR COMPLIANCE WITH THEIR NPDES PERMITS. THIS STAFF GUIDE PROVIDES STEP-BY-STEP GUIDELINES ON COURSE PLANNING, DEVELOPMENT AND IMPLEMENTATION INVOLVING CLASSROOM INSTRUCTION AND LABORATORY APPLICATION OF CRITICAL LEARNING OUTCOMES. PART I IS CONCERNED WITH THE ADMINISTRATIVE ASPECTS OF THE TRAINING PROGRAM, PART II CONSISTS OF INSTRUCTIONAL STAFF GUIDELINES ON TECHNICAL CONTENT, LEARNING OBJECTIVES, AND LESSON-BY-LESSON GUIDES FOR THE SELF-MONITORING PROCEDURES CONTAINED IN THIS COURSE. INCLUDED IN THIS DOCUMENT ARE MATERIALS RELATED TO DETERMINING DISSOLVED OXYGEN, PH, FECAL COLIFORM, WATER FLOW, SUSPENDED SOLIDS, AND CHLORINE. (CS)

TITLE EFFLUENT MONITORING PROCEDURES: NUTRIENTS. STAFF GUIDE.

PUB DATE 77

DESC COURSE DESCRIPTIONS, *EDUCATIONAL PROGRAMS, ENVIRONMENTAL EDUCATION, *INSTRUCTIONAL MATERIALS, *LABORATORY TECHNIQUES, *POLLUTION, POST SECONDARY EDUCATION, SKILL DEVELOPMENT, TEACHING METHODS, *WATER POLLUTION CONTROL, *WASTEWATER TREATMENT, *EFFLUENTS, *MONITORING, *NUTRIENTS

EDRS PRICE EDRS PRICE MF-$0.83 HC-$12.71 PLUS POSTAGE

DESC NOTE 247P., FOR RELATED DOCUMENTS, SEE SE 023 377-383, SOME PAGES MAY REPRODUCE POORLY DUE TO PRINT QUALITY.

ISSUE RIEAPR78

ABSTRACT THIS IS ONE OF SEVERAL SHORT-TERM COURSES DEVELOPED TO ASSIST IN THE TRAINING OF WASTE WATER TREATMENT PLANT OPERATIONAL PERSONNEL IN THE TESTS MEASUREMENTS, AND REPORT PREPARATION REQUIRED FOR COMPLIANCE WITH THEIR NPDES PERMITS. THIS STAFF GUIDE PROVIDES STEP-BY-STEP GUIDELINES ON COURSE PLANNING, DEVELOPMENT AND IMPLEMENTATION INVOLVING CLASSROOM INSTRUCTION AND LABORATORY APPLICATION OF CRITICAL LEARNING OUTCOMES. PART I IS CONCERNED WITH THE ADMINISTRATIVE ASPECTS OF THE TRAINING

PROGRAM. PART II CONSISTS OF INSTRUCTIONAL STAFF GUIDELINES ON TECHNICAL CONTENT, LEARNING OBJECTIVES, AND LESSON-BY-LESSON GUIDES FOR THE SELF-MONITORING PROCEDURES CONTAINED IN THIS COURSE. INCLUDED ARE A VARIETY OF TECHNIQUES FOR DETERMINING VARIOUS MATERIALS IN WATER INCLUDING PHOSPHORUS, NITROGEN, AMMONIA, CADMIUM, OIL, AND GREASE. (CS)

TITLE	FACILITIES FOR CONTROLLING THE ACTIVATED SLUDGE PROCESS BY MEAN CELL RESIDENCE TIME
AUTHOR	BURCHETT, M.E.; TCHOBANDOGLOUS, G.
CORP AUTH	YODER-TROTTER-ORLOB AND ASSOCIATES, WALNUT CREEK, CALIF.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 46, NO 5, P 973-979, MAY 1974. 7 FIG, 6 REF.
IDEN	*MEAN CELL RESIDENCE TIME.
KEYWORDS	*ACTIVATED SLUDGE, *TREATMENT FACILITIES, *CONTROL SYSTEMS, AUTOMATIC CONTROL, OPERATION AND MAINTENANCE, *WASTE WATER TREATMENT
ABSTRACT	SEVERAL METHODS NOW BEING USED BY OPERATORS TO CONTROL THE ACTIVATED SLUDGE PROCESS ARE DISCUSSED. THE USE OF THE MEAN CELL RESIDENCE TIME (MCRT) IS RECOMMENDED AS THE MOST SUITABLE OPERATIONAL CONTROL PARAMETER. THE BASIC CONCEPTS INVOLVING THE THEORETICAL AND PRACTICAL REASONS FOR CONTROLLING THE MCRT ARE DISCUSSED. THE PHYSICAL FEATURES OF A CONTROL SYSTEM DEVELOPED TO USE THIS METHOD ARE PRESENTED. THE FOLLOWING ADVANTAGES FOR THE PROPOSED CONTROL SYSTEM ARE: MINIMUM REQUIRED OPERATOR ATTENTION, INEXPENSIVE CAPITAL COSTS, MORE POSITIVE PROCESS CONTROL, AND MORE STABLE PROCESS OPERATION. (SA

TITLE	GET THE MOST FROM THE FINAL CLARIFIERS.
AUTHOR	BOYLE, W. H.
CORP AUTH	ENVIREX INC., WAUKESHA, WIS.
AVAIL	WATER AND WASTES ENGINEERING, VOL 12, NO 10, P 53-55, 82, OCTOBER, 1975. 4 FIG.
IDEN	*CLARIFIERS, HYDRAULIC REMOVAL MECHANISMS, SLUDGE RETURN.
KEYWORDS	*WASTE WATER TREATMENT, *ACTIVATED SLUDGE, HYDRAULIC MACHINERY, HYDRAULICS, SLUDGE, DESIGN.
ABSTRACT	THE FINAL CLARIFIER PERFORMS ONE OF THE MOST IMPORTANT UNIT FUNCTIONS IN THE ACTIVATED SLUDGE PROCESS. THE HYDRAULIC REMOVAL MECHANISM, SOMETIMES CALLED A VACUUM OR SUCTION TYPE DEVICE, IS THE PREFERRED SLUDGE COLLECTION MECHANISM WHEN DEALING WITH A LIGHT FLOCCULANT SLUDGE. A BRIEF

REVIEW IS PRESENTED OF THE MAIN REQUIREMENTS FOR A HYDRAULIC REMOVAL MECHANISM WHICH ARE RAPID SLUDGE REMOVAL, MINIMUM SLUDGE AGITATION, MAXIMUM SOLIDS CONCENTRATION, FLEXIBILITY, AND BALANCED HYDRAULIC DESIGN. ONE OF THE TWO MAIN TYPES OF CIRCULAR HYDRAULIC REMOVAL MECHANISMS IS A RECTANGULAR TAPERED HEADER MADE OF 0.25 INCH STEEL PLATE WITH ORIFICES DRILLED INTO THE HEADER FOR THE REMOVAL OF SLUDGE (THE HEADER DESIGN). THE OTHER DEVICE INCORPORATES SEVERAL WITHDRAWAL PIPES WITH THE SLUDGE CHANNELED BY DEFLECTOR PLATES TO THESE PIPES AND TRANSPORTED TO COLLECTION WELLS (RISER PIPE DESIGN). THE HYDRAULIC DESIGN OF EACH OF THESE DEVICES IS EXPLAINED. CHOICE OF HYDRAULIC SLUDGE REMOVAL MECHANISM SHOULD BE BASED ON PERFORMANCE, HOW THE DEVICE AFFECTS THE MAIN PROCESS REQUIREMENTS, AND AN ECONOMIC EVALUATION OF CAPITAL AND OPERATIONAL/MAINTENANCE EXPENDITURES. (ORR-FIRL)

TITLE	GUIDE TO WASTEWATER TREATMENT: BIOLOGICAL-SYSTEM DEVELOPMENTS.
AUTHOR	FORD, D. L.; TISCHLER, L. F.
CORP AUTH	ENGINEERING-SCIENCE, INC., AUSTIN, TX.
AVAIL	CHEMICAL ENGINEERING, VOL 84, NO 17, P 131-135, AUGUST, 1977. 2 FIG. 13 REF.
KEYWORDS	*BIOLOGICAL TREATMENT, *INDUSTRIAL WASTES, *ACTIVATED SLUDGE, *TRICKLING FILTERS, *BIODEGRADATION, EQUALIZING RESERVOIRS, ORGANIC LOADING, DILUTION, SOLVENT EXTRACTIONS, SUSPENDED SOLIDS, DESIGN CRITERIA, NITRIFICATION, FILTRATION, *WASTE WATER TREATMENT
ABSTRACT	HIGH-RATE BIOLOGICAL TREATMENT SYSTEMS SUCH AS ACTIVATED SLUDGE, TRICKLING FILTERS, AND ROTATING DISCS ARE REVIEWED FOR USE IN MUNICIPAL AND INDUSTRIAL WASTE WATER TREATMENT. VARIOUS ASPECTS OF SUSPENDED-GROWTH SYSTEMS SUCH AS THE COMPLETELY-MIXED ACTIVATED SLUDGE PROCESS ARE DISCUSSED, INCLUDING CONTACT STABILIZATION, SOLIDS REMOVAL, AND EFFLUENT POLISHING, FIXED-GROWTH SYSTEMS SUCH AS THE CONVENTIONAL TRICKLING FILTER AND THE ROTATING BIOLOGICAL FILTER ARE DESCRIBED AND COMPARED WITH SUSPENDED-GROWTH SYSTEMS. FLOW EQUALIZATION AND AUXILIARY BASINS IN INDUSTRIAL WASTE WATER TREATMENT ARE SUGGESTED TO OFFSET PROBLEMS ASSOCIATED WITH HYDRAULIC- AND ORGANIC-LOAD VARIATIONS TO BIOLOGICAL SYSTEMS. PRETREATMENT WITH HYDROLYSIS IS SUGGESTED TO ENHANCE BIODEGRADABILITY. PRE-DILUTION OF INFLUENT

STREAMS HAVING HIGH ORGANIC CONCENTRATIONS BY STREAMS HAVING LOW ORGANIC CONCENTRATIONS IS SUGGESTED TO IMPROVE OVERALL PERFORMANCE OF A BIOLOGICAL SYSTEM. STEAM OR SOLVENT STRIPPING OF INDUSTRIAL WASTE STREAMS IS RECOMMENDED TO REDUCE HIGH-ORGANIC LOADS, MINIMIZE LOADING VARIATIONS, AND REDUCE INHIBITION OF BIOLOGICAL PROCESSES BY PARTICULARLY TOXIC WASTES. INCREASING THE AMOUNT OF BIOLOGICAL SOLIDS IN THE AERATION BASIN OF SUSPENDED GROWTH SYSTEMS BY INCREASING THE SLUDGE-RECYCLE RATIO AND/OR REDUCING SLUDGE WASTAGE IS REPORTED TO PREVENT BIOLOGICAL UPSET. VARIOUS PROCESSES USED IN THE REMOVAL OF SECONDARY SOLIDS ARE DISCUSSED. DESIGN AND OPERATIONAL VARIABLES WHICH CAN AFFECT PROCESS PERFORMANCE ARE DISCUSSED, INCLUDING SLUDGE AGE, TEMPERATURE, SLUDGE BULKING, NITRIFICATION, AND ACTIVATED CARBON TREATMENT. ((SCHULZ-FIRL)

TITLE	HANDBOOK FOR WATER AND WASTEWATER ANALYSIS.
PUB DATE	76
AVAIL	VWR SCIENTIFIC, PO BOX 3200, SAN FRANCISCO, CA 94119
DESC	*ANALYTICAL TECHNIQUES, CHEMICAL ANALYSIS, *INSTRUCTIONAL MATERIALS, *LABORATORY TECHNIQUES, *MANUALS, POST SECONDARY EDUCATION, *WATER ANALYSIS
ABSTRACT	ANALYTICAL TECHNIQUES FOR USE IN WATER AND WASTEWATER LABORATORIES.

TITLE	HANDBOOK OF ADVANCED WASTEWATER TREATMENT, 2ND EDITION
AUTHOR	CULP, RUSSELL L.; AND OTHERS
PUB DATE	78
AVAIL	VAN NOSTRAND/REINHOLD CO., 300 PIKE ST., CINCINNATI, OH 45202
DESC	CARBON DIOXIDE, *CHEMISTRY, CHLORINATION, DEMINERALIZATION, *DISINFECTION, *ECONOMICS, FILTRATION, FLOCCULATION, *HIGHER EDUCATION, *INSTRUCTIONAL MATERIALS, *LAND APPLICATION, *OPERATIONS (WASTEWATER), POST SECONDARY EDUCATION, *SLUDGE, WASTEWATER SLUDGE, *WASTEWATER TREATMENT, *WATER POLLUTION CONTROL
DESC NOTE	632P.
ABSTRACT	INCLUDED IN THIS BOOK ARE CHAPTERS ON THE PURPOSE AND BENEFITS OF ADVANCED WASTEWATER TREATMENT, CHEMICAL CLARIFICATION, RECARBONATION, FILTRATION, ACTIVATED CARBON ADSORPTION AND REGENERATION, DISINFECTION, NITROGEN REMOVAL, CHEMICAL SLUDGE

HANDLING, DEMINERALIZATION, LAND TREATMENT OF WASTEWATERS, ESTIMATING THE COSTS OF WASTEWATER TREATMENT FACILITIES AND SELECTING AND COMBINING UNIT PROCESSES. SOME OF THE TOPICS INCLUDED ARE: (1) COAGULATION, FLOCCULATION, AND SEDIMENTATION; (2) SINGLE STAGE VS, TWO STAGE CARBONATION; (3) DESIGN OF FILTER SYSTEMS; (4) EVALUATION OF ACTIVATED CARBON; (5) CHLORINATION; (6) BIOLOGICAL NITROGEN REMOVAL; (7) ELECTRODIALYSIS; AND (8) ION EXCHANGE. THIS BOOK CONTAINS DESIGN EXAMPLES AND CASE HISTORIES OF OPERATING PLANTS. IT IS USEFUL AS A REFERENCE BOOK, OR A TEXT IN GRADUATE OR UNDERGRADUATE ENVIRONMENTAL ENGINEERING COURSES. (BB)

TITLE THE IMPACT OF OILY MATERIAL ON ACTIVATED SLUDGE SYSTEMS.

CORP AUTH HYDROSCIENCE, INC., WESTWOOD, N.J.

AVAIL COPY AVAILABLE FROM GPO SUP DOC AS SN5501-0088, $1.25; MICROFICHE FROM NTIS AS PB-212 422, $0.95. ENVIRONMENTAL PROTECTION AGENCY, WATER POLLUTION CONTROL RESEARCH SERIES, MARCH 1971, 110 P, 29 FIG, 10 TAB, 38 REF. EPA PROGRAM 12050 DSH 03/71.

IDEN *SPENT CRANKCASE OIL, *VEGETABLE OIL, *CRUDE OIL, REFINERY WASTE OIL, LOAD TOLERANCE.

KEYWORDS *OIL WASTES, *ACTIVATED SLUDGE, *SEWAGE TREATMENT, *WASTE WATER DISPOSAL, BIOLOGICAL TREATMENT, OIL, BIODEGRADATION, ABSORPTION, SLUDGE TREATMENT

ABSTRACT THE PREFORMANCE OF SMALL SCALE CONTINUOUS ACTIVATED SLUDGE SYSTEMS WAS OBSERVED AFTER BEING EXPOSED TO A VAREITY OF OILY COMPOUNDS SUCH AS CRANKCASE OIL, CRUDE OIL AND VEGETABLE OIL, AT SEVERAL LOADING LEVELS. BATCH STUDIES WERE CONDUCTED TO DETERMINE BIODEGRADABILITY AND THE EFFECT OF EMULSIFICATION AND TEMPERATURE ON THE RATE OF BIOLOGICAL REACTION. OILS ARE ABSORBED ON THE FLOC AND SLOWLY DEGRADE WHEN THEY ARE INTRODUCED INTO AN ACTIVATED SLUDGE SYSTEM. THE OIL ACCUMULATES ON THE SLUDGE CAUSING A LOSS OF DENSITY AND ACCEPTABLE SETTLING CHARACTERISTICS IF THE LOADING RATE IS HIGHER THAN THE DEGRADATION WASTAGE. THE ABILITY OF THE MICROBIAL SYSTEM TO REMOVE OTHER SUBSTRATES IS NOT INHIBITED ALTHOUGH THE BIOLOGICAL SYSTEM FAILS DUE TO THE LOSS OF SLUDGE. 0.10 POUNDS PER DAY PER POUND OF SLUDGE UNDER AERATION SHOULD BE THE MAXIMUM CONTINUOUS FEED LEVEL OF OILS TO ACTIVATED SLUDGE. SHOCK LOADS SHOULD NOT EXCEED 5% OF THE WEIGHT OF THE SLUDGE UNDER AERATION. (SMITH-TEXAS)

TITLE	IS INADEQUATE SLUDGE AGE AND DISSOLVED OXYGEN CONTROL PREVENTING OPERATORS FROM GETTING THE BEST FROM THEIR ACTIVATED-SLUDGE PLANTS.
AUTHOR	PITMAN, A. R.
PUB DESC	WATER POLLUTION CONTROL, VOL 77, NO 1, P 97-99, 1978. 1 FIG.
KEYWORDS	*ACTIVATED SLUDGE, *DISSOLVED OXYGEN, *FLOCCULATION, *SUSPENDED SOLIDS, *OPTIMIZATION, OXYGEN DEMAND, BACTERIA, PROTOZOA, WASTE WATER TREATMENT, SLUDGE DIGESTION, MUNICIPAL WASTES.
ABSTRACT	THE OPTIMIZATION OF THE ACTIVATED SLUDGE WASTE WATER TREATMENT PROCESS IS CONSIDERED WITH RESPECT TO SLUDGE AGE AND DISSOLVED OXYGEN CONTROL. CLARIFIER CAPACITY INCREASES AT A CONSTANT FEED RATE OF HOMOGENOUS SLUDGE AND A DISSOLVED OXYGEN LEVEL OF 2 MG/LITER. AS SLUDGE AGE INCREASES UNDER THESE CIRCUMSTANCES, EFFLUENT CLARITY IMPROVES DUE TO INCREASED BIOFLOCCULATION EFFICIENCY; THE SLUDGE SETTLING RATE INCREASES WITH HIGHER FLOC DENSITY; AND THE QUANTITY OF SLUDGE PRODUCED DECREASES. THE OXIDATION OF ORGANIC NITROGEN AND AMMONIA ALSO IMPROVES WHILE THE FLOC OXYGEN DEMAND AND MIXED LIQUOR SUSPENDED SOLIDS INCREASE. AS SLUDGE AGE INCREASES, OPTIMUM CONDITIONS ARE APPROACHED. THESE INCLUDE THE REDUCTION OF THE PROTOZOA POPULATION, THE PRESENCE OF BACTERIA IN THE ENDOGENOUS GROWTH PHASE, THE DETERIORATION OF BIOFLOCCULATION, AND THE CONTINUING INCREASE OF FLOC DENSITY, SUSPENDED SOLIDS, TOTAL OXYGEN DEMAND, AND CLARIFIER SOLIDS LEVELS. WHEN SLUDGE AGE EXCEEDS THE OPTIMUM CONDITIONS, DEFLOCCULATION OCCURS. TWO EXAMPLES OF EFFLUENT DEFLOCCULATION ARE PRESENTED. IN ONE CASE, CONTROL OF THE DISSOLVED OXYGEN LEVEL BELOW CAPACITY IMPROVES THE CLARIFIED EFFLUENT QUALITY. IN THE SECOND CASE, REDUCING SLUDGE AGE IMPROVES THE AMBIENT DISSOLVED OXYGEN LEVEL. (LISK-FIRL)

TITLE	INTERMEDIATE ACTIVATED SLUDGE. TRAINING MODULE 2.116.3.77.
PUB DATE	SEP 77
DESC	*INSTRUCTIONAL MATERIALS, *POST SECONDARY EDUCATION, SECONDARY EDUCATION, *TEACHING GUIDES, *UNITS OF STUDY, *WATER POLLUTION CONTROL: *ACTIVATED SLUDGE, OPERATIONS (WASTEWATER), *WASTEWATER TREATMENT
ERIC NO.	ED151221
EDRS PRICE	EDRS PRICE MF-$0.83 HC-$4.67 PLUS POSTAGE.
DESC NOTE	89P.; FOR RELATED DOCUMENTS SEE SE 024 025-047;

