SUMMARIES OF SOLID WASTE

INTRAMURAL RESEARCH AND DEVELOPMENT PROJECTS

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FOREWORD

THE FEDERAL RESEARCH AND DEVELOPMENT attack on solid waste management problems employs a variety of approaches, not the least of which are intramural undertakings. This type of exploration not only enjoys freedom of movement regarding investigative areas, it is also highly flexible because control of project direction is always close to the work itself. This report summarizes the approaches and progress associated with projects being pursued on an intramural basis.

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INTRODUCTION

Research efforts of the Bureau of Solid Waste Management (predecessor of the Solid Waste Management Office) were carried out extramurally through research grants, demonstration grants, and the contract mechanism beginning in Fiscal Year 1960.* An intramural research program, however, was not initiated until Fiscal Year 1967 when planning began for the present experimental compost plant facility now located at Johnson City, Tennessee, and for the two laboratories now operating in Cincinnati. These laboratories were established to perform necessary service functions to support other efforts of the Bureau, as well as to begin the conduct of in-house research and development for better solid waste management. The tasks associated with analyzing samples from field investigations being conducted in connection with studies sponsored by various elements of the Bureau represent a significant but ofttimes unheralded effort.

Early in Fiscal Year 1968, the first modest resources were applied to several intramural research and development projects. The efforts were carried out in laboratory facilities located

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*Lefke, L. W., A. G. Keene, R. A. Chapman, and H. Johnson, comps. Summaries of solid waste research and training grants--1970. Public Health Service Publication No. 1596. Washington, U.S. Government Printing Office, 1971. (In press.)

at 5555 Ridge Avenue and at 5995 Center Hill Avenue. Effort is made, through the Office of Program Development, to coordinate the efforts made in extramural projects with the efforts undertaken by the staff of the Division of Research and Development. In three instances, cooperative work with other governmental agencies has been conducted.

During Fiscal Year 1969 over 600 samples, representing more than 4,200 laboratory determinations were processed for various Bureau field investigations and projects.

JOINT PUBLIC HEALTH SERVICE -- TENNESSEE VALLEY AUTHORITY COMPOSTING PROJECT, JOHNSON CITY, TENNESSEE

PROJECT OFFICER: Gordon Stone PROJECT: RC 056601

OBJECTIVE: The major goal is to determine whether municipal solid waste and sewage sludge can be disposed of properly by the composting process. Specific objectives are: (1) to determine if garbage and refuse can be converted into a safe product that has some economic value; (2) to determine whether overall waste disposal costs can be reduced.

The project will: demonstrate the engineering and economic factors involved in producing compost from mixed refuse and raw and digested sewage sludge; include research in the health aspects of using and processing compost; determine whether the addition of chemical fertilizers improves the composting process and increases the value or usefulness of the finished product; investigate the uses and market potential of the finished product.

APPROACH: Cities are finding disposal of the solid wastes being discarded by their expanding populations increasingly difficult and expensive. Land suitable for sanitary landfills is often scarce and costly. Improper burning results in air pollution. Discharging of solid waste or incompletely treated sewage and sewage sludge into streams creates water pollution problems.

This experimental composting project is being conducted jointly by the U.S. Public Health Service, the Tennessee Valley Authority, and the City of Johnson City, Tennessee. The U.S. Public Health Service is involved in the experimental composting

project through the research and development efforts of the Bureau of Solid Waste Management. The Tennessee Valley Authority is applying its resources through its Divisions of Construction and Design, Health and Safety, Reservoir Properties, and Agricultural Development.

The project's central feature is the composting plant in Johnson City, Tennessee. The plant is located next to the city's sewage treatment facility. Approximately 50 tons of solid waste are received daily, of which about 25 percent is rejected as noncompostable. All the compostable solid waste and sewage sludge from the city's 34,000-population is processed into compost. The solid waste is ground by either a rasping machine or a hammermill and mixed with the sewage sludge. The mixture is then windrowed on a five-acre field for 30 to 44 days. During this time, the mixture is turned 8 to 12 times while the moisture remains at 50 to 60 percent. After the decomposition process, the compost is cured for approximately two weeks in an open shed; it is then ready for distribution. For certain uses, regrinding and screening to a smaller size are desirable. About 25 tons of compost are produced daily.

PROGRESS: Microbiological studies indicate that the hazards associated with a solid waste-sewage sludge compost are essentially the same as those related to other naturally occurring environmental contacts. The process, including the economics of production, has been studied. Work on the testing and marketing of the compost is now being carried out by the Tennessee Valley Authority.

PUBLICATIONS

Kochtitzky, O. W., W. K. Seaman, and J. S. Wiley. Municipal Composting research at Johnson City, Tennessee. Compost Science, 9(4):5-16, Winter 1969.

Sewage sludge and refuse composting test begins. Environmental Science & Technology, 2(8):589-591, Aug. 1968.

Stutzenberger, F. J. Microbiological activity in solid waste composting. In Proceedings of the Fourth Joint Meeting of the Clinical Society and Commissioned Officers Association of the United States Public Health Service, June 2-5, 1969, Boston, Massachusetts. Washington Commissioned Officers Association. p. 37. (Abstract.)

Stutzenberger, F. J., A. J. Kaufman, and D. R. Lossin. Cellulolytic activity in municipal solid waste composting. Canadian Journal of Microbiology, 16(7):553-560, July 1970.

Wiley, J. S., F. E. Gartrell, and H. G. Smith. Concept and design of the joint U.S. Public Health Service--Tennessee Valley Authority Composting Project, Johnson City, Tennessee. [Cincinnati], U.S. Department of Health, Education, and Welfare, 1968. 14 p.

Wiley, J. S., and O. W. Kochtitzky. Composting developments in the United States. Compost Science, 6(2):5-9, Summer 1965.

PRESENTATION

Stone, G. E. Engineering aspects of composting at Johnson City, Tennessee. Informal presentation at Roundtable on Composting, Annual Meeting of the American Society for Microbiology, Miami, May 8, 1969.

DUST EXPLOSION PROJECT

PROJECT OFFICER: Robert C. Thurnau PROJECT: WP-02-69-24

OBJECTIVE: To study the explosiveness of incinerator dust.

APPROACH: Using a modified version of the dust explosion apparatus employed by the U.S. Department of the Interior's Bureau of Mines, the lower explosive limit of incinerator

dust was studied. This involved the dispersion and ignition of the dust.

PROGRESS: Incinerator dust was found to be nonexplosive under ordinary conditions. There was, however, a potential explosive hazard if the dust concentration reached a high level and a large igniting force was applied. Threshold values for these have yet to be determined. All of the explosive indices were well below unity, indicating a slight hazard. The indices are defined as a ratio of the minimum explosive concentration of the dust to the minimum explosive concentration of coal dust, with unity being a moderate hazard.

Ground solid waste was found to be moderately explosive and had an index of 0.8--identical to the figure published by the Bureau of Mines.

THE OCCURRENCE AND SIGNIFICANCE OF PESTICIDES IN SOLID WASTES*

PROJECT OFFICERS: E. P. Floyd
Henry Johnson

PROJECT: RS-03-68-06

OBJECTIVE: To estimate the significance of pesticidal residues in solid wastes and to recommend ways to neutralize or dispose of them.

APPROACH: Data on industrial production and consumer use were used to estimate the extent of the chemical pesticide waste problem. Plans were made to conduct a systematic search for the presence of pesticidal residues in solid wastes, to measure the amounts of those found, to study the potential effect of such amounts on man, and to determine a disposal process.

*Previously a separate project.

(This project is now an integral part of the one entitled "Toxic and Hazardous Materials in Solid Wastes.")

PROGRESS: Data were collected on the production and use of chemical pesticides and methods currently employed for disposing of them. Initial plans were made for screening tests to detect pesticide residues in compost and incinerator residues, and analytical methods were selected to identify some of the most common chlorinated hydrocarbon pesticides.