	PAGE 81 MISSING FROM DOCUMENT PRIOR TO BEING SHIPPED TO EDRS FOR FILMING; BEST COPY AVAILABLE
ISSUE	RIEJUL78
ABSTRACT	THIS DOCUMENT IS AN INSTRUCTIONAL MODULE PACKAGE PREPARED IN OBJECTIVE FORM FOR USE BY AN INSTRUCTOR FAMILIAR WITH OPERATION OF ACTIVATED SLUDGE WASTEWATER TREATMENT PLANTS. INCLUDED ARE OBJECTIVES, INSTRUCTOR GUIDES, STUDENT HANDOUTS AND TRANSPARENCY MASTERS. THIS IS THE SECOND LEVEL OF A THREE MODULE SERIES AND CONSIDERS AERATION DEVICES, PROCESS CONTROL PROCEDURES, MICROORGANISMS AND DATA TREND CHART PLOTTING. (AUTHOR/RH)

TITLE	INTRODUCTION TO WASTEWATER TREATMENT PROCESSES.
AUTHOR	RAMALHO, R. S.
PUB DATE	77
AVAIL	ACADEMIC PRESS, 111 FIFTH AVE., NEW YORK, NY 10003
DESC	BIOLOGY, CHEMISTRY, *ENGINEERING, *ENVIRONMENTAL INFLUENCES, EQUIPMENT, FACILITIES, *INSTRUCTIONAL MATERIALS, LAND USE, *POLLUTION, POST SECONDARY EDUCATION, PROBLEM SOLVING, *WASTE DISPOSAL, WATER QUALITY, *WATER POLLUTION CONTROL, *OPERATIONS (WASTEWATER), *WASTEWATER TREATMENT, *FACILITIES
DESC NOTE	409P.
ABSTRACT	THIS BOOK INTRODUCES FUNDAMENTAL PROCESSES OF WASTEWATER TREATMENT. THE TEXT IS DESIGNED TO TRAIN THE READER IN EVALUATION OF WASTEWATER TREATMENT PROBLEMS SO THAT PROPER PROCESSES AND EQUIPMENT MAY BE SELECTED. FOR EACH PROCESS THE TEXT PROVIDES: (1) A SUMMARY OF THEORY, INVOLVED IN THAT PROCESS, (2) DEFINITION OF IMPORTANT DESIGN PARAMETERS INVOLVED IN THE PROCESS, AND (3) DEVELOPMENT OF A SYSTEMATIC DESIGN PROCEDURE FOR THE TREATMENT PLANT. EVERY STEP OF THIS SEQUENCE IS ILLUSTRATED WITH NUMERICAL EXAMPLES. (CS)

TITLE	LABORATORY CONTROL FOR WASTEWATER FACILITIES, WASTEWATER TECHNOLOGY: A TWO-YEAR POST HIGH SCHOOL INSTRUCTIONAL PROGRAM. VOLUME III, PARTS A, B, C, D, E, F, G.
AUTHOR	WAGNER, DAVID; AND OTHERS
PUB DATE	JUL 76
DESC	BEHAVIORAL OBJECTIVES, CURRICULUM, ENVIRONMENT, *ENVIRONMENTAL TECHNICIANS, *INSTRUCTIONAL MATERIALS, LABORATORY PROCEDURES, *LABORATORY TECHNIQUES, *POLLUTION, POST SECONDARY EDUCATION, *WATER POLLUTION CONTROL, *WASTEWATER TREATMENT
ERIC NO.	ED148582

EDRS PRICE	EDRS PRICE MF-$0.83 HC-$20.75 PLUS POSTAGE
DESC NOTE	377P.; FOR RELATED DOCUMENTS, SEE SE 023 408-410 AND SE 023 432; CONTAINS OCCASIONAL LIGHT TYPE.
ISSUE	RIEMAY78
ABSTRACT	THIS VOLUME IS ONE IN A SERIES WHICH OUTLINES PERFORMANCE OBJECTIVES AND INSTRUCTIONAL MODULES FOR A COURSE OF STUDY WHICH EXPLAINS THE RELATIONSHIP AND FUNCTION OF THE PROCESS UNITS IN A WASTEWATER TREATMENT PLANT. EXAMPLES OF MODULES INCLUDE MEASURING SETTLEABLE MATTER, TOTAL SOLIDS, DISSOLVED SOLIDS, SUSPENDED SOLIDS, AND VOLATILE SOLIDS. THE MODULES ARE ARRANGED IN AN ORDER APPROPRIATE FOR TEACHING STUDENTS WITH NO EXPERIENCE. THEY CAN ALSO BE REARRANGED AND ADAPTED FOR COURSES TO UPGRADE PERSONNEL MOVING INTO SUPERVISORY POSITIONS OR DESIGNED AS A MINICOURSE. EACH MODULE CONTAINS A STATEMENT OF PURPOSE, OBJECTIVES, CONDITIONS, ACCEPTABLE PERFORMANCE, INSTRUCTOR ACTIVITY AND STUDENT ACTIVITY. THE TASKS ARE ORGANIZED IN THE GENERAL CATEGORIES: NORMAL OPERATIONS, ABNORMAL OPERATIONS, PREVENTIVE MAINTENANCE, CORRECTIVE MAINTENANCE, LABORATORY CONTROL, SYSTEMS INTERACTION, AND MANAGEMENT/SUPERVISORY PROCEDURES. INCLUDED IN THIS VOLUME ARE 29 MODULES. THE MODULES ARE DESIGNED TO TEACH THE STUDENT LABORATORY PROCEDURES FOR ANALYZING VARIOUS POLLUTANTS AND VARIABLES RELATED TO WASTEWATER. MOST STANDARD TESTS ARE INCLUDED. (CS)
INSTITUTION NAME	CHARLES COUNTY COMMUNITY COLL., LA PLATA, MD.; CLEMSON UNIV., S.C.; GREENVILLE TECHNICAL COLL., S.C.; LINN-BENTON COMMUNITY COLL., ALBANY, OREG.

TITLE	MANUAL FOR ACTIVATED SLUDGE SEWAGE TREATMENT.
AUTHOR	GOODMAN, B. L.
PUB DATE	71
AVAIL	TECHNOMIC PUBLISHING CO., INC., 265 WEST STATE STREET, WESTPORT, CT 06880
DESC	*ACTIVATED SLUDGE, ENVIRONMENTAL TECHNICIANS, INSERVICE EDUCATION, *INSTRUCTIONAL MATERIALS, *MANUALS, *POST SECONDARY EDUCATION, *SLUDGE, *WASTE DISPOSAL, *WASTEWATER TREATMENT, WATER POLLUTION CONTROL
DESC NOTE	204P.
ABSTRACT	STEP BY STEP EXPLANATION OF THE PROCESS, FROM BASICS TO FINE POINTS OF ADVANCED WASTEWATER TREATMENT METHODS.

TITLE MANUAL OF INSTRUCTION FOR SEWAGE TREATMENT PLANT OPERATORS.

PUB DATE 65

AVAIL HEALTH EDUCATION SERVICE, PO BOX 7283, ALBANY, NY 12224 ($2.00)

DESC ANALYTICAL TECHNIQUES, *INSTRUCTIONAL MATERIALS, MAINTENANCE, *MANUALS, *OPERATIONS, *POST SECONDARY EDUCATION, PRIMARY TREATMENT, RECORD KEEPING, *SEWAGE, SLUDGE, *WASTE DISPOSAL, WASTEWATER CHARACTERISTICS, WASTEWATER SLUDGE, *WASTEWATER TREATMENT

DESC NOTE 243P.

ABSTRACT PREPARED FOR GRADE 2 OPERATORS, WRITTEN PRIMARILY AS A TEXT TO BE USED IN CONJUNCTION WITH TRAINING COURSE. HEAVILY NARRATIVE, AVOIDS OVERLY TECHNICAL TREATMENT, AND PRESENTS MATERIAL CONCISELY, APPENDICES SUPPORT BACKGROUND MATERIAL (EG ARITHMETIC, CHEMISTRY, BACTERIOLOGY, ETC). GLOSSARY.

TITLE MANUAL OF INSTRUCTION FOR WASTE TREATMENT PLANT OPERATORS.

AVAIL HEALTH EDUCATION SERVICE, PO BOX 7126, ALBANY, NY 12224 ($2.00)

DESC *CHEMICAL ANALYSIS, *ENVIRONMENT, *INSTRUCTIONAL MATERIALS, NATURAL RESOURCES, *OPERATIONS (WATER), POST SECONDARY EDUCATION, WASTEWATER TREATMENT, *WATER ANALYSIS, WATER POLLUTION CONTROL, *WATER QUALITY

DESC NOTE 308P.

ABSTRACT THIS MANUAL IS INTENDED TO BE A TEXTBOOK FOR A WATER TREATMENT OPERATORS COURSE. IT CONTAINS CHAPTERS ON THE PURPOSE OF WATER TREATMENT, WATER SOURCES AND USES, HYDRAULICS AND ELECTRICITY, WATER CHEMISTRY, MICROBIOLOGY, WATER QUALITY, CHEMICAL COAGULATION, SEDIMENTATION, FILTRATION, CHLORINATION, SOFTENING, AERATION, IRON AND MAGNESIUM, TASTE AND ODOR CONTROL, CORROSION, FLUORIDATION, PROTECTION OF TREATED WATER, RECORDS AND REPORTING, TREATMENT PLANT MAINTENANCE AND ACCIDENT PREVENTION, MATHEMATICS, AND LABORATORY EXAMINATION OF WATER. THE MANUAL SHOULD BE UNDERSTANDABLE TO THE AVERAGE PLANT OPERATOR WITH A HIGH SCHOOL EQUIVALENT BACKGROUND. EXTREMELY TECHNICAL MATERIAL HAS BEEN AVOIDED. (BB)

TITLE A MANUAL OF SIMPLIFIED LABORATORY METHODS FOR OPERATORS OF WASTEWATER TREATMENT FACILITIES.

AUTHOR WESTERHOLD, ARNOLD F., ED.; BENNETT, ERNEST C., ED

PUB DATE APR 74

DESC CHEMISTRY, ENVIRONMENTAL EDUCATION, *ENVIRONMENTAL TECHNICIANS, INDEPENDENT STUDY, *INSTRUCTIONAL MATERIALS, JOB SKILLS, *LABORATORY TECHNIQUES, *POLLUTION, *POST SECONDARY EDUCATION, PUBLIC HEALTH, *WATER POLLUTION CONTROL, *WASTEWATER TREATMENT

ERIC NO. ED149972

EDRS PRICE EDRS PRICE MF-$0.83 HC-$4.67 PLUS POSTAGE.
94P., PAGES 1-1 THROUGH 1-12 (GENERAL INTRODUCTION) REMOVED DUE TO COPYRIGHT RESTRICTION; SECTION 8 MISSING; CONTAINS OCCASIONAL LIGHT TYPE; BEST COPY AVAILABLE

ISSUE RIEJUN78

ABSTRACT THIS MANUAL IS DESIGNED TO PROVIDE THE SMALL WASTEWATER TREATMENT PLANT OPERATOR, AS WELL AS THE NEW OR INEXPERIENCED OPERATOR, WITH SIMPLIFIED METHODS FOR LABORATORYY ANALYSIS OF WATER AND WASTEWATER. IT IS EMPHASIZED THAT THIS MANUAL IS NOT A REPLACEMENT FOR STANDARD METHODS BUT A GUIDE FOR PLANTS WITH INSUFFICIENT EQUIPMENT TO PERFORM ANALYSES IN ACCORDANCE WITH STANDARD METHODS. EACH OF THE SECTIONS IS DESIGNED TO BE COMPLETE WITHIN ITSELF. THE TESTS AND MEASUREMENTS PRESENTED INCLUDE: ACIDS, BIOCHEMICAL OXYGEN DEMAND (BOD), DISSOLVED OXYGEN, RESIDUES, SLUDGE, AND SUSPENDED SOLIDS. (CS)

INSTITUTION NAME ILLINOIS STATE ENVIRONMENTAL PROTECTION AGENCY, SPRINGFIELD.

TITLE THE MATHEMATICS OF ACTIVATED SLUDGE CONTROL.

AUTHOR UHTE, WARREN R.

CORP AUTH BROWN AND CALDWELL, SAN FRANCISCO, CALIF.

AVAIL JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 42, NO 7, P 1292-1304, JULY 1970. 1 FIG, 1 TAB.

IDEN SUSPENDED SOLIDS, WASTING, COMPUTATION, PROCESS CONTROL.

KEYWORDS *MATHEMATICAL MODEL, *ACTIVATED SLUDGE, *CONTROL, SLUDGE, KINETICS, DESIGN.

ABSTRACT FOR THE USE OF THE MEAN CELL RESIDENCE OR THE SOLIDS RETENTION TIME IN THE CONTROL OF AN ACTIVATED SLUDGE SYSTEM, ONE MUST SELECT THE DESIRED TIME, COMPUTE THE TOTAL SOLIDS PRESENT IN THE SYSTEM AND DETERMINE THE TOTAL VOLATILE SOLIDS TO BE WASTED PER DAY. THE SOLIDS IN THE SYSTEM MAY BE EXPRESSED AS THE SUM OF THOSE IN THE AERATION FACILITIES SECONDARY SEDIMENTATION UNITS AND THE SLUDGE RETURN SYSTEM. SOLIDS ARE WASTED BOTH OVER

THE EFFLUENT WEIR AND THROUGH THE SOLIDS DISPOSAL SYSTEM. NUMERICAL EXAMPLES SHOW THESE COMPUTATIONS FOR CONVENTIONAL, STEP FEED, HIGH RATE AND MULTIPLE STEP OPERATIONS OF AN HYPOTHETICAL PLANT. ASSUMED PLANT DESIGN IS FOR AN 18 MGD FLOW. THE PLANT LAYOUT INCLUDES FOUR AERATION TANKS, MIXED LIQUOR CHANNEL AND RETURN ACTIVATED SLUDGE CHANNEL, AND FOUR SECONDARY SEDIMENTATION BASINS. (HANCUFF-TEXAS)

TITLE MAXIMIZING PHOSPHORUS REMOVAL IN ACTIVATED SLUDGE.

AUTHOR ELLIOTT, W. R.; RIDING, J. T.; SHERRARD, J. H.

CORP AUTH VIRGINIA POLYTECHNIC INST. AND STATE UNIV., BLACKSBURG. DEPT. OF CIVIL ENGINEERING.

PUB DESC WATER AND SEWAGE WORKS, VOL 125, NO 3, P 88-92, MARCH, 1978. 38 REF.

KEYWORDS *PHOSPHORUS, *BIOLOGICAL TREATMENT, *ACTIVATED SLUDGE, *CHEMICAL PERCIPITATION, NUTRIENT REMOVAL, ABSORPTION, BIODEGRADATION, CALCIUM CARBONATE, LIME, PILOT PLANTS, LABORATORY TESTS, HARDNESS (WATER), PHOSPHATES, LIMITING FACTORS, PUBLICATIONS, WASTE WATER TREATMENT, MUNICIPAL WASTES.

ABSTRACT IMPROVING PHOSPHORUS REMOVAL IN ACTIVATED SLUDGE BY MICROBIAL GROWTH, EXCESS UPTAKE, AND CHEMICAL PRECIPITATION WAS DISCUSSED IN A REVIEW OF PUBLISHED EXPERIMENTAL DATA AND ON-SITE TESTS IN WASTE WATER TREATMENT PLANTS. LABORATORY DATA ON MICROBIAL UPTAKE IDENTIFIED THE C:P RATIO AS A LIMITING FACTOR IN PHOSPHORUS REMOVAl; THE HIGHER COD:P RATIO PROVIDED MORE OF THE STOICHIOMETRIC REQUIREMENT. VARIATIONS IN MEAN CELL RESIDENCE TIME AFFECTED PHOSPHORUS REMOVAL, ALTHOUGH THE AVERAGE SLUDGE PHOSPHORUS CONTENT OF 2-3% BY WEIGHT WAS NOT SIGNIFICANTLY IMPROVED. ENHANCED PHOSPHORUS REMOVAL WAS ACHIEVED IN PLUG FLOW REACTORS WITH DISSOLVED OXYGEN CONTROL AT PH6; ANAEROBIC CONDITIONS WERE AVOIDED BY ADEQUATE SLUDGE REMOVAL. BATCH STUDIES ON EXCESS UPTAKE DEMONSTRATED THAT 80% REMOVAL OCCURRED FOR A LOW PHOSPHATE CONCENTRATION, 5MG/LITER, IN THE PRESENCE OF A HIGH MICROBIAL POPULATION. THE PRESENCE OF NA(+) AND K AND THE RATE OF AERATION WERE CITED AS LIMITING FACTORS IN EXCESS PHOSPHORUS UPTAKE. FULL-SCALE STUDIES VERIFIED THAT PHOSPHORUS WAS RELEASED INTO THE EFFLUENT STREAM UNDER ANAEROBIC CONDITIONS. PRECIPITATION WITH CACO3 RESULTED IN HYDROLYSIS OF PHOSPHATES AT THE HEAD OF THE AERATION TANK, DECREASED CO2

GENERATION, AND THE FORMATION OF CALCIUM PHOSPHATE SLUDGE. THE OPTIMUM CONDITIONS FOR PHOSPHORUS REMOVAL IN A PLUG FLOW SYSTEM WERE CONCLUDED TO BE: PH 7.5-8.5 LESS THAN 350 MG/LITER CACO3, AND 24 MG/LITER MG(++). (LISK- FIRL)

TITLE THE METAZOA OF WASTE TREATMENT PROCESSES-ROTIFERS.
AUTHOR CALAWAY, W. T.
CORP AUTH FLORIDA UNIV., GAINESVILLE.
AVAIL JOURNAL OF WATER POLLUTION CONTROL FEDERATION, VOL 40, NO 11, PART 2, P R412-R422, NOV. 1968. 3 FIG, 0 TAB, 23 REF.
IDEN *METAZOA
DESC *ACTIVATED SLUDGE, *ROTIFERS, *MICROBIOLOGY, *EFFICIENCIES, TREATMENT, WASTE TREATMENT, TRICKLING FILTER, SEWAGE TREATMENT, ANIMALS, WASTE WATER TREATMENT.
ABSTRACT DIFFERENT WASTE WATER TREATMENT PROCESSES DEVELOP DIFFERENT CHARACTERISTICS FAUNA. THE ACTIVATED SLUDGE PROCESS COMMONLY SUPPORTS ROTIFERS AS ITS PRINCIPAL METAZOA, TRICKLING FILTERS SUPPORT POPULATIONS OF ROTIFERS, ROUND WORMS, AND ANNELIDS, AND THE METAZOA OF LAGOONS VERY WIDELY. ALTHOUGH THE METAZOA SOMETIMES CAUSE TREATMENT PROBLEMS THEY CONSUME LARGE AMOUNTS OF BACTERIA AND SOLIDS AND THEREFORE ARE GENERALLY HELPFUL IN TREATMENT. THEY ALSO BREAK UP BIOLOGICAL MASSES AND EXPOSE NEW AREAS TO OXYGEN. THE ROTIFERS AID IN KEEPING AN ACTIVELY GROWING BACTERIAL POPULATION BY CONSUMING BACTERIA AND THEREBY ENCOURAGING REPLACEMENT GROWTH. BY CONSUMING UNFLOCCULATED BACTERIA, THE ROTIFERS CONTRIBUTE TO CLEARER EFFLUENCE. THEIR SECRETION CAN ALSO CONTRIBUTE TO FLOCCULATION OF SUSPENDED MATERIALS. THE BDELLOID ROTIFERS DOMINATE AS PROCESS STABILITY IS APPROACHED. (DIFILIPPO-TEXAS)

TITLE MICROSCOPIC ANALYSIS OF PLANKTON, PERIPHYTON, AND ACTIVATED SLUDGE. TRAINING MANUAL.
PUB DATE JUN 76
DESC BIOLOGICAL SCIENCES; CHEMISTRY; ENVIRONMENT; *INSTRUCTIONAL MATERIALS; LABORATORY PROCEDURES, *MANUALS, *MICROBIOLOGY, POST SECONDARY EDUCATION, SCIENCE EDUCATION, *WASTE DISPOSAL, WATER POLLUTION CONTROL, *WATER RESOURCES, *ACTIVATED SLUDGE, *WASTEWATER TREATMENT