PUBLICATIONS

Breidenbach, A. W. Application of solid waste research to pesticide disposal. In Proceedings; National Working Conference on Pesticide Disposal, Beltsville, Md., June 30--July 1, 1970. [Washington], U.S. Department of Agriculture and President's Cabinet Committee on the Environment, Subcommittee on Pesticides [Research Panel]. p. 120-123.

Breidenbach, A. W. Editorial. Pesticides Monitoring Journal, 2(2):71, Sept. 1968.

Floyd, E. P. Occurrence and significance of pesticides in solid wastes; a Division of Research and Development open-file report (RS-02-68-15). [Cincinnati], U.S. Department of Health, Education, and Welfare, 1970. 34 p. [Restricted distribution.]

Floyd, E. P., and A. W. Breidenbach. Preliminary estimate of the significance of pesticide residues in solid wastes and problems of reduction or elimination of these residues. [Cincinnati], U.S. Department of Health, Education, and welfare, [1968]. 6 p.

TOXIC AND HAZARDOUS MATERIALS IN SOLID WASTES

PROJECT OFFICER: Henry Johnson PROJECT: RS-03-68-06

OBJECTIVE: Phase I: to measure quantities of selenium compounds in solid wastes before, during, and after an incineration

process and in leachates from a land disposal site. Phase II: to inventory and evaluate storage and disposal practices involving such hard-to-handle industrial solid wastes as pesticides, waste oils, and cyanides.

APPROACH: Phase I: fluorometrically examine samples, representing each phase of incineration processing, using 2,3-diaminonaphthalene as the reagent. Samples from two plants and runoff samples from two landfills were analyzed. In Phase II, procedures will be established for the collection, evaluation, and dissemination of basic data and information on existing practices.

PROGRESS: Condensation of Phase I data:

RESULTS OF SELENIUM DETERMINATIONS
IN SOLID WASTE SAMPLES

Material	No. samples	Average concentration
Newspaper	8	8.6 ppm w/w
Cardboard	8	2.8 ppm w/w
Laboratory tissue	4	7.1 ppm w/w
Finished compost A	1	0.76 ppm w/w
Finished compost B	1	0.43 ppm w/w
Raw refuse	18	1.27 ppm w/w
Residue	4	0.073 ppm w/w
Residue quench water	4	None detected
Fly ash quench water	4	0.012 ppm w/v
Stack gas	11	0.89 $\mu g/M^3$
Landfill runoff H	4	0.003 ppm w/v
Landfill runoff N	2	None detected

In Phase II, procedures are being developed.

PUBLICATIONS

Breidenbach, A. W. Application of solid waste research to pesticide disposal. In Proceedings; National Working Conference on Pesticide Disposal, Beltsville, Md., June 30--July 1, 1970. [Washington], U.S. Department of Agriculture and President's Cabinet Committee on the Environment, Subcommittee on Pesticides [Research Panel]. p. 120-123.

Johnson, H. Determination of selenium in solid waste. Environmental Science & Technology, 4(10):850-853, Oct. 1970.

GRINDER EVALUATION AND DEVELOPMENT

PROJECT OFFICER: Thomas G. Sanders PROJECT: WP-02-69-26

OBJECTIVE: To accumulate and establish the power requirements and associated operating costs of several types of grinders for the comminution of solid waste, and to study the functional relationship between its moisture content and any other relevant parameters to grinder power input. The operating costs of other grinders individually, in series, slurry-fed, and dry-fed, will be evaluated. Various separation and feed systems will be studied to increase their respective efficiencies and hence allow more effective utilization of the several size-reduction processes.

APPROACH: The pilot-plant study at Cincinnati will entail comminuting 1,000 to 6,000 lb of solid waste from municipal sources with varying moisture content in each experimental run. While the refuse is being macerated, the power to the hammermill motor will be continuously recorded on a strip chart. Not only can the total gross and net power be recorded

by the wattmeter, but the maximum and minimum power loads can be continuously monitored.

Another study will be made at the Joint Public Health Service--Tennessee Valley Authority Composting Project at Johnson City, Tennessee, facility utilizing its equipment. Since the grinding equipment there is running continuously in order to produce 20 tons of compost a day, much data describing the power requirements, hammerwear, downtime, and maintenance repair can be compiled.

This broad, continuous study describing the operating costs of several grinders combined with the more detailed, definitive research of the different parameters (moisture, metal, and cellulose content, and size and feed rate of the grinder) affecting grinding costs will provide a better insight into the costs of grinding and the parameters that influence these expenses.

PROGRESS: Experimentation has indicated that moisture content has a significant effect on grinding characteristics. Not enough data have been accumulated, however, to ascertain a definitive relationship or the limits thereof.

Ancillary studies have indicated that moisture losses occur while solid waste is being comminuted, but in an amount less than expected; not more than a 6 percent loss has occurred during the experiments.

Additional studies are under way to substantiate the functional relationship of net power input and final moisture content, to amass more operating cost data, and to study further moisture losses when solid waste is comminuted. Plans are being completed to initiate a full-scale study of the grinders at Johnson City, Tennessee.

DEVELOPMENT OF A HIGH-TEMPERATURE, LOW-CAPACITY REFUSE INCINERATOR

PROJECT OFFICER: Donald A. King PROJECT: WP-03-68-08

OBJECTIVE: To develop a high-temperature solid waste incinerator that can economically and effectively dispose of the municipal solid waste from small communities.

APPROACH: The incinerator has a horizontal cylindrical combustion chamber. The solid waste is forced by a hydraulic ram to form a fuel plug which advances the solid waste, subsequently pushing the residue into the ash hopper. Preheated air is forced into the furnace tangentially to the wall to produce a spiral flow of the gases.

The incinerator will be operated under various conditions of solid waste loading, air supply, air velocity, and type of refuse. The unit will be evaluated by: (1) collecting temperature data at a number of points throughout the unit; (2) continuously analyzing stack gases for CO_2, CO, and O_2; (3) making chemical and bacteriological examinations of the residue and fly ash; (4) visually checking the physical effects of high-temperature incineration on the incinerator structure for each experimental test.

PROGRESS: The construction of the incinerator at the Solid Waste Research and Technical Development Facility at Center Hill in Cincinnati, Ohio, has been completed. Preliminary testing has begun. The theory that a plug of compacted solid waste in the charging chute can provide an adequate seal must be valid if the incinerator is to function as designed. It has been found that the theory is not valid for optimum conditions of incineration. When the solid waste is compacted in the chute to a density of about 40 lb per cubic foot there is no leakage from the incinerator. The refuse will not,

however, burn inside the combustion chamber when this condition exists. The high degree of compaction makes combustion almost impossible. On the other hand, when the refuse is loose enough to burn the seal is lost and smoke leaks back through the chute.

The preliminary tests indicate that the theory of using a refuse plug for sealing purposes should be discarded and that a different way to seal the chute and hopper should be developed. Efforts are under way to seal the chute, hopper, and charging platen. With the unit sealed, the incinerator can be operated for almost an hour before the air is cut off in order for the hopper to be refilled. It is planned to redesign the hopper system so that the sealed hopper can be refilled quickly. This would permit uninterrupted operation of the incinerator and allow its capabilities to be properly evaluated.

INVESTIGATION OF POSSIBLE DESIGN AND EFFICIENCY IMPROVEMENTS FOR A ROTARY KILN INCINERATOR

PROJECT OFFICER: Donald A. Oberacker PROJECT: WP-02-68-12

OBJECTIVE: To survey the subject by a literature search, to observe several large municipal rotary kiln incinerators, and to collect baseline technical information on their respective theoretical designs, operational characteristics, and economics.

APPROACH: The literature search has been supplemented by discussions with design and manufacturing companies, incinerator inspection visits (including technical discussions with foremen), and brief experiments on feed rate, volume reduction, weight reduction, and residue sampling.