ERIC NO. ED161715
DESC NOTE 342P.; CONTAINS OCCASIONAL LIGHT AND SMALL TYPE
ISSUE RIEMAR79
ABSTRACT THIS MANUAL IS INTENDED FOR PROFESSIONAL PERSONNEL IN THE FIELDS OF WATER POLLUTION CONTROL, LIMNOLOGY, WATER SUPPLY AND WASTE TREATMENT, PRIMARY EMPHASIS IS GIVEN TO PRACTICE IN THE IDENTIFICATION AND ENUMERATION OF MICROSCOPIC ORGANISMS WHICH MAY BE ENCOUNTERED IN WATER AND ACTIVATED SLUDGE. METHODS FOR THE CHEMICAL AND INSTRUMENTAL EVALUATION OF PLANKTON ARE COMPARED WITH THE RESULTS OF MICROSCOPIC EXAMINATION IN AN EXTENSIVE PRACTICAL EXERCISE. PROBLEMS OF SIGNIFICANCE AND CONTROL ARE ALSO CONSIDERED. (AUTHOR/BB)

TITLE OPERATION OF WASTEWATER TREATMENT PLANTS: A HOME STUDY TRAINING PROGRAM.
AUTHOR KERRI, K., ED.
PUB DATE 70
AVAIL DEPARTMENT OF CIVIL ENGINEERING, CALIFORNIA STATE UNIVERSITY AT SACRAMENTO, 6000 JAY STREET, SACRAMENTO, CA 95819
DESC ACTIVATED SLUDGE, CHLORINATION, *INSTRUCTIONAL MATERIALS, MAINTENANCE, *MANUALS, *OPERATIONS (WASTEWATER), PRIMARY TREATMENT, *POST SECONDARY EDUCATION, PUMPS, SAFETY, SEDIMENTATION, SLUDGE TREATMENT, STABILIZATION LAGOONS, TRICKLING FILTERS, *WASTE DISPOSAL, *WASTEWATER TREATMENT
DESC NOTE 1317P. REVISED ANNUALLY; ALSO AVAILABLE ON ERIC MICROFICHE ED150008.
ABSTRACT WRITTEN BY EXPERIENCED OPERATORS WITH THE INTENT OF PROVIDING OPERATORS WITH THE INFORMATION THEY NEED TO KNOW TO OPERATE THEIR PLANTS AS EFFICIENTLY AS POSSIBLE. OPERATORS, PERSONS INTERESTED IN BECOMING OPERATORS, AND PERSONS INTERESTED IN THE OPERATION OF TREATMENT PLANTS WILL FIND VALUABLE INFO IN THE MANUAL. TOPICS COVERED INCLUDE DESCRIPTION OF PLANTS, RACKS, SCREENS, COMMINUTORS, GRIT REMOVAL, SEDIMENTATION, TRICKLING FILTERS, ACTIVATED SLUDGE, SLUDGE DISGESTION AND HANDLING, PONDS, CHLORINATION, MAINTENANCE, SAFETY, MATH, LAB, RECORD.

TITLE OPERATIONAL CONTROL PROCEDURES FOR THE ACTIVATED SLUDGE PROCESS: APPENDIX.
AUTHOR WEST, ALFRED W.
PUB DATE MAR 74

DESC	*ENVIRONMENTAL TECHNICIANS, *INSTRUCTIONAL MATERIALS, *JOB SKILLS, LABORATORY TRAINING, MANAGEMENT, *MEASUREMENT TECHNIQUES, POLLUTION, *POST SECONDARY EDUCATION, WASTE DISPOSAL, *WATER POLLUTION CONTROL, ACTIVATED SLUDGE, *WASTEWATER TREATMENT, WATER QUALITY

DESC	*ENVIRONMENTAL TECHNICIANS, *INSTRUCTIONAL MATERIALS, *JOB SKILLS, LABORATORY TRAINING, MANAGEMENT, *MEASUREMENT TECHNIQUES, POLLUTION, *POST SECONDARY EDUCATION, WASTE DISPOSAL, *WATER POLLUTION CONTROL, ACTIVATED SLUDGE, *WASTEWATER TREATMENT, WATER QUALITY
ERIC NO.	ED156472
EDRS PRICE	EDRS PRICE MF-$0.83 HC-$2.06 PLUS POSTAGE.
DESC NOTE	37P., FOR RELATED DOCUMENTS, SEE SE 024 421-423; GRAPHS AND CHARTS MAY NOT REPRODUCE WELL
ISSUE	RIENOV78
ABSTRACT	THIS DOCUMENT IS THE APPENDIX FOR A SERIES OF DOCUMENTS DEVELOPED BY THE NATIONAL TRAINING AND OPERATIONAL TECHNOLOGY CENTER DESCRIBING OPERATIONAL CONTROL PROCEDURES FOR THE ACTIVATED SLUDGE PROCESS USED IN WASTEWATER TREATMENT. CATEGORIES DISCUSSED INCLUDE: CONTROL TEST DATA, TREND CHARTS, MOVING AVERAGES, SEMI-LOGARITHMIC PLOTS, PROBABILITY PLOT EXAMPLES, TESTING EQUIPMENT AND SYMBOLS AND TERMINOLOGY. (CS)

TITLE	OPERATIONAL CONTROL PROCEDURES FOR THE ACTIVATED SLUDGE PROCESS, PART I - OBSERVATIONS, PART II - CONTROL TESTS.
AUTHOR	WEST, ALFRED W.
PUB DATE	MAY 74
DESC	*ENVIRONMENT, *INSTRUCTIONAL MATERIALS, *JOB SKILLS, LABORATORY TRAINING, MANAGEMENT, MEASUREMENT TECHNIQUES, POLLUTION, *POST SECONDARY EDUCATION, WASTE DISPOSAL, *WATER POLLUTION CONTROL, ACTIVATED SLUDGE, *WASTEWATER TREATMENT, WATER QUALITY
ERIC NO.	ED156469
EDRS PRICE	EDRS PRICE MF-$0.83 HC-$2.06 PLUS POSTAGE.
DESC NOTE	31P.; FOR RELATED DOCUMENTS, SEE SE 024 422-424; CONTAINS OCCASIONAL LIGHT TYPE; PHOTOGRAPHS MAY NOT REPRODUCE WELL.
ISSUE	RIENOV78
ABSTRACT	THIS IS THE FIRST IN A SERIES OF DOCUMENTS DEVELOPED BY THE NATIONAL TRAINING AND OPERATIONAL TECHNOLOGY CENTER DESCRIBING OPERATIONAL CONTROL PROCEDURES FOR THE ACTIVATED SLUDGE PROCESS USED IN WASTEWATER TREATMENT. PART I OF THIS DOCUMENT DEALS WITH PHYSICAL OBSERVATIONS WHICH SHOULD BE PERFORMED DURING EACH ROUTINE CONTROL TEST. PART II DISCUSSES THE CONTROL TESTS THAT ARE USED TO DIRECTLY IDENTIFY PROCESS PERFORMANCE AND TO DICTATE PROCESS CONTROL ADJUSTMENTS. INCLUDED ARE

CENTRIFUGE TESTS, EFFLUENT TURBIDITY TESTS AND DISSOLVED OXYGEN TESTS. (CS)

TITLE	OPERATIONAL CONTROL PROCEDURES FOR THE ACTIVATED SLUDGE PROCESS, PART III-A: CALCULATION PROCEDURES.
AUTHOR	WEST, ALFRED W.
PUB DATE	DEC 73
DESC	*CALCULATION, ENVIRONMENT, *INSTRUCTIONAL MATERIALS, *JOB SKILLS, LABORATORY TRAINING, MANAGEMENT, MEASUREMENT TECHNIQUES, POLLUTION, *POST SECONDARY EDUCATION, WASTE DISPOSAL, *WATER POLLUTION CONTROL, *ACTIVATED SLUDGE, *WASTEWATER TREATMENT, WATER QUALITY
ERIC NO.	ED156470
EDRS PRICE	EDRS PRICE MF-$0.83 HC-$3.50 PLUS POSTAGE.
DESC NOTE	56P.; FOR RELATED DOCUMENTS, SEE SE 024 421-424
ISSUE	RIENOV78
ABSTRACT	THIS IS THE SECOND IN A SERIES OF DOCUMENTS DEVELOPED BY THE NATIONAL TRAINING AND OPERATIONAL TECHNOLOGY CENTER DESCRIBING OPERATIONAL CONTROL PROCEDURES FOR THE ACTIVATED SLUDGE PROCESS USED IN WASTEWATER TREATMENT. THIS DOCUMENT DEALS EXCLUSIVELY WITH THE CALCULATION PROCEDURES, INCLUDING SIMPLIFIED MIXING FORMULAS, AERATION TANK CHARACTERISTICS, ORGANIC LOADING AND PURIFICATION PRESSURES, CLARIFIER SLUDGE FLOW DEMAND, AND MIXING FORMULA DEVELOPMENT. (CS)

TITLE	OPERATIONAL CONTROL PROCEDURES FOR THE ACTIVATED SLUDGE PROCESS, PART III-B: CALCULATION PROCEDURES FOR STEP-FEED PROCESS RESPONSES AND ADDENDUM NO. 1.
AUTHOR	WEST, ALFRED W.
PUB DATE	FEB 75
DESC	*CALCULATION, ENVIRONMENT, *INSTRUCTIONAL MATERIALS, *JOB SKILLS, LABORATORY TECHNIQUES, MANAGEMENT, MEASUREMENT TECHNIQUES, POLLUTION, *POST SECONDARY EDUCATION, WASTE DISPOSAL, *WATER POLLUTION CONTROL, *ACTIVATED SLUDGE, *WASTEWATER TREATMENT, WATER QUALITY
ERIC NO.	ED156471
EDRS PRICE	EDRS PRICE MF-$0.83 HC-$2.06 PLUS POSTAGE.
DESC NOTE	44P., FOR RELATED DOCUMENTS, SEE SE 024 421-424
ISSUE	RIENOV78
ABSTRACT	THIS IS THE THIRD IN A SERIES OF DOCUMENTS DEVELOPED BY THE NATIONAL TRAINING AND OPERATIONAL TECHNOLOGY CENTER DESCRIBING OPERATIONAL CONTROL PROCEDURES FOR THE ACTIVATED SLUDGE PROCESS USED

IN WASTEWATER TREATMENT. THIS DOCUMENT DEALS WITH THE CALCULATION PROCEDURES ASSOCIATED WITH A STEP FEED PROCESS. ILLUSTRATIONS AND EXAMPLES ARE INCLUDED TO EMPHASIZE HOW THE ACTIVATED SLUDGE PROCESS REACTS TO CHANGES IN WASTEWATER FEED-POINT LOCATIONS. THE SUMMARY ILLUSTRATES THE TYPES OF CHANGES THAT OCCUR WHEN A PLUG-FLOW SYSTEM IS SWITCHED TO VARIOUS STEP-FEED COMBINATIONS. (CS)

TITLE	OPERATIONAL CONTROL TESTS FOR THE ACTIVATED SLUDGE PROCESS - PART I (XT-40).
AUTHOR	WEST, A. W.
PUB DATE	71
DESC	*AUDIOVISUAL AIDS, *INSTRUCTIONAL MATERIALS, *LABORATORY PROCEDURES, POLLUTION, *POST SECONDARY EDUCATION, WATER POLLUTION CONTROL, *SLUDGE, *SOLID WASTES, WASTEWATER TREATMENT, *ACTIVATED SLUDGE
DESC NOTE	INCLUDED IS A 16 MINUTE TAPE, 51 SLIDES, ALSO A SCRIPT. AVAILABLE ON LOAN FROM NTOTC, 26 W ST. CLAIR, CINCINNATI, OHIO 45268
ABSTRACT	THIS MODULE IS DESIGNED FOR WASTEWATER WORKS OPERATORS WHO WISH TO UPGRADE PLANT PERFORMANCE AND TO INCREASE THEIR OWN KNOWLEDGE AND SKILLS. THIS IS PART ONE OF A THREE-PART LESSON SERIES ON OPERATIONAL CONTROL TESTS FOR THE ACTIVATED SLUDGE PROCESS. ENTITLED "OBSERVATIONS," THIS FIRST PART IS CONCERNED WITH THE ACCURATE READING OF METERS AND WITH THE VISUAL OBSERVATIONS TO BE MADE BOTH AT THE AERATOR (FOAM CHARACTERISTICS, SLUDGE, COLOR, AND ODOR) AND AT THE FINAL CLARIFIERS (CLARITY, EVIDENCES OF BULKING AND OF SEPTIC SOLIDS). PROVISIONAL INTERPRETATIONS TO BE MADE OF THESE VISUAL OBSERVATIONS ARE PRESENTED, AND THE EFFECTIVE USE OF A SLUDGE BLANKET FINDER IS DISCUSSED IN DETAIL. (AUTHOR/JK)

TITLE	OPERATIONAL CONTROL TESTS FOR THE ACTIVATED SLUDGE PROCESS - PART II (XT-41).
AUTHOR	WEST, A. W.
PUB DATE	71
DESC	*AUDIOVISUAL AIDS, *INSTRUCTIONAL MATERIALS, *LABORATORY PROCEDURES, POLLUTION, *POST SECONDARY EDUCATION, *SOLID WASTES, WATER POLLUTION CONTROL, *SLUDGE, WASTEWATER TREATMENT, *ACTIVATED SLUDGE
DESC NOTE	INCLUDED IS A 17 MINUTE TAPE, 47 SLIDES AND A SCRIPT. AVAILABLE ON LOAN FROM NTOTC, 26 W ST. CLAIR, CICINNATI, OHIO 45268

PERFORMANCE AND TO INCREASE THEIR OWN KNOWLEDGE AND SKILLS. THIS IS PART TWO OF A THREE-PART LESSON SERIES ON OPERATIONAL CONTROL TESTS FOR THE ACTIVATED SLUDGE PROCESS. THIS PART IS A DETAILED DISCUSSION OF THE PREFERRED TECHNIQUES INVOLVED IN CONDUCTING SETTLOMETER TESTS TO DETERMINE SETTLING CHARACTERISTICS AND IN CENTRIFUGING SAMPLES TO DETERMINE THE CONCENTRATION OF MIXED LIQUOR AND RETURN SLUDGE. HANDLING THE RELATED SAMPLES IS INCLUDED ALONG WITH PROVISIONAL INTERPRETATIONS AND APPLICATIONS OF THE TESTS. (AUTHOR/JK)

TITLE OPERATIONAL CONTROL TESTS FOR THE ACTIVATED SLUDGE PROCESS - PART III (XT-42).
AUTHOR WEST, A. W.
PUB DATE 71
DESC *AUDIOVISUAL AIDS, *INSTRUCTIONAL MATERIALS, *LABORATORY PROCEDURES, POLLUTION, *POST SECONDARY EDUCATION, *SOLID WASTES, WATER POLLUTION CONTROL, *SLUDGE, WASTEWATER TREATMENT, *ACTIVATED SLUDGE
DESC NOTE INCLUDED IS A 22 MINUTE TAPE, 67 SLIDES, AND A SCRIPT. AVAILABLE ON LOAN FROM NTOTC, 26 W. ST. CLAIR, CINCINNATI, OHIO 45268
ABSTRACT THIS MODULE IS DESIGNED FOR EXPERIENCED WASTEWATER WORKS OPERATORS WHO WISH TO UPGRADE PLANT PERFORMANCE AND TO INCREASE THEIR OWN KNOWLEDGE AND SKILLS. THIS IS PART THREE OF A THREE-PART LESSON SERIES ON OPERATIONAL CONTROL TESTS FOR THE ACTIVATED SLUDGE PROCESS. THIS CONCLUDING PART PRESENTS DEVELOPMENT OF SETTLING AND CONCENTRATION CURVES FROM SETTLOMETER AND CENTRIFUGE TESTS RESULTS, TECHNIQUES FOR CONDUCTING TURBIDITY TESTS AS WELL AS THE SIGNIFICANCE OF TURBIDITY RESULTS, A SUMMARY OF ALL THE TESTS PRESENTED IN THE THREE-PART SERIES, THE CONTROL ADJUSTMENTS WHICH ARE MADE ON THE BASIS OF THESE TEST RESULTS, AND PROGRESSIVE TREND CHARTS OF PROCESS CHARACTERISTICS. (AUTHOR/JK)

TITLE OXYGEN ACTIVATED SLUDGE CONSIDERATIONS FOR INDUSTRIAL APPLICATIONS.
AUTHOR ADAMS, C. E., JR.; ECKENFELDER, W. W., JR.; KOON, J. H.; SHELBY, S. E.
CORP AUTH AWARE, INC., NASHVILLE, TN.
PUB DESC AVAILABLE FROM COPYRIGHT CENTER, INC., NEW YORK, NY AS 0065-8812-78-9754-0178 ($0.95). IN: WATER--1977, AICHE SYMPOSIUM SERIES, VOL 74, NO 178, EDITED BY G. F. BENNETT, P 93-101, 1978, 9 FIG, 6 REF.

KEYWORDS *ACTIVATED SLUDGE, *WASTE WATER TREATMENT, *INDUSTRIAL WASTE, *OXYGENATION, *BIOLOGICAL TREATMENT, *EVALUATION, WASTE TREATMENT, AERATION, HYDROGEN ION CONCENTRATION, ORGANIC COMPOUNDS, SLUDGE, SUSPENDED SOLIDS, ECONOMICS, COSTS, APPRAISALS, INSTALLATION COSTS, OPERATING COSTS, ODOR.