PROCEDURES FOR THE PREPARATION OF SOLID WASTE SAMPLES FOR ANALYSIS

PROJECT OFFICER: Israel Cohen PROJECT: RS-03-68-19

OBJECTIVE: To develop procedures for preparing samples for laboratory analysis from raw solid waste and derived material.

APPROACH: To make use of a variety of comminuting and mixing apparatus and drying procedures, to evaluate the final products for uniformity, and to compare the analytical data derived in the laboratory analyses.

PROGRESS: A W-W grinder*, a Wiley No. 3 mill, and an Iler pulverizer have been used to grind raw and composted refuse. In the Wiley mill, it was ground to a particle size of 2 mm to 1/2 mm (9 mesh to 32 mesh). Incinerator residue was ground to finer than 60 mesh in the Iler pulverizer. The W-W grinder was used to reduce the particle size of raw combustible refuse to less than 1-1/2 inches. This product was then fed into the Wiley mill for final size reduction. Some rather crude homemade devices were used as mixers with gratifying results. During 1970, efforts were to be made to obtain smaller particle sizes and to use more sophisticated mixers.

*Mention of commercial products does not imply endorsement by the U.S. Government.

ENVIRONMENTAL DATA MANAGEMENT STUDIES FOR MARINE DISPOSAL OF SOLID WASTES

PROJECT OFFICER: Lynn P. Wallace PROJECT: CT-02-69-45

OBJECTIVE: To develop the ability to answer, on short notice, questions as to whether a specific marine area is suitable

for accepting a particular solid waste. To identify what additional information is needed, if available environmental data are insufficient to respond.

APPROACH: The National Oceanographic Data Center (NODC) operates a data storage, retrieval, and analysis system for marine environmental data. It also maintains liaison with the Federal Water Pollution Control Administration, which is responsible for maintaining water quality data on coastal waters.

Under the terms of an interagency agreement between NODC and the Bureau, data banks at NODC and elsewhere are being examined in order to evaluate the adequacy of physical, geological, chemical, and biological oceanographic data for the Bureau's needs.

PROGRESS: The extent and accessibility of pertinent oceanographic data indicate that, although computerized data analysis and retrieval systems will be used in the future, manual bibliographic search and evaluation methods are best for the present.

Efforts during FY 1969 were directed at collating and evaluating data from two areas, the first off New York and the second off Los Angeles. Work in FY 1970 was to concentrate on the New York Bight.

PUBLICATION

Schuyler, S., and G. Heimerdinger. Continental margin data collection pilot project; a Division of Research and Development open-file report (CT-02-69-45). [Cincinnati], U.S. Department of Health, Education, and Welfare, 1970. [81 p.] [Restricted distribution.]

PATHOGENS ASSOCIATED WITH SOLID WASTE DISPOSAL PROCESSES

PROJECT OFFICER: Mirdza L. Peterson PROJECT: RS-03-68-16

OBJECTIVE: To help develop design criteria and operational standards for disposing of waste through incineration, composting, landfilling, and other disposal systems by determining the distribution and survival patterns of pathogenic microorganisms before, during, and after processing and disposal; to evaluate the efficacy of the various operations employed in processing solid waste for disposal in removing and destroying the pathogens.

APPROACH: To accomplish these objectives it was necessary to develop microbiological methods to measure the levels of microbial pathogens associated with municipal waste disposal processes. Field studies were needed to determine the efficacy of several incinerator types to destroy bacteria associated with solid waste.

PROGRESS: Samples of solid waste and its residue were taken from eight municipal incinerators of different design and examined for (1) total bacterial cell number, (2) total coliforms, (3) fecal coliforms, (4) heat resistant spores, and (5) selected enteric pathogens. Of the eight incinerators tested, only one produced residue devoid of fecal coliforms; seven others produced residue containing fecal coliform population of less than 10 to 4,700 per g.

Quantitative studies were made of dust in three specific waste handling areas of six municipal incinerators; the dumping floor, the charging floor, and the residue areas. Total microbial cell counts in the areas tested ranged from 1 to 153 organisms per 0.25 cu ft of air.

PUBLICATIONS

Armstrong, D. H. Portable sampler for microorganisms in incinerator stack emissions. Applied Microbiology, 19(1):204-205, Jan. 1970.

Peterson, M. L., and F. J. Stutzenberger. Microbiological evaluation of incinerator operations. Applied Microbiology, 18(1):8-13, July 1969.

AN INVESTIGATION OF THE USE OF SCRAP TIRES AS ARTIFICIAL REEFS

PROJECT OFFICER: Clarence A. Clemons PROJECT: CT-02-69-44

OBJECTIVE: To determine whether significant quantities of scrap tires can be used in a marine environment to help reduce a major source of solid waste.

APPROACH: Through an agreement between the Bureau of Solid Waste Management and the Bureau of Sport Fisheries and Wildlife (U.S. Department of the Interior), scientists from the Sandy Hook Marine Laboratory are conducting field investigations to determine: (1) where and how many scrap tires may be used for artificial reefs, (2) the costs of building such reefs, (3) the number of reefs that may be established, (4) suitable designs, and (5) the geophysical environs and depths of water most adaptable to establishing artificial reefs.

Important considerations in site selection are the depths of water, bottom types, ease of access to survey teams, and distance from coastal population centers. Most of the research will center on transporting the tires and placing them in various configurations.

A continuing program of environmental monitoring will be developed, and diver-biologists will inspect the reefs periodically to determine the effectiveness of various designs. The first-year effort will concentrate on building reefs containing 10,000 to 50,000 tires each. Their effectiveness will be subjected to comprehensive evaluation during the second year.

PROGRESS: Approximately 25,000 tires have been placed in a reef 3 miles off East Rockaway Inlet, Long Island, New York. It is in 60 ft of water and is 1 mile long by 1/2 mile wide. Approval has been obtained for establishing another artificial reef off the Atlantic Coast.

Two construction designs have been selected for detailed investigation. In one case, eight tires are placed on two rods and the bottom tire is filled with concrete. In the other, a cement anchor is attached to each tire. The average cost per tire has been 44¢ but it is expected to drop. After preliminary investigations are concluded, staging operations will be moved from Sandy Hook.

RECLAMATION OF VALUABLE COMPOUNDS FROM AGRICULTURAL REFUSE AND MUNICIPAL WASTES

PROJECT OFFICER: Daniel F. Bender PROJECT: RC-02-68-18

OBJECTIVE: The long-range goal is to develop a process for recovering valuable organic chemicals from incinerated, pyrolyzed, and agricultural wastes. The immediate goal is to identify the organic materials that may be present in order to assign them economic values and to decide upon large-scale isolation methods.

APPROACH: The waste has been collected, prepared for extraction, extracted with solvents and chromatographed with column and thin-layer chromatography for separation of the extracted material. Absorption and fluorescent spectroscopy was applied to the separated material.

PROGRESS: Small amounts of anthracene, phenanthrene, and pyrene were detected in fly ash. A scheme has been partially developed for obtaining alkaloids from vegetation waste (tomato vines and

leaves). On the basis of the present data, the economic significance remains uncertain. No investigations are being pursued at the present time.

PRESENTATION

Bender, D. F., W. J. Kroth, G. Meyer, M. L. Wilson, and R. O. Carter. Constituents of incinerated and pyrolyzed solid wastes: polynuclear aromatic hydrocarbons in fly ash and residue from municipal incinerators. Presented at 158th National Meeting, American Chemical Society, New York, Sept. 7-12, 1969.

THE CHEMICAL AND PHYSICAL TRANSFORMATION OF WASTE RUBBER INTO USEFUL MATERIALS

PROJECT OFFICER: Clarence A. Clemons PROJECT: RC-02-68-05

OBJECTIVE: To determine how and to what extent discarded rubber and rubber products are being utilized to investigate, identify, and evaluate the technical feasibility of using various types of waste rubber.