ABSTRACT A NUMBER OF FACTORS ARE DISCUSSED WHICH MUST BE EVALUATED WHEN ASSESSING THE RELATIVE MERITS OF AIR OXYGENTED VERSUS PURE OXYGEN OXYGENATED ACTIVATED SLUDGE SYSTEMS FOR INDUSTRIAL USE. ORGANIC REMOVAL KINETICS MAY PLAY A MORE IMPORTANT ROLE IN TREATING INDUSTRIAL WASTES THAN MUNICIPAL WASTES BECAUSE OF THEIR HIGH STRENGTH. IT IS SHOWN THAT A HIGHER DISSOLVED OXYGEN LEVEL IN THE AERATION BASIN WILL RESULT IN A HIGHER RESISTANCE TO ORGANIC SHOCK LOADINGS AND A MORE AEROBIC FLOC. A HIGHER TEMPERATURE BECAUSE OF THE ENCLOSURE OF THE AERATION BASIN IS AN ADVANTAGE OF THE PURE OXYGEN SYSTEM, ESPECIALLY IN COLD CLIMATES. EQUILIBIRUM OF THE AERATION BASIN PH CAN BE A PROBLEM WITH THE PURE OXYGEN SYSTEM BECAUSE IT INTAILS A SLIGHTLY LOWER PH. WITH HIGHLY ACIDIC INDUSTRIAL WASTE WATERS IT MAY BE DIFFICULT TO MAINTAIN PH TO AN ACCEPTABLE RANGE BETWEEN 6.5 AND 7.5. ALSO, THE ENCLOSED OXYGEN SYSTEM MAY RESULT IN DIFFICULTIES BY RETAINING VOLATILE ORGANICS WHICH CAN INHIBIT THE SYSTEM. PURE OXYGEN SYSTEMS ARE PREFERABLE TO AIR OXYGEN SYSTEMS FOR CONTROL OF ODORS AND SUSCEPTIBILITY TO SHOCK LOADINGS. ANOTHER FACTOR TO BE CONSIDERED IS MIXED LIQUOR VOLATILE SUSPENDED SOLIDS CONCENTRATIONS WHICH CAN BE HANDLED EFFECTIVELY BY BOTH SYSTEMS IF THEY ARE PROPERLY DESIGNED; HOWEVER, THE PURE OXYGEN SYSTEM DOES HAVE THE ADVANTAGE OF BEING ABLE TO SUPPLY SUFFICIENT OXYGEN TO MAINTAIN RELATIVELY HIGH MIXED LIQUOR OR SOLIDS LEVELS WITHOUT REQUIRING USE OF HIGH POWER LEVELS WHICH WOULD PROMOTE BREAK-UP OF FLOC PARTICLES. ECONOMICALLY, A PURE OXYGEN SYSTEM COSTS MORE TO CONSTRUCT BUT MAY OFFER SUBSTANTIAL SAVINGS IN OPERATING COSTS, BASED MOSTLY ON THE POWER REQUIREMENTS TO ACHIEVE THE NECESSARY DISSOLVED OXYGEN CONCENTRATION. (SEE ALSO W79-00342) (MAJTENYI-IPA)

TITLE PERFORMANCE OF CIRCULAR FINAL CLARIFIERS AT AN ACTIVATED SLUDGE PLANT

AUTHOR MUNCH, W. L.; FITZPATRICK, J. A.
CORP AUTH METROPOLITAN SANITARY DISTRICT OF GREATER CHICAGO

PUB DESC	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 50, NO 2, P 265-276, FEBRUARY, 1978. 10 FIG, 2 TAB, 10 REF.
KEYWORDS	*ACTIVATED SLUDGE, *SETTLING BASINS, *HYDRAULIC MODELS, *SOLID WASTES, *SEPARATION TECHNIQUES, SUSPENDED SOLIDS, HYDRAULICS, EFFLUENT STREAMS, PERFORMANCE, WASTE WATER TREATMENT, MUNICIPAL WASTES.
ABSTRACT	THE PERFORMANCE OF A 38 M-DIAM CIRCULAR CENTER-FEED CLARIFIER WAS EVALUATED UNDER VARYING CONDITIONS OF HYDRAULIC AND SOLIDS LOADING AT AN ACTIVATED SLUDGE TREATMENT FACILITY IN CHICAGO, ILLINOIS. LIMITING THE EFFLUENT FLOW TO 0.66 CU M/SEC WITH A 30% RETURN RATE ALLOWED A MAXIMUM SOLIDS LOADING RATE FOR EFFICIENT CLARIFICATION OF 146 KG/SQ M/DAY AT A MIXED LIQUOR CONCENTRATION OF 2,500 MG/LITER. HIGHER FLOW RATES WERE POSSIBLE WHEN THE MIXED LIQUOR CONTENT WAS DECREASED. A HIGHER SOLIDS LOADING RATE WAS ACCOMMODATED BY THE CLARIFIER WHEN THE HYDRAULIC LOADING RATE WAS MAINTAINED BELOW 0.83 CU M/SEC, VERIFYING THE DEPENDENCE OF SOLIDS LOADING ON HYDRAULIC LOAD. AN INCREASE IN THE THICKNESS OF THE SLUDGE BLANKET, OCCURRING AT HYDRAULIC LOADING IN EXCESS OF 0.83 CU M/SEC AT A 30% RETURN, THREATENED THE SOLIDS SEPARATION EFFICIENCY OF THE CLARIFIER. SLUDGE BLANKET LEVEL, SOLIDS SETTLEABILITY, AND HYDRAULIC LOADING REPORTEDLY HAD A GREATER IMPACT ON CLARIFIER SOLIDS SEPARATION PERFORMANCE THAN SHOCK HYDRAULIC LOADING. THE ACTUAL MAXIMUM SOLIDS LOADING RATE WAS SIGNIFICANTLY LOWER THAN THE THEORETICAL MAXIMUM. (LISK-FIRL)

TITLE	PRIMARY TREATMENT AND SLUDGE DIGESTION WORKSHOP.
PUB DATE	SEP 77
AVAIL	PUBLICATIONS CENTRE, ONTARIO MINISTRY OF GOVERNMENT SERVICES, 880 BAY ST., 5TH FLOOR, TORONTO, ONTARIO, CANADA M7A 1N8 ($2.00; ORDERS MUST BE ACCOMPANIED BY CHECK OR MONEY ORDER PAYABLE TO "THE TREASURER OF ONTARIO")
DESC	*BEHAVIORAL OBJECTIVES; *ENVIRONMENTAL EDUCATION; ENVIRONMENTAL TECHNICIANS, EQUIPMENT, JOB SKILLS, *POLLUTION, SAMPLING, WASTE DISPOSAL, *WATER POLLUTION CONTROL, *WORKSHOPS, ONTARIO, *SLUDGE, *WASTEWATER TREATMENT
ERIC NO.	ED155002
EDRS PRICE	EDRS PRICE MF-$0.83 PLUS POSTAGE. HC NOT AVAILABLE FROM EDRS.

DESC NOTE	269P; FOR RELATED DOCUMENTS, SEE SE 024 226-233, NOT AVAILABLE IN HARD COPY DUE TO COPYRIGHT RESTRICTIONS; CONTAINS COLORED PAGES WHICH MAY NOT NOT REPRODUCE WELL
ISSUE	RIEOCT78
ABSTRACT	THIS MANUAL WAS DEVELOPED FOR USE AT WORKSHOPS DESIGNED TO UPGRADE THE KNOWLEDGE OF EXPERIENCED WASTEWATER TREATMENT PLANT OPERATORS. EACH OF THE SIXTEEN LESSONS HAS CLEARLY STATED BEHAVIORAL OBJECTIVES TO TELL THE TRAINEE WHAT HE SHOULD KNOW OR DO AFTER COMPLETING THAT TOPIC. AREAS COVERED IN THIS MANUAL INCLUDE: SEWAGE CHARACTERISTICS; COLLECTION, TREATMENT, AND SEDIMENTATION; AEROBIC AND ANAEROBIC DIGESTION; SAMPLING AND INTERPRETATION; MONITORING AND CONTROL; AND SELECTED TESTS. (CS)

TITLE	PROCESS CONTROL BY OXYGEN-UPTAKE AND SOLIDS ANALYSIS.
AUTHOR	BENEFIELD, L. D.; RANDALL, C. W.; KING, P. H.
CORP AUTH	MISSISSIPPI STATE UNIV., MISSISSIPPI STATE. DEPT. OF CIVIL ENGINEERING.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 47, NO 10, P 2498-2503, OCTOBER, 1975. 2 FIG, 6 REF.
IDEN	PROCESS CONTROL, *OXYGEN-UPTAKE, *SOLIDS ANALYSIS, CLARIFIERS, SLUDGE AGE, SLUDGE WASTING, SUBSTRATE CONCENTRATION.
KEYWORDS	OXYGEN, *SOLIDS CONTACT PROCESSES, WASTE WATER TREATMENT, *ACTIVATED SLUDGE, ANALYSIS, SLUDGE TREATMENT, MICROORGANISM, MATHEMATICS, CONTROL SYSTEMS.
ABSTRACT	THE MOST COMMON METHODS USED BY PLANT OPERATORS TO CONTROL THE ACTIVATED SLUDGE PROCESS ARE DISCUSSED. THE THEORETICAL BASIS FOR ANOTHER METHOD HAVING CERTAIN ADVANTAGES OVER THE OTHERS WAS STUDIED. FOUR CONTROL METHODS IN COMMON USE ARE: SLUDGE WASTING TO MAINTAIN A CONSTANT MASS OF ORGANISMS IN THE SYSTEM; SLUDGE WASTING TO MAINTAIN A CONSTANT SPECIFIC RATE OF SUBSTRATE UTILIZATION; SLUDGE WASTING TO MAINTAIN A CONSTANT SLUDGE AGE; AND HYDRAULIC CONTROL TO MAINTAIN A CONSTANT SLUDGE AGE. THE LAST TWO, IN WHICH THE SLUDGE AGE IS KEPT CONSTANT, ARE THE MOST FAVORABLE ONES. THE MAJOR WEAKNESS IN THESE METHODS IS THE CONTINUAL SHIFTING IN THE SOLIDS BALANCE BETWEEN THE AERATION TANK AND THE CLARIFIER AS THE INFLUENT FLOW RATE DEVIATES. A NEW METHOD IS PROPOSED IN WHICH THE SOLIDS

SEPARATE AT A RATE SUCH THAT THE SOLIDS CONCENTRATION IS MAINTAINED IN THE SLUDGE RETURN LINES AND NO MICROBIAL GROWTH OCCURS IN THE SECONDARY CLARIFIER. ADVANTAGES OF THIS METHOD INCLUDE: THE EFFECT OF THE FLUCTUATING SOLIDS LEVEL IN THE SECONDARY CLARIFIER IS MINIMIZED; ANY CHANGE IN THE INFLUENT SUBSTRATE CONCENTRATION WILL BE REFLECTED IMMEDIATELY IN THE OXYGEN UPTAKE RATE; AND LOADING FLUCTUATIONS CAN BE COMPENSATED FOR BY VARYING THE INTERVAL BETWEEN CONTROL PERIODS. DISADVANTAGES OF THIS METHOD INCLUDE: THE REQUIREMENT FOR A LABORATORY STUDY TO DETERMINE CHANGES IN THE CONSTANTS; MORE OPERATOR ATTENTION THAN IS REQUIRED IN THE HYDRAULIC METHOD FOR CONTROLLING SLUDGE AGE; AND MATHEMATICAL MANIPULATIONS ARE REQUIRED THAN IN ANY OTHER OF THE METHODS. (PINTO-FIRL)

TITLE PROCESS CONTROL DEMANDS - PART A (XT-60)
WEST, A.
PUB DATE NOV 72
DESC *AUDIOVISUAL AIDS; *INSTRUCTIONAL MATERIALS; POLLUTION; *POST SECONDARY EDUCATION; SLIDES; WASTES; *WATER POLLUTION CONTROL, *ACTIVATED SLUDGE, *OPERATIONS (WASTEWATER)
DESC NOTE INCLUDED IS A 10 MINUTE TAPE, 19 SLIDES, AND A SCRIPT. AVAILABLE ON LOAN FROM NTOTC, 26 W. ST. CLAIR, CINCINNATI, OHIO 45268
ABSTRACT THIS MODULE IS DESIGNED FOR EXPERIENCED WASTEWATER WORKS OPERATORS WHO DESIRE TO UPGRADE PLANT PERFORMANCE AND TO INCREASE THEIR OWN KNOWLEDGE AND SKILLS. PROVIDED IS AN INTRODUCTION TO A SERIES ON OPERATIONAL CONTROL OF AN ACTIVATED SLUDGE PROCESS. A PLANT SCHEMATIC IS USED TO PRESENT THE EFFECTS OF RETURN SLUDGE FLOW ADJUSTMENTS ON SLUDGE CONCENTRATIONS, SLUDGE DETENTION TIMES, PROCESS EQUILIBRIUM, SLUDGE CHARACTERISTICS, AND FINAL EFFLUENT QUALITY. (AUTHOR/JK)

TITLE PROCESS CONTROL DEMANDS - PART B (XT-61).
WEST, A.
PUB DATE NOV 72
DESC *AUDIOVISUAL AIDS, *INSTRUCTIONAL MATERIALS, POLLUTION, *POST SECONDARY EDUCATION, *TECHNICAL EDUCATION, *WATER POLLUTION CONTROL, *PLANT OPERATIONS, *WASTEWATER TREATMENT, SLUDGE, *ACTIVATED SLUDGE

DESC NOTE	INCLUDED IS A 15 MINUTE TAPE AND A SCRIPT. AVAILABLE ON LOAN FROM NTOTC, 26 W. ST. CLAIR, CINCINNATI, OHIO 45268
ABSTRACT	THIS MODULE IS DESIGNED FOR EXPERIENCED WASTEWATER WORKS OPERATORS WHO WISH TO UPGRADE PLANT PERFORMANCE AND TO INCREASE THEIR OWN KNOWLEDGE AND SKILLS. ONE OF A SERIES, THIS MODULE PRESENTS THE DERIVATION OF MIXING FORMULA THAT WILL BE USED IN SUBSEQUENT SECTIONS TO DEVELOP THE RETURN SLUDGE FLOW DEMAND FORMULA USED IN OPERATIONAL CONTROL OF AN ACTIVATED SLUDGE PROCESS. A SCHEMATIC IS USED TO ILLUSTRATE COMPONENTS OF THE FORMULA AND TO DEVELOP A FINAL MASS BALANCE RATIO OF RETURN SLUDGE CONCENTRATION TO MIXED LIQUOR CONCENTRATION IN TERMS OF CLARIFIER SLUDGE PERCENTAGE. SIMPLE MIXING FORMULAE ARE THEN DERIVED FOR EACH OF THE THREE FACTORS ALONG WITH EXAMPLE CALCULATIONS. (AUTHOR/JK)

TITLE	PROCESS DESIGN MANUAL: WASTEWATER TREATMENT FACILITIES FOR SEWERED SMALL COMMUNITIES.
AUTHOR	LEFFEL, R. E.; AND OTHERS
PUB DATE	OCT 77
DESC	*ENGINEERING, ENVIRONMENT, *INSTRUCTIONAL MATERIALS, *MANUALS, POLLUTION, *POST SECONDARY EDUCATION, SCIENCE EDUCATION, TECHNICAL REPORTS, *UTILITIES, *WASTE DISPOSAL, WATER POLLUTION CONTROL, WATER RESOURCES, *WASTEWATER TREATMENT, *OPERATIONS (WASTEWATER), RURAL AREAS
ERIC NO.	ED162869
EDRS PRICE	EDRS PRICE MF-$1.00 HC-$26.11 PLUS POSTAGE.
DESC NOTE	496P.; FOR RELATED DOCUMENTS, SEE SE 025 368-370
ISSUE	RIEAPR79
ABSTRACT	THIS MANUAL ATTEMPTS TO DESCRIBE NEW TREATMENT METHODS, AND DISCUSS THE APPLICATION OF NEW TECHNIQUES FOR MORE EFFECTIVELY REMOVING A BROAD SPECTRUM OF CONTAMINANTS FROM WASTEWATER. TOPICS COVERED INCLUDE: FUNDAMENTAL DESIGN CONSIDERATIONS, FLOW EQUALIZATION, HEADWORKS COMPONENTS, CLARIFICATION OF RAW WASTEWATER, ACTIVATED SLUDGE, PACKAGE PLANTS, FIXED GROWTH SYSTEMS, WASTEWATER TREATMENT PONDS, FILTRATION AND MICROSCREENING, PHYSICAL-CHEMICAL TREATMENT, NUTRIENT REMOVAL, SLUDGE AND PROCESS SIDESTREAM HANDLING, DISINFECTION AND POSTAERATION, OPERATION AND MAINTENANCE, AND COST EFFECTIVENESS. A GLOSSARY IS ALSO INCLUDED. (AUTHOR/BB)
INSTITUTION NAME	CAMP, DRESSLER & MCKEE, INC., BOSTON, MASS.

TITLE	ROLE OF ACTIVATED SLUDGE FINAL SETTLING TANKS.
AUTHOR	DICK, RICHARD I.
CORP AUTH	ILLINOIS UNIV., URBANA. DEPT. OF CIVIL ENGINEERING.
AVAIL	JOURNAL OF THE SANITARY ENGINEERING DIVISION, ASCE, VOL 96, NO SA2, P 423-436, APRIL 1970. 10 FIG, 17 REF.
IDEN	*THICKENING, *FINAL SETTLING TANK, *FLUX RATE, CLARIFICATION, SUSPENDED SOLIDS.
KEYWORDS	*ACTIVATED SLUDGE, SEWAGE TREATMENT, SEDIMENTATION, *WASTE WATER TREATMENT.
ABSTRACT	THE FINAL SETTLING TANK IN THE ACTIVATED SLUDGE PROCESS HAS TWO FUNCTIONS: CLARIFICATION AND THICKENING. CONVENTIONAL DESIGN PROCEDURES HAVE CONSIDERED ONLY THE CLARIFICATION FUNCTION. HOWEVER, INADEQUATE PERFORMANCE OF THICKENING FUNCTIONS PRODUCES ADVERSE EFFECTS, INCLUDING: LOSS OF SUSPENDED SOLIDS TO THE EFFLUENT AND INSUFFICIENT SUSPENDED SOLIDS CONCENTRATION IN THE SLUDGE RECYCLE WHICH LEADS TO LOWER MIXED LIQUOR SUSPENDED SOLIDS CONCENTRATIONS IN THE AERATION TANK. TO ASSURE PROPER PERFORMANCE OF THE FINAL SETTLING TANK THE TANK SHOULD BE SIZED FOR EACH FUNCTION AND THE LARGER SIZE SHOULD GOVERN THE DESIGN. THE AREA REQUIRED FOR THICKENING MUST BE SUFFICIENT SO THAT SOLIDS ARE APPLIED TO THE TANK AT A RATE LESS THAN THE RATE AT WHICH SOLIDS ARE ABLE TO REACH THE BOTTOM OF THE TANK. THE RATE WHICH BIOLOGICAL SOLIDS REACH THE BOTTOM OF THE TANK IS TERMED THE FLUX RATE. CHARACTERISTICALLY, THIS FLUX RATE PASSES THROUGH A MINIMUM FOR SOME CONCENTRATION OF ACTIVATED SLUDGE PRESENT IN THE SETTLING TANK. THIS MINIMUM FLUX RATE ACTS AS A BOTTLENECK AND GOVERNS THE AREA REQUIRED FOR THICKENING. SEVERAL METHODS FOR DETERMINING THE LIMITING CAPACITY ARE GIVEN IN AN ILLUSTRATIVE EXAMPLE. (DIFILIPPO-TEXAS)

TITLE	SEWAGE TREATMENT: BASIC PRINCIPLES AND TRENDS.
AUTHOR	BOLTON, R. L.; KLEIN, L. 76
AVAIL	ANN ARBOR SCIENCE PUBLISHERS, P.O. BOX 1425, ANN ARBOR, MI 48106
DESC	CALCULATION, *CHEMICAL ANALYSIS, CHEMISTRY, ENVIRONMENTAL INFLUENCES, *INSTRUCTIONAL MATERIALS, MEASUREMENT TECHNIQUES, POLLUTION, *POST SECONDARY EDUCATION, *PUBLIC HEALTH, *WASTE DISPOSAL, WATER QUALITY, *WATER POLLUTION CONTROL, *OPERATIONS (WASTEWATER), *WASTEWATER TREATMENT

ABSTRACT PROVIDED IS INFORMATION ON THE BASIC PRINCIPLES OF THE PROCESSES OF SEWAGE TREATMENT, ESPECIALLY AS IT RELATES TO THE CHEMISTRY OF SEWAGE TREATMENT. THE TEXT DISCUSSES THE NATURE OF SEWAGE AND CHEMICAL ANALYSIS AND THEN PROCEEDS THROUGH THE TREATMENT PROCESSES TO FINAL DISPOSAL. THE LAST CHAPTERS DEAL WITH CURRENT TRENDS IN THE FIELD OF WATER POLLUTION CONTROL AND WITH CHEMICAL CALCULATIONS. CONVERSION TABLES FOR BRITISH METRIC UNITS ARE INCLUDED IN THE APPENDIX.

TITLE SEWAGE TREATMENT PLANT DEPENDABILITY WITH SPECIAL REFERENCE TO THE ACTIVATED SLUDGE PROCESS.

AUTHOR WEST, A. W.

CORP AUTH NATIONAL FIELD INVESTIGATIONS CENTER - CINCINNATI, OHIO.

AVAIL AVAILABLE FROM THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161, AS PB-231 070, $3.25 IN PAPER COPY. $2.25 IN MICROFICHE, MARCH, 1971. 12 P.

KEYWORDS *SEWAGE TREATMENT, *DESIGN CRITERIA, *OPERATION AND MAINTENANCE, FACILITIES, *ACTIVATED SLUDGE, BIOLOGICAL TREATMENT, WATER POLLUTION CONTROL, WATER QUALITY CONTROL, *TREATMENT FACILITIES, *WASTE WATER TREATMENT.

ABSTRACT THIS WORK IS A REFERENCE FOR SEWAGE TREATMENT PLANT DEPENDABILITY LECTURES PRESENTED AT TRAINING SESSIONS, SYMPOSIA, AND WORKSHOPS. DESIGN CONSIDERATIONS NECESSARY TO ACHIEVE CONSISTENTLY SATISFACTORY PLANT PERFORMANCE AND FINAL EFFLUENT QUALITY INCLUDE THE PROPER TREATMENT PROCESSES, A GENEROUS PLANT CAPACITY, ESSENTIAL FLEXIBILITY, AND TRUE CONTROLLABILITY OF THE PLANT. THE TREATMENT PROCESS OR MODIFICATION MOST APPROPRIATE TO THE KNOWN WASTE CHARACTERISTICS AND EFFLUENT QUALITY REQUIREMENTS SHOULD BE CHOSEN. EXAMPLES INCLUDE THE CLASSIC ACTIVATED SLUDGE PROCESS, THE COMPLETE MIX MODIFICATION AND THE STEP AERATION MODIFICATION. PILOT STUDIES ON A BENCH, PILOT, OR DEMONSTRATION SCALE MAY BE PERFORMED TO RESOLVE UNCERTAININITIES ABOUT THE CORRECT PROCESS TO CHOOSE. THE SUGGESTIONS CONTAINED IN DESIGN CRITERIA MANUALS SUCH AS THE "10-STATES STANDARDS" SHOULD BE CONSIDERED AS MINIMUM REQUIREMENTS NEEDED TO PROVIDE ADEQUATE SAFETY FACTORS TO ASSURE PLANT DEPENDABILITY. ITEMS DISCUSSED UNDER FLEXIBILITY OF A PLANT INCLUDE: PROCESS; AERATION TANKS; FINAL CLARIFIERS; RETURN SLUDGE PUMPING FACILITIES; EXCESS SLUDGE WASTING; EMERGENCY

CHEMICAL TREATMENT; SLUDGE HANDLING FACILITIES; EQUALIZING TANKS; AND HOLDING PONDS. THE ACTIVATED SLUDGE SYSTEM IS A CONTROLLABLE PROCESS THAT SHOULD HAVE THE APPROPRIATE METERS AND ACCURATELY CONTROLLABLE GATES, VALVES, PUMPS, AND BLOWERS FOR OPTIMUM PERFORMANCE. QUALIFIED OPERATORS ARE NEEDED TO ACHIEVE THE HIGH QUALITY EFFLUENT THAT CAN BE PRODUCED BY A PROPERLY DESIGNED WASTE TREATMENT PLANT; DEDICATED, EXPERIENCED OPERATORS ARE NEEDED EVEN MORE AT PLANTS WHICH HAVE DESIGN DEFECTS. (ORR-FIRL)

TITLE	START-UP MUNICIPAL WASTEWATER TREATMENT FACILITIES.
AUTHOR	RADAR, R. D.; GREEN, R. L.; PAGE, G. L., JR.
CORP AUTH	WILEY AND WILSON, INC., LYNCHBURG, VA
AVAIL	FOR SALE BY THE SUPERINTENDENT OF DOCUMENTS, U.S. GOVERNMENT PRINTING OFFICE, WASHINGTON, D.C. 20402 PRICE $1.40. ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, DC, OFFICE OF WATER PROGRAM OPERATION, REPORT EPA-43019-74-008, DECEMBER 1973. 92P, 3 FIG, 2 TAB, 42 REF. EPA CONTRACT 68-01-0341.
IDEN	PROCEDURES, PROCESS, SEED SLUDGE, STAFFING, STANDARD OPERATING PROCEDURES, SITE MEETINGS, INVENTORY INSPECTION PRETESTING, OPERATOR TRAINING, SETTLEABLE SOLIDS, TOTAL SOLIDS, VOLATILE SOLIDS, VOLATILE ACIDS, MIXED LIQUOR SUSPENDED SOLIDS.
KEYWORDS	*ADMINISTRATIVE DECISIONS, *TREATMENT FACILITIES, *WASTE WATER TREATMENT, *OPERATIONS, *LABORATORY TESTS, *SAMPLING, TESTING, ANALYSIS, CONTROLS, ACTIVATED SLUDGE, TRICKLING FILTER, OXIDATION LAGOONS, ANAEROBIC DIGESTION, SAFETY, CHLORINATION, SUSPENDED SOLIDS, HYDROGEN ION CONCENTRATION, ALKALINITY, BIOCHEMICAL OXYGEN DEMAND, CHEMICAL OXYGEN DEMAND, PRE-TREATMENT (WATER), SEWAGE TREATMENT.
ABSTRACT	THIS MANUAL PROVIDES GUIDANCE FOR PUTTING INTO INITIAL OPERATION MUNICIPAL WASTEWATER TREATMENT PLANT, A NEW ADDITION TO AN EXISTING TREATMENT PLANT, OR A CHANGE IN THE MODE OF THE TREATMENT PLANT'S OPERATION SO THAT THE TREATMENT PLANT OR PROCESS WILL EFFECTIVELY TREAT THE WASTEWATER IN COMPLIANCE WITH SPECIFIC CONDITIONS AND LIMITATIONS ESTABLISHED FOR TREATMENT FACILITY. THE MANUAL WAS DEVELOPED AND PREPARED WITH THE AID AND COOPERATION OF WASTEWATER TREATMENT PLANT OPERATORS AND SUPERINTENDENTS, START-UP EXPERTS, THE ACADEMIC COMMUNITY, MANUFACTURERS AND

SUPPLIERS OF WASTEWATER TREATMENT PLANT EQUIPMENT, AND A LITERATURE REVIEW OF WASTEWATER TREATMENT PLANT OPERATIONS AND RECOGNIZED START-UP TECHNIQUES. INFORMATION IS PROVIDED ON PREPARING FOR ACTUAL TREATMENT PLANT START-UP. PREPARATIONS FOR START-UP INCLUDE: STAFFING THE PLANT, DEVELOPING STANDARD OPERATING PROCEDURES, DRY- AND WET-RUN TESTING OF EQUIPMENT, ON-SITE OPERATOR TRAINING, SAFETY, AND ESTABLISHING PROCEDURES WHEN CONSTRUCTION IS CONTINUING DURING START-UP. THIS MANUAL DESCRIBES START-UP PROCEDURES FOR SOME OF THE MORE COMMON PRETREATMENT AND PRIMARY TREATMENT UNITS; FOR THE SPECIFIC SECONDARY TREATMENT PROCESSES OF ACTIVATED SLUDGE, TRICKLING FILTERS, STABILIZATION PONDS AND AERATED LAGOONS; AND FOR THE SLUDGE HANDLING UNITS AND THE ANAEROBIC DIGESTION PROCESS. THE START-UP PROCEDURES FOR ADVANCED WASTEWATER TREATMENT UNITS AND PROCESSES ARE NOT CONSIDERED IN THIS MANUAL. (EPA)

TITLE	UPGRADING BIOLOGICAL TREATMENT (XT-25).
AUTHOR	WEST, A. W.
PUB DATE	AUG 71
DESC	*AUDIOVISUAL AIDS, ENGINEERING, *INSTRUCTIONAL MATERIALS, POLLUTION, *POST SECONDARY EDUCATION, *WATER POLLUTION CONTROL, *PLANT OPERATIONS, *WASTEWATER TREATMENT, *BIOLOGICAL TREATMENT
DESC NOTE	INCLUDED IS A 28 MINUTE TAPE AND 63 SLIDES, ALSO A SCRIPT. AVAILABLE ON LOAN FROM NTOTC, 26 W. ST. CLAIR, CINCINNATI, OHIO 45268
ABSTRACT	THIS MODULE IS DESIGNED FOR EXPERIENCED AND SUPERVISORY WASTEWATER WORKS OPERATORS AND MANAGERIAL PERSONNEL, AND SHOULD ALSO BE OF INTEREST TO DESIGN ENGINEERING PERSONNEL. IT DISCUSSES WAYS TO GET MAXIMUM USE OF PRESENT EXISTING SECONDARY TREATMENT PROCESSES BY IMPROVED OPERATIONAL CONTROL OF DESIGN. IT INCLUDES CASE HISTORIES OF HOW THE POLLUTIONAL STRENGTH OF AN ACTIVATED SLUDGE PLANT EFFLUENT WAS REDUCED TO ONE-QUARTER OF ITS FORMER STRENGTH AT ONE LOCATION, AND HOW TRICKLING FILTER PRETREATMENT WITH ACTIVATED SLUDGE POLISHING ACCOMPLISHED 99% REDUCTION FOR A COMBINATION OF DOMESTIC SEWAGE AND STRONG MEAT PACKING WASTES AT ANOTHER. (AUTHOR/JK)

TITLE	USE OF HIGH-PURITY OXYGEN IN THE ACTIVATED SLUDGE PROCESS, VOLUME 1.
AUTHOR	MCWHIRTER, J. R.

PUB DATE	78
AVAIL	CRC PRESS, INC., 2255 PALM BEACH LAKES BLVD., WEST PALM BEACH, FL 33409
DESC	ACTIVATED SLUDGE, DEWATERING, *INSTRUCTIONAL MATERIALS, OPERATIONS, *OXYGEN, POST SECONDARY EDUCATION, *SECONDARY TREATMENT, *WASTE DISPOSAL, WASTEWATER SLUDGE, *WASTEWATER TREATMENT
DESC NOTE	250P. CAT. NO. 5101EF32
ABSTRACT	CONSTITUTES A COMPREHENSIVE SOURCE OF BACKGROUND AS WELL AS CURRENT-DAY TECHNOLOGY STATUS REGARDING THE USE OF OXYGEN IN SECONDARY WASTEWATER TREATMENT. DIVIDED INTO THREE BASIC PARTS, THE FIRST SECTION CONSISTS OF BACKGROUND AND HISTORICAL INFORMATION, THE SECOND DEALS WITH CURRENT-DAY DESIGN AND APPLICATIONS. THE LAST IS ON PRESENT-DAY EXPERIENCE AND OPERATIONAL INFORMATION FROM OXYGENATION SYSTEMS CURRENTLY IN OPERATION AND UNDER DESIGN.

TITLE	USE OF HIGH-PURITY OXYGEN IN THE ACTIVATED SLUDGE PROCESS, VOLUME 2.
AUTHOR	MCWHIRTER, J. R.
PUB DATE	78
AVAIL	CRC PRESS, INC., 2255 PALM BEACH LAKES BLVD., WEST PALM BEACH, FL 33409
DESC	ACTIVATED SLUDGE, DEWATERING, *INSTRUCTIONAL MATERIALS, OPERATIONS, *OXYGEN, POST SECONDARY EDUCATION, *SECONDARY TREATMENT, *WASTE DISPOSAL, WASTEWATER SLUDGE, *WASTEWATER TREATMENT
DESC NOTE	250P. CAT. NO. 5102EF32

TITLE	WASTEWATER ENGINEERING: COLLECTION, TREATMENT, DISPOSAL.
PUB DATE	72
DESC	MCGRAW-HILL BOOK COMPANY, 1221 AVENUE OF THE AMERICAS, NEW YORK, NY 10020 *DESIGN, *ENGINEERING, *FACILITIES, *INSTRUCTIONAL MATERIALS, *OPERATIONS (WASTEWATER), POST SECONDARY EDUCATION, PUMPS, *SEWERS, SLUDGE, *WASTEWATER TREATMENT, WATER CHARACTERISTICS, *WATER RESOURCES
DESC NOTE	782P. (NO. 041675-3); SOLUTION MANUAL (NO. 041676-1)
ABSTRACT	INCLUDES: DEVELOPMENT AND TRENDS IN WASTEWATER ENGINEERING; DETERMINATION OF SEWAGE FLOWRATES; HYDRAULICS OF SEWERS; DESIGN OF SEWERS; PUMPS AND PUMPING STATIONS; WASTEWATER CHARACTERISTICS; PHYSICAL UNIT OPERATIONS; CHEMICAL UNIT PROCESSES; DESIGN OF FACILITIES FOR: PHYSICAL AND CHEMICAL

TREATMENT OF WASTEWATER, FOR BIOLOGICAL TREATMENT, DISPOSAL OF SLUDGE AND MORE.

TITLE	WASTEWATER TREATMENT - SERIES C.
AVAIL	NEW ENGLAND REGIONAL WASTEWATER INST., 2 FORT ROAD, SOUTH PORTLAND, ME 04106 (FREE RENTAL)
DESC	CHEMICAL TREATMENT, DISINFECTION, FILTRATION, *INSTRUCTIONAL MATERIALS, *PRIMARY TREATMENT, POST SECONDARY EDUCATION, SEDIMENTATION, *SECONDARY TREATMENT, *SLIDES, SLUDGE DEWATERING, STABILIZATION LAGOONS, *TERTIARY TREATMENT, VISUAL AIDS, WASTE DISPOSAL, *WASTEWATER TREATMENT
DESC NOTE	ORDER SERIES C WITH ACCOMPANYING NARRATIVE: 100 SLIDES.
ABSTRACT	FOCUSING ON THE TECHNICAL ASPECTS OF WASTEWATER TREATMENT. IT FEATURES PRIMARY AND SECONDARY FACILITIES AND INCLUDES SEGMENTS ON THE TRAINING OF PLANT OPERATORS AND ON SAFETY.

TITLE	WATER AND WASTEWATER TREATMENT: CALCULATIONS FOR CHEMICAL AND PHYSICAL PROCESSES.
AUTHOR	HUMENICK, MICHAEL J. JR.
PUB DATE	77
AVAIL	MARCEL DEKKER, 270 MADISON AVE., NEW YORK, NY 10016
ABSTRACT	THIS BOOK PRESENTS THE INFORMATION NEEDED BY AN ENVIRONMENTAL TECHNICIAN TO PERFORM THE PROCESS CALCULATIONS NECESSARY IN THE OPERATION OF WATER OR WASTEWATER TREATMENT FACILITIES. THE MATERIAL IS ORGANIZED SO AS A PROBLEM IS PRESENTED, THE SOLUTION FOLLOWS IMMEDIATELY. EACH TOPIC AREA HAS NUMEROUS PRACTICE EXAMPLES WITH SOLUTIONS AND ANSWERS. SUBJECT AREAS INCLUDE: COAGULATION AND FLOCCULATION; WATER CONDITIONS, SEDIMENTATION; FILTRATION; ACTIVATED CARBON; ADSORPTION; CHLORINATION AND AERATION. THE APPENDICES CONTAIN INFORMATION REGARDING PHYSICAL AND CHEMICAL PROPERTIES, CONVERSION FACTORS, AND COMPUTER PROGRAMS. (CS)

TITLE	WATER AND WASTEWATER TREATMENT, VOL. 4
AUTHOR	HUMENICK, MICHAEL J., JR.
PUB DATE	77
DESC	*CALCULATION, *CHEMICAL REACTIONS, *DESIGN, ENVIRONMENTAL INFLUENCES, ENGINEERING, *INSTRUCTIONAL MATERIALS, POLLUTION, *POST SECONDARY EDUCATION, PUBLIC HEALTH, WASTE DISPOSAL, *WATER POLLUTION CONTROL, *OPERATIONS (WASTEWATER), *OPERATIONS (WATER), *WASTEWATER

TREATMENT, WATER TREATMENT

DESC NOTE 236P.

ABSTRACT INCLUDED IN THIS VOLUME ARE CALCULATION PROCEDURES WHICH CAN BE UTILIZED IN THE DESIGN OF SUCH PROCESSES AS EQUALIZATION, COAGULATION AND FLOCCULATION, CHEMICAL PRECIPITATION, AND GRAVITY SEDIMENTATION. EXAMPLES OF PROBLEMS RELATED TO FILTRATION, ACTIVATED CARBON ABSORPTION, ION EXCHANGE, CHLORINATION, DISINFECTION, AND AERATION ARE ALSO COVERED. INFORMATION OF PHYSICAL AND CHEMICAL PROPERTIES, CONVERSION FACTORS, AND COMPUTER PROGRAMS ARE DETAILED IN THE APPENDIXES. (CS)

TITLE WPCF WASTEWATER TREATMENT PLANT OPERATOR TRAINING PROGRAM, INTERMEDIATE COURSE: STUDENT WORKBOOK, VOL. 1, PARTS 1 AND 2.

PUB DATE 78

AVAIL WATER POLLUTION CONTROL FEDERATION, 2626 PENNSYLVANIA AVE., WASHINGTON, D.C. 20036

DESC *ACTIVATED SLUDGE, AUDIOVISUAL AIDS, CERTIFICATION, *CLARIFICATION (WASTEWATER), ENVIRONMENTAL TECHNICIANS, *INSTRUCTIONAL MATERIALS, JOB SKILLS, *OPERATIONS (WASTEWATER), POLLUTION, *POST SECONDARY EDUCATION, *WASTEWATER COLLECTION, *WASTEWATER TREATMENT, WATER POLLUTION CONTROL.

DESC NOTE 244P. COURSE MATERIALS: 35 MM SLIDES (340), 9 TAPE CASSETTES, ADMINISTRATOR HANDBOOK, CARRYING CASE, AND STUDENT WORKBOOK (PARTS 1 AND 2) - ORDER NO. E0291 $400.00; STUDENT WORKBOOK ONLY - ORDER NO. E0292, $4.50; OTHER VOLUMES; EW003822 AND EW003823

ABSTRACT THIS DOCUMENT IS ONE IN A SERIES OF SELF-INSTRUCTIONAL WORKBOOKS FOR TRAINING WASTEWATER TREATMENT PLANT OPERATIONS IN THE BASIC FUNCTIONS OF FACILITY OPERATION. THE WORKBOOK CONTAINS A PRE- AND POST-TEST QUESTIONNAIRE FOR EACH UNIT AS WELL AS SELF-TESTS AS INTERIM GUIDES. THE UNITS DISCUSSED IN THE VOLUME ARE A GENERAL INTRODUCTION, THE COMMUNITY WASTEWATER SYSTEM, PRE-TREATMENT, CLARIFICATION, AND ACTIVATED SLUDGE. (CS)

TITLE WPCF WASTEWATER TREATMENT OPERATOR TRAINING PROGRAM, INTERMEDIATE COURSE: STUDENT WORKBOOK, VOL. 8.

PUB DATE 78

AVAIL WATER POLLUTION CONTROL FEDERATION, 26226 PENNSYLVANIA AVE., WASHINGTON, DC 20037

DESC AUDIOVISUAL AIDS, CERTIFICATION, *ENVIRONMENTAL TECHNICIANS, *INSTRUCTIONAL MATERIALS, JOB SKILLS, *OPERATIONS (WASTEWATER), POLLUTION, *POST SECONDARY EDUCATION, *SLUDGE, *TRICKLING FILTERS, *WASTE STABILIZATION PONDS, *WASTEWATER TREATMENT, WATER POLLUTION CONTROL.

DESC NOTE 144P. COURSE MATERIALS: 35 MM SLIDES (APPROX. 230), 7 TAPE CASSETTES, ADMINISTRATOR HANDBOOK, CARRYING CASE, AND STUDENT WORKBOOK - ORDER NO. E0293, $300.00; STUDENT WORKBOOK ONLY - ORDER NO. E0294, $3.50; OTHER VOLUMES: EW003821 AND EW003823

ABSTRACT THIS DOCUMENT IS ONE IN A SERIES OF SELF-INSTRUCTIONAL WORKBOOKS FOR TRAINING WASTEWATER TREATMENT PLANT OPERATORS IN THE BASIC FUNCTIONS OF FACILITY OPERATION. THE WORKBOOK CONTAINS A PRE- AND POST-TEST QUESTIONNAIRE FOR EACH UNIT AS WELL AS SELF-TESTS AS INTERIM GUIDES. THE UNITS DISCUSSED IN THIS VOLUME ARE WASTE STABILIZATION PONDS, TRICKLING FILTERS, AND SLUDGE HANDLING AND DIGESTION. (CS)

TITLE WPCF WASTEWATER TREATMENT PLANT OPERATOR TRAINING PROGRAM, INTERMEDIATE COURSE: STUDENT WORKBOOK, VOL. C.

PUB DATE 78

AVAIL WATER POLLUTION CONTROL FEDERATION, 2626 PENNSYLVANIA AVE., WASHINGTON, D.C. 20037

DESC AUDIOVISUAL AIDS, CERTIFICATION, *DISINFECTION, *ENVIRONMENTAL TECHNICIANS, *INSTRUCTIONAL MATERIALS, JOB SKILLS, *OPERATIONS (WASTEWATER), POLLUTION, *POST SECONDARY EDUCATION, *PUMPS, *SAFETY, *WASTEWATER TREATMENT, WATER POLLUTION CONTROL.