APPROACH: The project will proceed through: (1) preliminary structuring, (2) literature survey and analyses, (3) field discussions and survey, (4) data analysis and projections, and (5) reporting.

Various industrial, government, technical, and trade publications will be screened to obtain information on the overall nature of the rubber industry and qualitative and quantitative data on how many wastes are disposed of or used. Contracts will be let to obtain specific information sources, uses, practices, and potential of reclaimed, ground, and other forms of scrap rubber.

The information obtained will be correlated and analyzed. The results and data obtained from in-house research should produce a comprehensive delineation of current technical, economic, and social aspects of waste rubber utilization. A selection of the most feasible technological paths to reduce waste accumulation will be highlighted in a publication to supplement the contractor's final published report.

PROGRESS: Two extramural projects are under way. Uniroyal Chemical is studying various segments of the industry under a contract (PH 68-86-208) entitled "Solid Waste Management and Rubber Reuse Potential in the Rubber Industry." The Sandy Hook Marine Laboratory is investigating the wholesale use of rubber tires to build artificial reefs. (*See* [Project CT-02-69-44].)

Separate contacts have been made with major rubber industries, various trade and manufacturing associations, and institutions. Literature reviews have been completed and bibliographies assembled in cooperation with Uniroyal Chemical and the University of Akron Rubber Library. A separate report highlighting various means of increasing the utilization of waste rubber is scheduled for publication in 1970.

UTILIZATION OF SOLID WASTES BY CHEMICAL TRANSFORMATION

PROJECT OFFICERS: T. C. Purcell
C. J. Rogers

PROJECT: RC-03-68-21

OBJECTIVE: To develop physical, chemical, and microbial systems for converting solid wastes into useful materials.

APPROACH: Chemical extraction, physical processing, acid, alkaline, photochemical treatment, fermentation processes, and related laboratory and pilot-scale procedures will be utilized

to convert cellulosic wastes into useful products. Wet-chemical, microbiological, and spectrophotometric analysis will be used to separate and identify specific reaction intermediates and product components.

PROGRESS: Several processes have been investigated for degrading cellulosic wastes from filter paper, newspaper, rice hulls, kraft paper, and mixed refuse. Microorganisms and enzymes have been accumulated and preliminary tests run to determine their relative abilities to degrade the cellulose.

Results from waste cellulose biodegradation studies using selected fungi indicate that cells with a 15 percent protein content can be harvested. This compares well with cereal grains, which contain from 12 to 15 percent protein. Advantages of the fungal degradation process are that the substrate does not require an alkali or acid chemical pretreatment process nor does a cellulosic residue remain.

A 2-liter pressure reactor was used to produce glucose by an acid-hydrolysis process. The variables investigated at three levels each were contact time, temperature, and acid concentration. Analytical methods have been developed for identifying the glucose, methylhydroxy furfural, levulinic acid, and formic acid produced in the hydrolysate.

PUBLICATION

Rogers, C. J., and T. C. Purcell. Identification of bacteria by rapid spectrophotofluorometric methods. Environmental Science & Technology, 3(8):764-766, Aug. 1969.

PRESENTATION

Rogers, C. J., and T. C. Purcell. Production of organic compounds from waste cellulose by biosynthesis. Presented at American Chemical Society, 158th National Meeting, Division of Water, Air, and Waste Chemistry, New York, Sept. 7-12, 1969.

FIELD EVALUATION OF SANITARY LANDFILL TECHNIQUES

PROJECT OFFICER: Richard J. Wigh PROJECT: UD-02-69-31

OBJECTIVE: To develop on a pilot scale more efficient land disposal methods that can protect the quality of the environment and provide for utilization of the completed fill surface.