DESC NOTE 90P. COURSE MATERIALS: 35 MM SLIDES (APPROX. 270), 7 TAPE CASSETTES, ADMINISTRATOR HANDBOOK, CARRYING CASE, AND STUDENT WORKBOOK - ORDER NO. E0296, $3.50; OTHER VOLUMES: EW003821 AND EW003822

ABSTRACT THIS DOCUMENT IS ONE IN A SERIES OF SELF-INSTRUCTIONAL WORKBOOKS FOR TRAINING WASTEWATER TREATMENT PLANT OPERATORS IN THE BASIC FUNCTIONS OF FACILITY OPERATION. THE WORKBOOK CONTAINS A PRE- AND POST-TEST QUESTIONNAIRE FOR EACH UNIT AS WELL AS SELF-TESTS AS INTERIM GUIDES. THE UNITS DISCUSSED IN THIS VOLUME ARE DISINFECTION, SAFETY, AND PUMPING.

Part IV

Reference Materials Not Abstracted

TITLE THE ABC WAY TO BETTER WASTEWATER TREATMENT.
AUTHOR KERL, J. F.
CORP AUTH ENVIRONMENTAL QUALITY ENGINEERING, INC., OAKLAND, CALIF.
AVAIL AMERICAN DYESTUFF REPORTER, VOL 62, NO 8, P 24-25, AUGUST 1973. 1 FIG, 1 ILLUS, 2 REF.

TITLE ACTINOMYCETES OF SEWAGE-TREATMENT PLANTS.
AUTHOR LECHEVALIER, H. A.; LECHEVALIER, M. P.; WYSZKOWSKI, P. E.
CORP AUTH RUTGERS - THE STATE UNIV., PISCATAWAY, NJ. WAKSMAN INST. OF MICROBIOLOGY.
AVAIL THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-272 589, IN PAPER COPY, IN MICROFICHE. REPORT EPA-600/2-77-145, 1977. 89 P. 6 FIG, 15 TAB, 5 REF.

TITLE ACTINOMYCETES OF SEWAGE-TREATMENT PLANTS.
AUTHOR LECHEVALIER, H. A.
CORP AUTH RUTGERS - THE STATE UNIV., NEW BRUNSWICK, NJ. WAKSMAN INST. OF MICRIBIOLOGY.
AVAIL THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161, AS PB-245 914, $4.50 IN PAPER COPY, $3.00 IN MICROFICHE. ENVIRONMENTAL PROTECTION AGENCY, ENVIRONMENTAL PROTECTION TECHNOLOGY STUDIES SERIES NO. EPA-600/2-75-031, SEPTEMBER 1975. 62 P, 23 TAB, 19 REF. R-802003.

TITLE ACTIVATED SLUDGE.
AUTHOR SAUNDERS, F. M.
CORP AUTH GEORGIA INST. OF TECH., ATLANTA.
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 49, NO 6, P 1005-1016, JUNE, 1977. 114 REF.

TITLE ACTIVATED SLUDGE (LITERATURE REVIEW).
AUTHOR SCHROEDER, E. D.
CORP AUTH CALIFORNIA UNIV., DAVIS. DEPT. OF CIVIL ENGINEERING.
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 48, NO 6, P 1098-1107, JUNE, 1976. 110 REF.

TITLE ACTIVATED SLUDGE (LITERATURE REVIEW).
AUTHOR AZAD, H. S.; BERGMANN, D. E.; STUMPF, M. R.
CORP AUTH WATER POLLUTION CONTROL FEDERATION, WASHINGTON, DC
AVAIL JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 42, NO 6, P 897-910, JUNE 1970. 105 REF.

TITLE	ADDITION OF POWDERED ACTIVATED CARBON TO ACTIVATED SLUDGE REACTORS.
AUTHOR	KLEI, H. E.; SUNDSTROM, D. W.
CORP AUTH	CONNECTICUT UNIV., STORRS. INST. OF WATER RESOURCES.
AVAIL	THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-264 887, IN PAPER COPY, IN MICROFICHE. COMPLETION REPORT, MARCH 1977. 41 P, 2 TAB, 27 FIG, 4 REF, OWRT A-057-CONN(1), 14-31-0001-5007.

TITLE	ADVANCED AUTOMATIC CONTROL STRATEGIES FOR THE ACTIVATED SLUDGE TREATMENT PROCESS.
AUTHOR	PETERSACK, J. F.; SMITH, R. G.
CORP AUTH	SYSTEMS CONTROL, INC., PALO ALTO, CALIF.
AVAIL	THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161. ENVIRONMETNAL PROTECTION AGENCY, REPORT EPA-670/2-75-039. MAY 1975., 154 P, 33 FIG, 11 TAB, 14 REF, 3 APPEND. 1BB043; ROAP 21ASC; TASK 007 R800356.

TITLE	AERATION TANK FOR ACTIVATED SLUDGE TREATMENT OF WASTE WATER - IS SMALLER AND REQUIRES LESS POWER FOR A GIVEN TREATMENT CAPACITY.
AVAIL	NETHERLANDS PATENT NL 7610-431. ISSUED MARCH 28, 1977. DERWENT NETHERLANDS PATENTS ABSTRACTS, VOL Y, NO 15, P D5, MAY, 1977.

TITLE	AIR V. OXYGEN IN DORSET.
AVAIL	WATER AND WASTE TREATMENT, VOL 20, NO 1, P 14-15, JANUARY, 1977. 1 FIG, 1 TAB.

TITLE	AIR VS 02: TWO ACTIVATED SLUDGE SYSTEMS COMPARED.
AUTHOR	MILLER, M. A.
CORP AUTH	UNION CARBIDE CORP., TONAWANDA, NY ENVIRONMENTAL SYSTEMS DEPT.
AVAIL	WATER AND WASTES ENGINEERING, VOL 15, NO 4, P 58-60, 62-65, APRIL, 1978. 6 FIG, 8 TAB, 17 REF.

TITLE	ALBUQUERQUE PLANT DESIGNED WITH COMPUTER IN MIND.
AUTHOR	RICOY, J. L.; MATOTAN, W. I.
CORP AUTH	WILLIAM MATOTAN AND ASSOCIATES, ALBUQUERQUE, NM
AVAIL	WATER AND WASTES ENGINEERING, VOL 13, NO 1, P 32-35, 37, JANUARY, 1976.

TITLE	ALUM ADDITION AIDS SLUDGE PROCESS IN PHOSPHORUS REMOVAL.
AVAIL	WATER AND WASTES ENGINEERING, VOL 15, NO 3, P 14, MARCH, 1978.

TITLE	ALUM ADDITION TO ACTIVATED SLUDGE WITH TERITARY SOLIDS REMOVAL.
AUTHOR	HAIS, A. B.; STAMBERG, J. B.; BISHOP, D. F.
CORP AUTH	DISTRICT OF COUMBIA DEPT. OF ENVIRONMENTAL SERVICES, WASHINGTON.
AVAL	COPY AVAILABLE FROM GPO SUP AS EP1.23:670-73-037, $0.65; MICROFICHE FROM NTIS AS PB-225 028/0, $1.45. ENVIRONMENTAL PROTECTION AGENCY, TECHNOLOGY SERIES REPORT EPA-670/2-73-037, AUGUST 1973, 25 P, 7 FIG, 5 TAB, 8 REF. EPA PROJECT 11010 EYM. CONTRACT 14-12-818.

TITLE	ALUM ADDITION AND STEP-FEED STUDIES IN OXYGEN ACTIVATED SLUDGE.
AUTHOR	BISHOP, D. F.; HEIDMAN, J. A.; BRENNER, R. C.; STAMBERG, J. B.
CORP AUTH	DEPARTMENT OF ENVIRONMENTAL SERVICES, WASHINGTON, DC.
AVAIL	THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-272 892, IN PAPER COPY, IN MICROFICHE, REPORT EPA-600/2-77/166, 1977. 31 P, 6 FIG, 10 TAB, 10 REF.

TITLE	APPLICATION OF MICROBIOLOGY AND BIOENGINEERING PRINCIPLES TO BIOLOGICAL WASTE TREATMENT.
AUTHOR	LEVIN, GILBERT V.; COHEN, OBADIAH P.
CORP AUTH	BIOSPHERICS INC., ROCKVILLE, MD
AVAIL	CHEMICAL ENGINEERING PROGRESS, SYMPOSIUM SERIES, VOL 67, NO 107, P 131-134, 1971. 1 TAB, 44 REF.

TITLE	ATP POOLS IN ACTIVATED SLUDGE.
AUTHOR	CHIU, S. Y.; KAO, I. C.; ERICKSON, L. E.;
CORP AUTH	FAN, L. T. KANSAS STATE UNIV., MANHATTAN. DEPT. OF CHEMICAL ENGINEERING.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 45, NO 8, P 1746-1758, AUGUST 1973. 18 FIG, 4 TAB, 30 REF. OWRR A-045-KAN(3) 14-31-0001-3516.

TITLE	AUTOMATIC DISSOLVED OXYGEN CONTROL.
AUTHOR	FLANAGAN, M. J.; BRACKEN, B. D.; ROESLER, J. F.
CORP	FLANAGAN AND ASSOCIATES, SAN FRANCISCO, CALIF.
AVAIL	JOURNAL OF THE ENVIRONMENTAL ENGINEERING DIVISION, PROCEEDINGS OF ASCE, VOL 103, NO EE4, P 707-722, DIVISION, PROCEEDINGS OF ASCE, VOL 103, NO EE4, P 707-722, AUGUST 1977. 9 TAB, 5 FIG, 3 REF, 1 APPEND.

TITLE	AUTOMATION OF THE CONTROL AND OPERATION OF WATER POLLUTION CONTROL WORKS.
AUTHOR	COTTON, P.
CORP AUTH	NORWICH SEWAGE TREATMENT WORKS (ENGLAND)
AVAIL	WATER POLLUTION CONTROL, VOL 72, NO 8, P 635-657, 1973. 25 REF.

TITLE BIOFLOCCULATION AND THE ACCUMULATION OF CHEMICALS BY FLOC-FORMING ORGANISMS.
AUTHOR DUGAN, P. R.
CORP AUTH OHIO STATE UNIV., COLUMBUS, DEPT. OF MICROBIOLOGY.
AVAIL THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-245 793, IN PAPER COPY, IN MICROFICHE. REPORT EPA-600/2-75-032, SEPTEMBER 1975. 148 P, 51 FIG, 21 TAB, 119 REF.

TITLE BIOLOGICAL CONCEPTS FOR DESIGN AND OPERATION OF THE ACTIVATED SLUDGE PROCESS.
AUTHOR GAUDY, F., JR.; GAUDY, T.
CORP AUTH OKLAHOMA STATE UNIV., STILLWATER, BIOENVIRONMENTAL ENGINEERING LABS.
AVAIL GPO SUP DOC AS EP 2.10: 17090 FQJ 09/71, $1.25; MICROFICHE FROM NTIS AS PB-211 131, $0.95. ENVIRONMENTAL PROTECTION AGENCY, WATER POLLUTION CONTROL RESEARCH SERIES, SEPTEMBER 1971. 154 P, 36 FIG, 3 TAB, 69 REF. EPA PROGRAM 17090 FQJ 09/71.

TITLE BIOLOGICAL METHODS FOR CONTROL OF NITROGEN IN MUNICIPAL WASTEWATERS.
AUTHOR ROSENKRANZ, W. A.
CORP AUTH ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, DC. OFFICE OF RESEARCH AND DEVELOPMENT.
AVAIL IN: 3RD USA/USSR SYMPOSIUM ON INTENSIFICATION OF BIO-CHEMICAL TREATMENT OF WASTEWATERS, HELD AT VOGEDO HEADQUARTERS, MOSCOW, USSR ON AUGUST 23-24, 1976. P 32-35, 1976. 4 FIG, 2 TAB, 5 REF.

TITLE BIOLOGICAL REGENERATION OF POWERED ACTIVATED CARBON ADDED TO ACTIVATED SLUDGE UNITS.
AUTHOR DEWALLE, F. B.; CHIAN, E. S. K.
CORP AUTH ILLINOIS UNIV. AT URBANA-CHAMPAIGN. DEPT. OF CIVIL ENGINEERING.
AVAIL WATER RESEARCH, VOL 11, NO 5, P 439-446, 1977. 9 FIG, 2 TAB, 33 REF.

TITLE BIOLOGICAL TREATMENT PROCESS IN COLD CLIMATES.
AUTHOR BOYLE, J. D.
CORP AUTH CH2M/HILL, CORVALLIS, OREG. WASTEWATER RECLAMATION.
AVAIL WATER AND SEWAGE WORKS, REFERENCE NUMBER, P R-28, R-30, R-32-R-34, R-37-R-38, R-43-R-44, R-46, R-48, R-50, APRIL 30, 1976. 16 FIG, 2 TAB, 9 REF.

TITLE BIOLOGICAL WASTE TREATMENT.
AUTHOR JANK, B. E.
CORP AUTH DEPARTMENT OF THE ENVIORNMENT, OTTAWA (ONTARIO). WASTEWATER TECHNOLOGY CENTRE.
AVAIL IN: PROCEEDINGS OF SEMINARS ON WATER POLLUTION ABATEMENT TECHNOLOGY IN THE PULP AND PAPER INDUSTRY, MAY 1975, OTTAWA, MONCTON, AND PRINCE GEORGE, CANADA, ENVIRONMENTAL PROTECTION SERVICE,

WATER POLLUTION CONTROL DIRECTORATE, ECONOMIC AND TECHNICAL REVIEW REPORT EPS 3-WP-76-4, P 35-80, MARCH, 1976. 14 FIG, 31 REF, 4 TAB.

TITLE BULKING CONTROL MADE EASY - WITH HYDROGEN PEROXIDE.
AUTHOR STRUNK, W. G.; SHAPIRO, J.
CORP AUTH FMC CORP., PRINCETON, NJ.
AVAIL WATER AND POLLUTION CONTROL, VOL 114, NO 7, P 10, 12, 14, 15, 40-41, JULY, 1976.

TITLE CASE HISTORIES: IMPROVED ACTIVATED SLUDGE PLANT PERFORMANCE BY OPERATIONS CONTROL.
AUTHOR WEST, A. W.
CORP AUTH FEDERAL WATER POLLUTION CONTROL ADMINISTRATION, CINCINNATI, OHIO. DIV. OF TECHNICAL SERVICES.
AVAIL PROCEEDINGS, 8TH ANNUAL ENVIRONMENTAL AND WATER RESOURCES ENGINEERING CONFERENCE, JUNE 5-6, 1969, TECHNICAL REPORT NO 20, DEPARTMENT OF ENVIRONMENTAL AND WATER RESOURCES ENGINEERING, VANDERBILT UNIVERSITY, P 161-170, (1969).

TITLE CELL YIELD AND GROWTH RATE IN ACTIVATED SLUDGE.
AUTHOR SHERRARD, J.H.; SCHROEDER, E. D.
CORP AUTH CORNELL UNIV., ITHACA, NY SCHOOL OF CIVIL AND ENVIRONMENTAL ENGINEERING.
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 45, NO 9, P 1889-1897, SEPTEMBER 1973. 8 FIG, 2 TAB, 12 REF.

TITLE CHEMICALLY ASSISTED BIOLOGICAL OXIDATION OF WASTES AND EXCESS SLUDGE.
AUTHOR GAUDY, A. F., JR.
CORP AUTH OKLAHOMA STATE UNIV., STILLWATER, BIOENVIRONMENTAL ENGINEERING LABS.
AVAIL WATER AND SEWAGE WORKS, REFERENCE ISSUE, P 48, 50-52, 54-56, APRIL, 1977. 11 FIG, 10 REF.

TITLE COMPARING DESIGN MODELS FOR ACTIVATED SLUDGE.
AUTHOR GAUDY, A. F., JR.; KINCANNON, D. F.
CORP AUTH OKLAHOMA STATE UNIV., STILLWATER. BIOENVIRONMENTAL ENGINEERING LABS.
AVAIL WATER AND SEWAGE WORKS, VOL 124, NO 2, P 66-70, FEBRUARY 1977. 1 FIG, 7 TAB, 16 REF.

TITLE COMPARISON OF COMPLETELY MIXED AND PLUG FLOW BIOLOGICAL SYSTEMS.
AUTHOR TOERBER, E. D.; PAULSON W. L.; SMITH, H. S.

CORP AUTH	FEHR AND GRAHAM CONSULTING ENGINEERS, FREEPORT, ILL.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 46, NO 8, P 1995-2014, AUGUST 1974. 26 FIG, 9 TAB, 3 REF.
TITLE	COMPUTER-ASSISTED ACTIVATED SLUDGE PLANT OPERATION.
AUTHOR	LACROIX, P. G.; BLOODGOOD, D. E.
CORP AUTH	OTTAWA UNIV. (ONTARIO). DEPT. OF CIVIL ENGINEERING.
AVAIL	EFFLUENT AND WATER TREATMENT JOURNAL, VOL 13, NO 11, P 701-714, NOVEMBER 1973. 3 FIG, 2 TAB, 26 REF.
TITLE	CONTROL OF ACTIVATED SLUDGE BULKING DURING BIOLOGICAL PURIFICATION (REGULIROVANIE PRIROSTA AKTIVNOGO ILA PRI BIOLOGICHESKOI OCHISTKE).
AUTHOR	EVILEVICH, M. A.; KOROVIN, L. K.
CORP AUTH	GIPROBUM (USSR).
AVAIL	BUMAZHNAYA PROMYSHLENNOST, NO 8, P 27-28, AUGUST, 1978. 3 FIG, 1 TAB.
TITLE	CONTROL OF ACTIVATED SLUDGE BY MEAN CELL RESIDENCE TIME.
AUTHOR	JENKINS, DAVID; GARRISON, WALTER E.
CORP AUTH	CALIFORNIA UNIV., BERKELEY. SANITATION ENGINEERING RESEARCH LAB.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 40, NO 11, PART 1, P 1905-1919, NOV 1968. 6 FIG, 2 TAB, 15 REF.
TITLE	DEMONSTRATION OF A HIGH-RATE ACTIVATED SLUDGE SYSTEM.
AUTHOR	HUANG, C. H.; FEURSTEIN, D. L.; MILLER, E. L.
CORP AUTH	ENGINEERING-SCIENCE, INC., BERKELEY, CALIF.
AVAIL	THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-240 005, IN PAPER COPY, IN MICROFICHE, REPORT EPA-670/2-75-037, MARCH 1975. 150 P, 25 FIG, 22 TAB, 46 REF, 1 APPEND.
TITLE	DESIGN AND CONTROL OF NITRIFYING ACTIVATED SLUDGE. SYSTEMS.
AUTHOR	LAWRENCE, A. W.; BROWN, C. G.
CORP AUTH	CORNELL UNIV., ITHACA, NY DEPT. OF ENVIRONMENTAL ENGINEERING.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 48, NO 7, P 1779-1803, JULY 1976. 13 FIG, 8 TAB,

TITLE	THE DESIGN AND OPERATION OF ACTIVATED SLUDGE FINAL SETTLING TANKS.
AUTHOR	HIBBERD, R. L.; JONES, W. F.
CORP AUTH	SATEC LTD., CREWE (ENGLAND).
AVAIL	WATER POLLUTION CONTROL, VOL 78, NO 1, P 14-32, 1974, 13 FIG, 9 TAB, 11 REF.

TITLE	THE DESIGN AND SELECTION OF MECHANICAL AERATION DEVICES.
AUTHOR	SHAW, J. A.
CORP AUTH	LIGHTNIN MIXER PTY LTD., CAMBERWELL (AUSTRALIA).
AVAIL	IN: WATER POLLUTION CONTROL IN DEVELOPING COUNTRIES. PROCEEDINGS OF THE INTERNATIONAL CONFERENCE, HELD AT BANGKOK, THAILAND, FEBRUARY 1978. EDITED BY E.A.R. OUANO, B. M. LOHANI & C.M. THANH. ASIAN INSTITUTE OF TECHNOLOGY, BANGKOK, THAILAND, (PERGAMON PRESS IN USA), P 709-722, 1978. 13 FIG.

TITLE	DESIGNING AND OPERATING AN OXYGEN ACTIVATED SLUDGE SYSTEM INCLUDING TERTIARY ALUM-MUD PRECIPITATION.
AUTHOR	FULLER, R. R.; GILBERT, D. W.
CORP AUTH	GULF STATES PAPER CORP., TUSCALOOSA, AL.
AVAIL	COPYRIGHT CLEARANCE CENTER, INC., NEW YORK, NY AS 0065-8812-78-9661-0178 ($1.25). IN: WATER--1977, AICHE SYMPOSIM SERIES, VOL 74, NO 178, EDITED BY G. F. /BENNETT, P 48-65, 1978, 6 FIG, 6 TAB, 3 REF.

TITLE	DESIGN AND OPERATIONAL MODEL FOR COMPLETE MIXING ACTIVATED SLUDGE SYSTEM.
AUTHOR	MCKINNEY, R. E.
CORP AUTH	KANSAS UNIV., LAWRENCE.
AVAIL	BIOTECHNOLOGY AND BIOENGINEERING, VOL 16, NO 6, P 703-722, JUNE, 1974. 14 REF.

TITLE	EFFECT OF PRIMARY EFFLUENT SUSPENDED SOLIDS AND BOD ON ACTIVATED SLUDGE PRODUCTION.
AUTHOR	VOSHEL, DORIS; SAK, J. G.
CORP AUTH	GRAND RAPIDS WATER POLLUTION CONTROL PLANT, MICH., AND DOW CHEMICAL CO., MIDLAND, MICH.
AVAIL	JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 40, NO 5, PART 2, P R203-R212, MAY 1968. 8 FIG, 3 TAB, 10 REF.

TITLE	EFFECT OF WASTEWATER COMPOSITION AND CELL RESIDENT TIME ON PHOSPHORUS REMOVAL IN ACTIVATED SLUDGE.
AUTHOR	STALL, T. R.; SHERRARD, J. H.
CORP AUTH	PHILLIPS PETROLEUM CO., BARTLESVILLE, OKLA.

AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 48, NO 2, P 307-322, FEBRUARY, 1976, 8 FIG, 4 TAB, 23 REF.

TITLE EFFECTS OF DISSOLVED OXYGEN IN THE OXYGENATION ACTIVATED SLUDGE PROCESS.
AUTHOR D'ANTONI, J. M.; STEIMLE, S. E.
CORP AUTH NUS CORP., HOUSTON, TX.
AVAIL COPYRIGHT CLEARANCE CENTER, INC., NEW YORK, NY AS 0065-8812-78-9823-1078 ($0.95). IN: WATER-1977, AICHE SYMPOSIUM SERIES, VOL 74, NO 178, EDITED BY G. F. BENNETT, P 66-74, 1978, 9 FIG, 2 TAB, 10 REF.

TITLE EFFECTS OF FLOW EQUALIZATION ON THE OPERATION AND PERFORMANCE OF AN ACTIVATED SLUDGE PLANT.
AUTHOR FOESS, G. W.; MEENAHAN, J. G.; BLOUGH, D.
CORP AUTH YPSILANTI TOWNSHIP, MI.
AVAIL THE NATIONAL TECHNICAL INFORMAITON SERVICE, SPRINGFIELD, VA 22161 AS PB-272 657, IN PAPER COPY, IN MICROFICHE. REPORT EPA-600/2-77-138, 1977. 95 P, 8 FIG, 17 TAB, 20 REF, 1 APPEND.

TITLE THE EFFECT OF HIGH PURITY OXYGEN ON THE ACTIVATED SLUDGE PROCESS.
AUTHOR BENEFIELD, L. D.; RANDALL, C. W.; KING, P. H.
CORP AUTH MISSISSIPPI STATE UNIV., MISSISSIPPI STATE. DEPT. OF CIVIL ENGINEERING.
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 49, NO 2, P 269-279, FEBRUARY, 1977. 17 FIG, 1 TAB, 12 REF.

TITLE EFFECTS OF IRON ON ACTIVATED SLUDGE TREATMENT.
AUTHOR CARTER, J. L.; MCKINNEY, R. E.
CORP AUTH MARQUETTE UNIV., MILWAUKEE, WIS.
AVAIL JOURNAL OF THE ENVIRONMENTAL ENGINEERING DIVISION, AMERICAN SOCIETY OF CIVIL ENGINEERS, VOL 99, NO EE2, P 135-152, APRIL 1973. 9 FIG, 3 TAB, 24 REF.

TITLE THE EFFECT OF SLUDGE WITHDRAWALS ON THE OPERATION OF SMALL ACTIVATED SLUDGE PLANTS.
AUTHOR DRAUTZ, K. E.
CORP AUTH RENSSELAER POLYTECHNIC INST., TROY, NY
AVAIL MASTERS'S THESIS, JUNE 1969. 111 P, 15 FIG, 34 TAB, 17 REF.

TITLE EVALUATION OF A COMPLETE MIXING ACTIVATED SLUDGE PLANT.
AUTHOR MCKINNEY, ROSS E.; BENJES, HENRY H., JR.; WRIGHT, JAMES R.
CORP AUTH KANSAS UNIV., LAWRENCE.
AVAIL JOURNAL OF WATER POLLUTION CONTROL FEDERATION, VOL 42, NO 5, PART 1, P 737-752, MAY 1970. 10 FIG, 1 TAB, 19 REF.

TITLE EVALUATION OF THE KRAUS MODEL OF ACTIVATED SLUDGE BULKING.
AUTHOR PIPES, WESLEY O.; MEADE, FRANK S.
CORP AUTH NORTHWESTERN UNIV., EVANSTON, ILL.
AVAIL PROCEEDINGS INDUSTRIAL WASTE CONFERENCE, 23RD, MAY 1968, P 111-125, 5 FIG, 7 TAB, 8 REF.

TITLE AN EXPERIMENTAL STUDY OF THE ROLE OF THE CILIATED *PROTOZOA IN THE ACTIVATED SLUDGE PROCESS.*
AUTHOR CURDS, C. R.; COCKBURN, A.; VANDYKE, JENNIFER M.
CORP AUTH WATER POLLUTION RESEARCH LAB., STEVENAGE (ENGLAND).
AVAIL WATER POLLUTION CONTROL, VOL 67, NO 3, 1968. P 312-329, 14 FIG, 3 TAB, 13 REF.

TITLE FACTORS AFFECTING EFFLUENT QUALITY FROM FILL-AND-DRAW ACTIVATED SLUDGE REACTORS.
AUTHOR DAIGGER, G. T.; GRADY, C. P. L., JR.
CORP AUTH PURDUE UNIV., LAFAYETTE, IN. ENVIRONMENTAL ENGINEERING LAB.
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 49, NO 12, P 2390-2396, DECEMBER, 1977. 1 FIG, 4 TAB, 12 REF.

TITLE FACTORS TO BE CONSIDERED IN THE DESIGN OF ACTIVATED SLUDGE PLANTS.
AUTHOR DOWNING, A. L.
CORP AUTH WATER POLLUTION RESEARCH LAB., STEVENAGE (ENGLAND).
AVAIL ADVANCES IN WATER QUALITY IMPROVEMENTS, (EDITORS: GLOYNA, E. F., AND ECKENFELDER, W. W., JR.), AUSTIN, TEXAS, UNIVERSITY OF TEXAS PRESS, 1968, P 190-202, 8 FIG, 14 REF.

TITLE FATE OF PHOSPHORUS IN WASTE TREATMENT PROCESSES: ENHANCED REMOVAL OF PHOSPHATE BY ACTIVATED SLUDGE.
AUTHOR MENAR, ARNOLD, B.; JENKINS, DAVID
CORP AUTH CALIFORNIA UNIV., RICHMOND. SANITARY ENGINEERING RESEARCH LAB.

AVAIL ENVIRONMENTAL SCIENCE AND TECHNOLOGY, VOL 4, NO 12, P 1115-1121, DECEMBER 1970. 6 TAB, 6 FIG, 12 REF.

TITLE FEDERAL ASSISTANCE PROJECT METROPOLITAN DENVER SEWAGE DISPOSAL DISTRICT NO. 1. OCTOBER 1969 - FEBRUARY 1970.
AUTHOR HEGG, BOB A.; BURGESON, JOHN R.
CORP AUTH ENVIRONMENTAL PROTECTION AGENCY, KANSAS CITY, MO.
AVAIL MARCH 1971, 42 P, 5 TAB, 6 FIG, 12 REF.

TITLE FULL SCALE OPERATION OF PLUG FLOW ACTIVATED SLUDGE SYSTEMS.
AUTHOR BEER, C.; HETLING, L. J.; WANG, L. K.
CORP AUTH NEW YORK STATE DEPT. OF ENVIRONMENTAL CONSERVATION, ALBANY; AND RENSSELAER POLYTECHNIC INST., TROY.
AVAIL NEW YORK STATE DEPT OF ENVIRONMENTAL CONSERVATION, TECHNICAL REPORT NO 42, AUG 1975, PRESENTED AT THE NEW ENGLAND WATER POLLUTION CONTROL ASSOCIATION MEETING, HARTFORD, CONN., OCTOBER 23, 1974, 45 P, 13 FIG, 7 TAB, 16 REF. EPA PROJECT 17050 EDL.

TITLE INDUSTRIAL WASTE PROCESS DESIGN.
AUTHOR ECKENFELDER, W. W., JR.; O'CONNER, D. J.
CORP AUTH MANHATTAN COLL., BRONX, NY. DEPT. OF CIVIL ENGINEERING.
AVAIL PROCEEDINGS AMERICAN SOCIETY OF CIVIL ENGINEERS, FEBRUARY 15-19, 1954, SANITARY ENGINEERING DIVISION, VOL 80, NO 411, P 411-1 TO 411-25. 13 FIG, 5 TAB, 26 REF.

TITLE INFLUENCE OF ACTIVATED SLUDGE CRT ON ADSORPTION.
AUTHOR KIM, B. R.; SNOEYINK, V. L.; SAUNDERS, F. M.
CORP AUTH ILLINOIS UNIV. AT URBANA-CHAMPAIGN, DEPT. OF CIVIL ENGINEERING.
AVAIL JOURNAL OF THE ENVIRONMENTAL ENGINEERING DIVISION PROCEEDINGS OF ASCE, VOL 102, NO EE1, P 55-70, FEBRUARY, 1976. 12 FIG, 2 TAB, 21 REF. 1 APPEND.

TITLE THE INFLUENCE OF PH AND ORGANIC LOADING ON THE FILAMENTATOUS BULKING OF ACTIVATED SLUDGE.
AUTHOR YASUDA, M.
CORP AUTH TOYAMA COLL. OF TECH. (JAPAN). DEPT. OF SANITARY ENGINEERING.
AVAIL TRANSACTIONS OF THE JAPAN SOCIETY OF CIVIL ENGINEERS, VOL 8, P 131-132, 1976. 5 FIG, 1 TAB.

TITLE	INSTANTANEOUS METERING AIDS - ACTIVATED SLUDGE PLANT.
AUTHOR	MATZNER, B. A.
CORP AUTH	SUFFOLK COUNTY DEPT. OF ENVIRONMENTAL CONTROL, HAUPPAUGE, NY OPERATIONS DIV.
AVAIL	WATER AND WASTES ENGINEERING, VOL 13, NO 8, P 18-20, AUGUST, 1976.

TITLE	INTRODUCTION TO WASTEWATER TREATMENT PROCESSES.
AUTHOR	RAMALHO, R. S.
CORP AUTH	LAVAL UNIV., QUEBEC.
AVAIL	ACADEMIC PRESS (NEW YORK, SAN FRANCISCO, LONDON). 1977. 409 P.

TITLE	INVENTORY OF ENERGY USE IN WASTEWATER SLUDGE TREATMENT AND DISPOSAL.
AUTHOR	SMITH, J. E.
AVAIL	INDUSTRIAL WATER ENGINEERING, VOL 14, NO 4, P 20-26, JULY/AUGUST, 1977. 12 FIG, 10 TAB.

TITLE	A KINETIC MODEL FOR DESIGN OF COMPLETELY-MIXED ACTIVATED SLUDGE TREATING VARIABLE-STRENGTH INDUSTRIAL WASTEWATERS.
AUTHOR	ADAMS, C. E.; ECKENFELDER, W. W.; HOVIOUS, J. C.
CORP AUTH	ASSOCIATED WATER AND AIR RESOURCES ENGINEERS, INC., NASHVILLE, TENN.
AVAIL	WATER RESEARCH, VOL 9, NO 1, P 37-42, JANUARY 1975. 4 FIG, 1 TAB, 5 REF.

TITLE	LEAST COST DESIGN OF ACTIVATED SLUDGE SYSTEMS.
AUTHOR	MIDDLETON, A. C.; LAWRENCE, A. W.
CORP AUTH	CORNELL UNIV., ITHACA, NY DEPT. OF ENVIRONMENTAL ENGINEERING.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 48, NO 5, P 889-905 MAY 1976. 11 FIG, 11 TAB, 17 REF.

TITLE	LOAD BALANCING AT SEWAGE-TREATMENT WORKS: THE SOUTHAMPTON UNIVERSITY PILOT PLANT AT MILLBROOK.
AUTHOR	HELLIWELL, P. R.; REED, R. J. R.
CORP AUTH	SOUTHAMPTON UNIV. (ENGLAND). DEPT. OF CIVIL ENGINEERING.
AVAIL	JOURNAL OF THE INSTITUTE OF WATER POLLUTION CONTROL, VOL 76, NO 3, P 355-372, 1977. 14 FIG, 2 TAB, 10 REF.

TITLE	LONG-TERM PERFORMANCE OF A COUPLED TRICKLING FILTER-ACTIVATED SLUDGE PLANT.
AUTHOR	STENQUIST, R. J.; PARKER, D. S.; LOFTIN, W. E.; BRENNER, R. C.
CORP AUTH	BROWN AND CALDWELL, WALNUT CREEK, CA
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 49, NO 1, P 2265-2284, NOVEMBER, 1977. 15 FIG, 10 TAB, 8 REF.

TITLE	MANY DESIGN PROBLEMS OVERCOME IN STATEN ISLAND PLANT.
AUTHOR	MITCHELL, R. D.
CORP AUTH	PIRNIE (MALCOLM), INC., WHITE PLAINS, NY
AVAIL	WATER AND WASTES ENGINEERING, VOL 13, NO 12, P 57-59, 68, DECEMBER, 1976. 1 FIG, 1 TAB.

TITLE	METHOD FOR MEASURING AEROBIC DECOMPOSITION ACTIVITY OF ACTIVATED SLUDGE IN AN OPEN SYSTEM.
AUTHOR	FARKAS, PETER
CORP AUTH	RESEARCH INST. FOR WATER RESOURCES DEVELOPMENT, BUDAPEST (HUNGARY).
AVAIL	FOURTH INTERNATIONAL CONFERENCE ON WATER POLLUTION RESEARCH, PRAGUE, CZECH., SEPTEMBER 2-6, 1968. PREPRINT, SEC, II, PAPER 1, 9 P, 6 FIG, 1 TAB, 15 REF.

TITLE	MICROBIOLOGY OF WASTE TREATMENT
AUTHOR	UNZ, R. F.
CORP AUTH	PENNSYLVANIA STATE UNIV., UNIVERSITY PARK.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 45, NO 6, P 1259-1265, JUNE 1973, 67 REF.

TITLE	MICROBIOLOGY OF WASTE TREATMENT, (LITERATURE REVIEW).
AUTHOR	UNZ, R. F.
CORP AUTH	PENNSYLVANIA STATE UNIV., UNIVERSITY PARK.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 49, NO 6, P 1255-1268, JUNE, 1977. 130 REF.

TITLE	MICROBIOLOGY OF WASTE TREATMENT, (LITERATURE REVIEW).
AUTHOR	UNZ, F. F.
CORP AUTH	PENNSYLVANIA STATE UNIV., UNIVERSITY PARK.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 48, NO 6, P 1367-1378, JUNE, 1976. 101 REF.

TITLE	MICROSCOPIC OBSERVATION OF ACTIVATED SLUDGE APPLIED TO THE MONITORING OF TREATMENT PLANTS (L'OBSERVATION MICROSCOPIQUES DES BOUES ACTIVEES APPLIQUE A LA SURVEILLANCE DES INSTALLATIONS D'EPURATION: TECHNIQUE D'ETUDE INTERPRETATION).
AUTHOR	DRAKIDES, C.
CORP AUTH	MONTPELLIER-2 UNIV. (FRANCE). LAB. DE GENIE CHIMIQUE, TRAITEMENT ET EPURATION DES EAUX.
AVAIL	TECHNIQUES ET SCIENCES MUNICIPALES-l'EAU, VOL 73, NO 2, P 85-98, FEBRUARY, 1978. 18 FIG, 16 REF.

TITLE	MODELING AND OPTIMIZATION OF STEP AERATION WASTE TREATMENT SYSTEMS.
AUTHOR	ERICKSON, LARRY E.; HO, Y. S.; FAN, L. T.
CORP AUTH	KANSAS STATE UNIV., MANHATTAN.
AVAIL	JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 40, NO 5, PART 1, P 717-732, MAY 1968. 6 FIG, 2 TAB, 5 REF.

TITLE	MODULES PERMIT EASY EXPANSION.
AUTHOR	WEAVER, J. H.
CORP AUTH	ROBERT AND CO. ASSOCIATES, WEST PALM BEACH, FLA.
AVAIL	WATER ANMD WASTES ENGINEERING, VOL 13, NO 11, P 73-74, NOVEMBER, 1976, 1 FIG.

TITLE	NEW SYSTEM PUTS THE WOOD TO WASTEWATER.
AUTHOR	WEBER, C. L.; JACOBSON, C. D.
CORP AUTH	KIRKHAM MICHAEL AND ASSOCIATES, OMAHA, NEBR.
AVAIL	WATER AND WASTES ENGINEERING, VOL 12, NO 12, P 51-52, 64, DECEMBER, 1975. 1 FIG.

TITLE	NITRIFICATION AND HEAVY METAL REMOVAL IN THE ACTIVATED SLUDGE TREATMENT PROCESS.
AUTHOR	RICHARDS, P. A.
CORP AUTH	TEXAS A AND M UNIV., COLLEGE STATION.
AVAIL	UNIVERSITY MICROFILMS, INC., ANN ARBOR, MICH., 48106. ORDER NO. 77-2662. PHD THESIS, 1976. 182 P.

TITLE	NITRIFICATION IN ACTIVATED SLUDGE PLANTS - GUIDELINES ON SOME OPERATION AND DESIGN ASPECTS.
AUTHOR	SMITH, A. G.
CORP AUTH	ONTARIO MINISTRY OF THE ENVIRONMENT, TORONTO. WASTEWATER TREATMENT SECTION.
AVAIL	RESEARCH PUBLICATION, W62, 1976. REVISED JULY 1977. 97 P, 17 FIG, 12 TAB, 66 REF.

TITLE	NITRIFICATION IN HIGH-SLUDGE AGE CONTACT STABILIZATION.
AUTHOR	ZOLTEK, J., JR.; LEFEBVRE, L.
CORP AUTH	FLORIDA UNIV., GAINESVILLE. DEPT. OF ENVIRONMENTAL ENGINEERING SCIENCES.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 48, NO 9, P 2183-2189, SEPTEMBER, 1976. 4 FIG, 1 TAB, 11 REF.

TITLE	NITRIFICATION IN TREATMENT PLANTS AND NATURAL WATERS: SOME IMPLICATIONS OF THE THEORETICAL MODELS.
AUTHOR	DOWNING, A. L.; KNOWLES, G.
CORP AUTH	WATER POLLUTION RESEARCH LAB., STEVENAGE (ENGLAND).
AVAIL	FIFTH INTERNATIONAL WATER POLLUTION RESEARCH CONFERENCE, SAN FRANCISCO, JULY 26-AUGUST 1, 1970. PREPRINT, PAPER I-8, 8 P, 4 FIG, 1 TAB, 6 REF.

TITLE	NITROGEN REMOVAL AND IDENTIFICATION FOR WATER QUALITY CONTROL.
AUTHOR	CARLSON, DALE A.
CORP AUTH	WASHINGTON UNIV., SEATTLE. DEPT. OF CIVIL ENGINEERING.
AVAIL	NATIONAL TECHNICAL INFORMATION SERVICE AS PB-204 231, $3.00 IN PAPER COPY, $0.95 IN MICROFICHE, AUGUST 15, 1971. 52 P, 12 FIG, 8 TAB, 85 REF. OWRR A-040-WASH(1).

TITLE	ONE-VERSUS TWO-STATE NITRIFICATION IN THE ACTIVATED SLUDGE PROCESS.
AUTHOR	STOVER, E. L.; KINCANNON, D. F.
CORP AUTH	OKLAHOMA STATE UNIV., STILLWATER. SCHOOL OF CIVIL ENGINEERING.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 48, NO 4, P 645-651, APRIL, 1976. 6 FIG, 17 REF.