APPROACH: After selecting, acquiring, and laying out the facility, individual cells will be constructed and instrumented to study bulk densities, final usage, structural stability of the fill, gas movement, accelerated decomposition, and water movement. Portions of the related project (UD-03-68-20) will be conducted at this site. The facility will also provide a site for related research in sample-size determination, waste composition, and pathogen survival.

PROGRESS: Land disposal sites throughout the Cincinnati area have been visited or reviewed from the data provided on the 1968 National Survey of Community Solid Waste Practices forms. A site in Boone County, Kentucky, operated by a private collection and disposal contractor, has been selected as the most promising. Local and State health department and zoning approval has been received. Surveying and site development plans have been completed. Determination of sampling intervals, calibration of equipment, and reports on settlement, water quality, and compacted densities have been initiated.

SELECTION AND PLACEMENT OF SOIL COVER MATERIALS IN A SANITARY LANDFILL

PROJECT OFFICER: Norbert B. Shomaker PROJECT: UD-03-68-20

OBJECTIVE: To define and establish criteria for the selection and placement of cover material at sanitary landfills.

APPROACH: A national soil-cover survey was conducted to obtain information on the types and distribution of soil cover now being used at sanitary landfills. Based on the results from this program, sites utilizing different soils were selected where behavior of the soil would be evaluated and those properties of a soil that may be influential in its proper functioning as a sanitary landfill cover material would be determined.

The functions of soil cover have been defined. An analysis of these functions is being performed to determine the necessary tests for studying and separating problems that are either soil- or refuse-dependent. When this is completed, a performance evaluation program will be initiated at some sites where information has already been collected and at others where adequate control can be obtained. Primary attention will be given to depth, compaction procedures, and settlement. Portions of this performance evaluation program will be conducted at the sanitary landfill site to be developed under Project UD-02-69-31 (Field Evaluation of Sanitary Landfill Techniques).

The abilities of specific soils to function adequately as landfill cover material will be compared and evaluated from the results of the laboratory work and field observations. Final criteria and guidelines will be prepared regarding soils, limitations, and construction procedures.

PROGRESS: Small samples were received from 44 landfills throughout the country. Classification tests, including natural moisture content, specific gravity, combined mechanical analysis, and Atterberg limits, have been performed on these samples. These standard laboratory tests were performed for the Bureau by the H. C. Nutting Company under contract PH-86-68-196. Nineteen of the landfills were visited to study placement procedures and to obtain additional information on the geology and compaction characteristics of the soil.

PHYSICAL AND CHEMICAL PARAMETERS AND METHODS FOR SOLID WASTE CHARACTERIZATION

PROJECT OFFICER: Nancy Ulmer PROJECT: RS-03-68-17

OBJECTIVE: To determine and recommend those physical and chemical parameters and methods that should be employed to meaningfully characterize solid wastes before, during, and after processing.

APPROACH: A thorough review of literature dealing with the characterization of solid waste was begun to facilitate the selection of possibly significant parameters. Methods for determining the selected parameters will be developed and evaluated in the laboratory. An assessment of the characterization data obtained will be performed to ascertain the significance of the selected parameters.

PROGRESS: After completing a review of approximately 100 references in literature dealing with solid waste characterization, a tentative list of the physical and chemical parameters of possible significance and a table presenting the range of values for 30 of the parameters were prepared. Biochemical oxygen demand, carbon, hydrogen, nitrogen, moisture, ash, volatiles, and calorific value were selected for initial investigation. Methods for determining the first four have been established in the laboratory, and evaluation procedures for the remainder are in progress.

Seven publications currently in press discuss the significance of the determination of: (1) the biochemical oxygen demand of quench water and the carbon, hydrogen, and nitrogen contents of solid wastes during the development, evaluation, and control of incineration processes; (2) the carbon and nitrogen contents and C/N ratios of solid wastes during the evaluation of composting processes.

The objectives and approach are being coordinated with those of Research Grant EC-00332-01, Standard Test Procedures for

Municipal Solid Wastes (Dr. R. H. Susag, Principal Investigator, University of Florida). Efforts are also being made to enlist university training grantees.

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