TITLE	OPERATING ACTIVATED-SLUDGE PLANTS TO EFFECT NUTRIENT REMOVAL.
AUTHOR	NICHOLLS, H. A.
AVAIL	WATER POLLUTION CONTROL, VOL 77, NO 1, P 99-101, 1978.

TITLE	OPERATING EXPERIENCE AND DESIGN CRITERIA FOR "UNOX" WASTEWATER TREATMENT SYSTEMS, DESIGN SEMINAR FOR WASTEWATER TREATMENT FACILITIES.
CORP AUTH	UNION CARBIDE CORP., TONAWANDA, NY LINDE DIV.

AVAIL REPORT PREPARED FOR ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, DC, TECHNOLOGY TRANSFER PROGRAM, FOR SEMINAR AT NEW YORK, NY, FEBRUARY 29-MARCH 2, 1972. 68 P.

TITLE OPERATION OF CONVENTIONAL ACTIVATED SLUDGE FOR MAXIMUM PHOSPHORUS REMOVAL.
AUTHOR MILBURY, WILLIAM F.; MCCAULEY, DONALD; HAWTHORNE, CHARLES H.
CORP AUTH WESTON (ROY F.), INC., WEST CHESTER, PA.
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 43, NO 7, JULY 1971, P 1890-1901. 3 FIG, 3 TAB, 7 REF.

TITLE OPERATIONAL CONTROL PROCEDURES FOR THE ACTIVATED SLUDGE PROCESS. PART III-B. CALCULATION PROCEDURES FOR STEP-FEED PROCESS RESPONSES.
AUTHOR WEST, A. W.
CORP AUTH NATIONAL FIELD INVESTIGATIONS CENTER-CINCINNATI, OH.
AVAIL REPORT, 1975. 31 P, 7 FIG, 2 TAB.

TITLE OPTIMIZATION OF THE ACTIVATED SLUDGE PROCESS-OPTIMUM VOLUME RATIO OF AERATION AND SEDIMENTATION VESSELS.
AUTHOR NAITO, M.; TAKAMATSU, T.; FAN, L. T.
CORP AUTH KANSAS UNIV., LAWRENCE. DEPT. OF CHEMICAL AND PETROLEUM ENGINEERING; AND KYOTO UNIV. (JAPAN). DEPT.
AVAIL WATER RES, VOL 3, NO 6, P 433-443, JUNE 1969. 8 FIG, 6 REF.

TITLE OPTIMIZE THE EFFLUENT SYSTEM. PART 6: BIOCHEMISTRY OF ACTIVATED SLUDGE PROCESS.
AUTHOR GRUTSCH, J. F.; MALLATT, R. C.
CORP AUTH STANDARD OIL CO. (INDIANA), CHICAGO, IL.
AVAIL HYDROCARBON PROCESSING, VOL 55, NO 8, P 137-142, AUGUST, 1976. 7 FIG, 2 TAB, 15 REF.

TITLE THE ORBAL EXTENDED AERATION ACTIVATED SLUDGE PLANT.
AUTHOR DREWS, R. L. C.; MALAN, W. M.; MEIRING, P. G. J.; MOFFATT, B.
CORP AUTH NATIONAL INST. FOR WATER RESEARCH, PRETORIA (SOUTH AFRICA).
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 44, NO 2, FEBRUARY 1972, P 221-231, 6 FIG, 5 TAB, 4 REF.

TITLE ORGANIC MATTER REMOVAL BY POWDERED ACTIVATED CARBON ADDED TO ACTIVATED SLUDGE.
AUTHOR DEWALLE, F. B.; CHIAN, E. S. K.; SMALL, E. M.
CORP AUTH ILLINOIS UNIV. AT URBANA-CHAMPAIGN. DEPT. OF CIVIL ENGINEERING.
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 49, NO 4, P 593-599, APRIL, 1977. 5 FIG, 1 TAB, 19 REF.

TITLE OXYGEN-ACTIVATED SLUDGE PLANT COMPLETES TWO YEARS OF SUCCESSFUL OPERATION.
AUTHOR MCDOWELL, C. S.; GIANELLI, J.
CORP AUTH AIR PRODUCTS AND CHEMICALS, INC., ALLENTOWN, PA.
AVAIL THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-272 271, IN PAPER COPY, IN MICROFICHE. REPORT EPA-600/2-77-040, JULY 1977. 195 P, 75 FIG, 12 TAB, 9 REF, 2 APPWEND.

TITLE OXYGEN AERATION AT NEWTON CREEK.
AUTHOR NASH, N.; KRASNOFF, P. J.; PRESSMAN, W. B.; BRENNER, R. C.
CORP AUTH NEW YORK STATE DEPT. OF WATER RESOURCES, NEW YORK.
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 49, NO 3, P 388-400, MARCH 1977, 4 FIG, 6 TAB, EPA PROJECT 11010 GEV.

TITLE PHOSPHORUS REMOVAL WITH PICKLE LIQUOR IN AN ACTIVATED SLUDGE PLANT.
CORP AUTH MILWAUKEE SEWERAGE COMMISSION, WIS.
AVAIL GPO SUP DOC. $1.25; MICROFICHE FORM NTIS AS PB-208 216, $0.95. ENVIRONMENTAL PROTECTION AGENCY WATER POLLUTION CONTROL RESEARCH SERIES, MARCH 1971. 143 P, 25 FIG, 7 TAB, 19 REF. EPA PROGRAM 11010 FLQ--03/71.

TITLE PHYSICAL CONDITIONING OF ACTIVATED SLUDGE FLOC.
AUTHOR PARKER, DENNY S.; KAUFMAN, WARREN J.; JENKINS, DAVID.
CORP AUTH CALIFORNIA UNIV., BERKELEY.
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 43, NO 9, P 1817-1833, SEPTEMBER 1971. 14 FIG, 6 TAB, 25 REF.

TITLE PLANT DATA ANALYSIS OF TEMPERATURE SIGNIFICANCE IN THE ACTIVATED SLUDGE PROCESS.
AUTHOR LIN, K-C.; HEINKE, G. W.
CORP AUTH NEW BRUNSWICK UNIV., FREDERICKTON. DEPT. OF CIVIL ENGINEERING.

AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 49, NO 2, P 286-295, FEBRUARY, 1977. 4 FIG, 3 TAB, 18 REF, 1 APPEND.
TITLE	POLLUTION ABATEMENT IN A BREWING FACILITY.
CORP AUTH	ENVIRONMENTAL PROTECTION AGENCY, WASHINGTON, DC, TECHNOLOGY TRANSFER STAFF.
AVAIL	EPA TECHNOLOGY TRANSFER CAPSULE REPORT NO. 6, (1974). 17 P, 8 FIG, 6 TAB.
TITLE	POLYMER ADDITION IMPROVES WASTE WATER TREATMENT PROCESS.
AUTHOR	CHURCHILL, R. J.; RYBACKI, R. L.
CORP AUTH	PETROLITE CORP., ST. LOUIS, MO. TRETOLITE DIV.
AVAIL	WATER AND SEWAGE WORKS, REFERENCE ISSUE, P 10-12, 14-17, 20, APRIL, 1977. 8 FIG, 2 TAB, 5 REF.
TITLE	PROCESS CONTROL OF ACTIVATED SLUDGE TREATMENT.
AUTHOR	KERMODE, R. I.; BRETT, R. W. J.
CORP AUTH	KENTUCKY WATER RESOURCES INST., LEXINGTON.
AVAIL	NTIS AS PB-227 238 $4.00 IN PAPER COPY, $1.45 IN MICROFICHE. RESEARCH REPORT NO 63, 1973. 88 P, 18 FIG. 40 REF, 9 TAB. OWRB(1) A-040-KY. 14-31-0001-3517. 14-31-0001-3817.
TITLE	PROCESS CONTROL OF ACTIVATED SLUDGE TREATMENT, PHASE II.
AUTHOR	KERMODE, R. I.; BRETT, R. W. J.; PAULT, J. D., JR.
CORP AUTH	KENTUCKY WATER RESOURCES INST., LEXINGTON.
AVAIL	THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-240 176, $4.75 IN PAPER COPY, $2.25 IN MICROFICHE. RESEARCH REPORT NO. 83, JANUARY 1975. 87 P, 29 FIG, 14 TAB, 14 REF. OWRT A-050-KY(1). 14-31-0001-4017.
TITLE	PROCESS DESIGN MANUAL FOR UPGRADING EXISTING WASTEWATER TREATMENT PLANTS.
CORP AUTH	WESTON (ROY F.), INC., WEST CHESTER, PA
AVAIL	EPA REGIONAL OFFICE TECHNOLOGY TRANSFER; IN MICROFICHE FROM NTIS AS PB-214 550 FOR $1.45. ENVIRONMENTAL PROTECTION AGENCY, TECHNOLOGY TRANSFER MANUAL, OCTOBER 1971, 275P. EPA PROJECT 17090 GNQ, CONTRACT 14-12-933.
TITLE	PROCESS OPTIMA IN ACTIVATED SLUDGE.
AUTHOR	POLOCSIK, S.; GRIEVES, R. B.: PIPES, W. O. JR.
CORP AUTH	ILLINOIS INST. OF TECH., CHCAGO.

AVAIL PROCEEDINGS, INDUSTRIAL WASTE CONFERENCE, 20TH, MAY 4, 5, 6, 1965, PURDUE UNIVERSITY, VOL XLIX, NO 4, P 197-209, JULY 1965. 5 FIG, 1 TAB, 4 REF. PUBLIC HEALTH SERVICE TRAINING GRANT NO 5T1ES26-02.

TITLE PROCESS STABILITY OF ACTIVITY SLUDGE PROCESSES.
AUTHOR CHIANG, C. H.
CORP AUTH PIRNIE (MALCOLM), INC., WHITE PLAINS, NY
AVAIL JOURNAL OF THE ENVIRONMENTAL ENGINEERING DIVISION-ASCE, VOL 103, NO EE2, P 259-271, APRIL, 1977. 3 FIG, 3 TAB, 2 APPEND.

TITLE ROLE OF NITROGEN IN ACTIVATED SLUDGE PROCESS.
AUTHOR WU, Y. C.
CORP AUTH PITTSBURGH UNIV., PA. DEPT. OF CIVIL AND ENVIRONMENTAL ENGINEERING.
AVAIL JOURNAL OF THE ENVIRONMENTAL ENGINEERING DIVISION, PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, VOL 102, NO EE5, PROCEEDINGS PAPER NO 12454, P 897-907, OCTOBER 1976.

TITLE SECONDARY TREATMENT.
AVAIL IN: 1977 PUBLIC WORKS MANUAL AND CATALOG FILE, BILLINGS, C. H., CONNER, S. H., AND KIRCHER, J. R., EDITORS, P D24-D32, 1977. 1 FIG.

TITLE SETTLING CHARACTERISTICS OF ACTIVATED SLUDGE AT LOW TEMPERATURE.
AUTHOR REED, SHERWOOD
CORP AUTH COLD REGIONS RESEARCH AND ENGINEERING LAB., HANOVER, N.H.
AVAIL NTIS AS AD-717 239, $3.00 IN PAPER COPY, $0.95 IN MICROFICHE. CRREL TECHNICAL REPORT 203, NOV 1970. 30 P, 17 FIG, 5 TAB, 25 REF.

TITLE SEWAGE TREATMENT WORKS FOR SMALL COMMUNITIES--A NEED FOR CAREFUL DESIGN AND OPERATION.
AUTHOR DREWS, R. J. L. C.; DENYSSCHEN, J. H.
CORP AUTH NATIONAL INST. FOR WATER RESEARCH, PRETORIA (SOUTH AFRICA).
AVAIL IN: WATER POLLUTION CONTROL IN DEVELOPING COUNTRIES. PROCEEDINGS OF THE INTERNATIONAL CONFERENCE HELD AT BANGKOK, THAILAND, FEBRUARY 1978. EDITED BY E.A.R. OUANO, B. M. LOHANI, | N. C. THANH. ASIAN INSTITUTE OF TECHNOLOGY, BANGKOK, THAILAND (PERGAMON PRESS IN USA), P 381-397, 1978, 7 FIG, 1 TAB, 9 REF.

TITLE	SHOCK LOAD RESPONSE OF ACTIVATED SLUDGE WITH CONSTANT RECYCLE SLUDGE CONCENTRATION.
AUTHOR	SALEH, M. M.; GAUDY, A. F., JR.
CORP AUTH	EL-AZHAR UNIV., CAIRO (EGYPT). SCHOOL OF CIVIL ENGINEERING.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 50, NO 4, P 764-774, APRIL, 1978. 190 FIG, 1 TAB, 11 REF.

TITLE	SIMPLIFIED OPTIMIZATION OF ACTIVATED SLUDGE PROCESS.
AUTHOR	GRADY, C. P. L., JR.
CORP AUTH	PURDUE UNIV., LAFAYETTE, INDIANA, SCHOOL OF CIVIL ENGINEERING.
AVAIL	JOURNAL OF THE ENVIRONMENTAL ENGINEERING DIVISION, PROCEEDINGS OF THE AMERICAN SOCIETY OF CIVIL ENGINEERS, VOL 103, NO EE3, PROCEEDINGS PAPER NO. 12974, P 413-429, JUNE 1977. 3 FIG, 6 TAB, 19 REF.

TITLE	START-UP OF NEW WASTE WATER TREATMENT PLANTS.
AUTHOR	CAVERLY, D. S.
CORP AUTH	ONTARIO WATER RESOURCES COMMISSION, TORONTO
AVAIL	JOURNAL OF THE WATER POLLUTION CONTROL FEDERATION, VOL 40, NO 4, P 571-580, APRIL 1968.

TITLE	SYSTEM ALTERNATIVES IN OXYGEN ACTIVATED SLUDGE.
AUTHOR	STAMBERG, J. B.; BISHOP, D. F.; BENNETT, S. M.; HAIS, A. B.
CORP AUTH	DISTRICT OF COLUMBIA DEPT. OF ENVIRONMENTAL SERVICES, WASHINGTON.
AVAIL	THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161, AS PB-241 310, $4.25 IN PAPER COPY, $2.25 in MICROFICHE. ENVIRONMENTAL PROTECTION AGENCY, CINCINNATI, OHIO. REPORT EPA-670/2-75-008, APRIL 1975. 59 P, 22 FIG, 7 TAB, 26 REF. 1BB043 ROAP 21-ASR TASK-015 68-01-0162.

TITLE	TECHNICAL ASSISTANCE PROJECT FORT COLLNS WASTEWATER TREATMENT FACILITY FORT COLLINS, COLORADO, JANUARY - FEBRUARY, 1973.
CORP AUTH	ENVIRONMENTAL PROTECTION AGENCY, DENVER, CO. REGION VIII.
AVAIL	THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-255 573, IN PAPER COPY, IN MICROFICHE. REPORT S AND A/TSB - 22, 1973 25 P, 4 FIG.

TITLE	TECHNICAL ASSISTANCE PROJECT VAIL WASTEWATER TREATMENT FACILITY VAIL, COLORADO, MARCH - APRIL 1973.
CORP AUTH	ENVIRONMENTAL PROTECTION AGENCY, DENVER, CO. REGION VIII.
AVAIL	THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-255 257, IN PAPER COPY, IN MICROFICHE. REPORT SA/TSB-21, 1973. 31 P, 4 FIG, 2 REF.

TITLE	TEMPERATURE EFFECTS ON THE ACTIVATED SLUDGE PROCESS.
AUTHOR	SAYIGH, B. A.; MALINA, J. F., JR.
CORP AUTH	TEXAS UNIV. AT AUSTIN. DEPT. OF CIVIL ENGINEERING.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 50 NO 4, P 678-687, APRIL, 1978. 13 FIG, 18 REF.

TITLE	TEMPERATURE EFFECTS ON GROWTH AND YIELD OF ACTIVATED SLUDGE.
AUTHOR	FRIEDMAN, A. A.; SCHROEDER, E. D.
CORP AUTH	TENNESSEE TECHNOLOGICAL UNIV., COOKEVILLE. DEPT. OF CIVIL ENGINEERING.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 44, NO 7, P 1433-1442, JULY 1972, 8 FIG, 3 TAB, 25 REF.

TITLE	TOWARD A MORE MEANINGFUL INDEX OF SLUDGE QUALITY.
AUTHOR	FITCH, B.; KOS, P.
CORP AUTH	CARNEGIE-MELLON UNIV., PITTSBURGH, PA.
AVAIL	JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 48, NO 8, P 1979-1987, AUGUST, 1976. 11 FIG, 1 REF.

TITLE	TRACE ELEMENTS IN BIOLOGICAL WASTE TREATMENT IWTH SPECIFIC REFERENCE TO THE ACTIVATED SLUDGE PROCESS.
AUTHOR	WOOD, D. K.; TCHOBANOGLOUS, G.
CORP AUTH	CALIFORNIA UNIV., DAVIS.
AVAIL	IN: PROCEEDINGS OF THE 29TH INDUSTRIAL WASTE CONFERENCE, MAY 7-9, 1974, PART 2, LAFAYETTE, INDIANA, PURDUE UNIVERSITY, P 648-661. 4 FIG, 6 TAB, 21 REF.

TITLE	TRICKLING FILTER VERSUS ACTIVATED SLUDGE: WHEN TO SELECT EACH PROCESS.
AUTHOR	KINCANNON, D. F.; SHERRARD, J. H.
CORP AUTH	OKLAHOMA STATE UNIV., STILLWATER, SCHOOL OF CIVIL ENGINEERING.

AVAIL WATER AND SEWAGE WORKS, VOL 121, NO 4, P 32-34, 36 APRIL 30, 1974. 1 FIG, 4 TAB, 9 REF.

TITLE UNIFIED BASIS FOR BIOLOGICAL TREATMENT DESIGN AND OPERATION.
AUTHOR LAWRENCE, ALONZO W.: MCCARTY, PERRY L.
CORP AUTH STANFORD UNIV., CALIF.
AVAIL JOURNAL, SANITARY ENGINEERING DIVISION, PROCEEDINGS AMERICAN SOCIETY OF CIVIL ENGINEERS, VOL 96, NO SA3, P 757-778, JUNE 1970. 4 FIG, 6 TAB, 48 REF.

TITLE WASTEWATER CHARACTERIZATION AND PROCESS RELIABILITY FOR POTABLE WASTEWATER RECLAMATION.
AUTHOR PETRASEK, A. C., JR.
CORP AUTH DALLAS WATER UTILITIES DEPT., TX.
AVAIL THE NATIONAL TECHNICAL INFORMATION SERVICE, SPRINGFIELD, VA 22161 AS PB-274 874, IN PAPER COPY, IN MICROFICHE. REPORT EPA-600/2-77-210, 1977. 124 P, 56 FIG, 22 TAB, 10 REF.

TITLE WASTEWATER TREATMENT DESIGN: ECONOMICS AND TECHNIQUES, PART I.
AUTHOR ECKENFELDER, W. W., JR.
CORP AUTH VANDERBILT UNIV., NASHVILLE, TENN.
AVAIL WATER AND SEWAGE WORKS, VOL 122, NO 6, P 63-65, JUNE, 1975. 67 FIG, 2 TAB.

TITLE WASTEWATER TREATMENT DESIGN, PART II.
AUTHOR ECKENFELDER, W. W., JR.
CORP AUTH VANDERBILT UNIV., NASHVILLE, TENN.
AVAIL WATER AND SEWAGE WORKS, VOL 122, NO 7, P 70, 75, JULY, 1975. 2 FIG, 1 TAB, 3 REF.

TITLE WASTEWATER TREATMENT PROBLEMS AT NORTH KANSAS CITY, MISSOURI.
AUTHOR SCHMIDT, P. J.
CORP AVAIL BLACK AND VEATCH, KANSAS CITY, MO
AVAIL JOURNAL WATER POLLUTION CONTROL FEDERATION, VOL 50, NO 4, P 635-644, APRIL, 1978. 5 FIG, 3 TAB.

TITLE WATER AND WASTEWATER TREATMENT.
AUTHOR SCHROEDER, E. D.
CORP AUTH CALIFORNIA UNIV., DAVIS. DEPT. OF CIVIL ENGINEERING.
AVAIL MCGRAW-HILL, NEW YORK, NY 1977, 370 P. $3.95.

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