United States
Environmental Protection
Agency

Water Engineering Research
Laboratory
Cincinnati OH 45268

Research and Development

EPA/600/S2-87/108 Apr. 1988

EPA

Project Summary

Centralized Management of Small Treatment Plants Using Instruments and Remote Alarms

Irwin J. Kugelman and Michael D. Cummins

Small wastewater treatment plants comprise the majority of the wastewater treatment plants in the United States. They also treat a significant portion of the total flow. The operation of these plants is intermittent with the plant often unattended the majority of time. Such operation can result in failure of the plants. Unfortunately, costs limit the use of increased operator surveillance.

Continuous monitoring of critical equipment and parameters, however, makes it unnecessary for operators to visit the remote sites on a daily basis. Except when critical alarms are identified, trips to each facility can be reduced to periodic (e.g., weekly) operations and maintenance visits. This mode of "circuit rider" operation reduces unnecessary travel between facilities and allows for increased productivity or reduced staffing of operations and maintenance crews.

The U.S. EPA and the County of Cuyahoga, Ohio, cooperated on a field evaluation of this concept. Several low-cost, field-proven sensors were installed at the Richmond Park Terrace Wastewater Treatment plant. These were wired to a programmable logic controller (PLC) and, in turn, to a telemetering system.

The results of the study revealed that a programmable controller provided a flexible low-cost alternative to conventional hard-wired relay electrical control systems and that the automatic dialer provided a flexible alarm system to contact operators by telephone when emergency service is required. The following basic sensor-controller-telephone alarm system was recommended for installation in intermittently or unmanned small treatment plants:

- **Programmable controller,**
- **Automatic dialer,**
- **Pressure switches,**
- **Wet well level indicators,**
- **Chlorine leak detectors, and**
- **Power demand sensors**

The system provided improved operation at the Richmond Park Terrace Wastewater Treatment Plant.

This Project Summary was developed by EPA's Water Engineering Research Laboratory, Cincinnati, OH, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).

Introduction

In the United States, domestic sewage treatment plants with a rated capacity of 1 million gal/day or less represent 85% of the number of plants and treat 15% of the aggregate flow. The operation and maintenance of these small treatment plants and associated lift stations pose a number of unique and difficult problems to the authority responsible for their performance. Because of financial and manpower limitations, these facilities must operate unattended the majority of the time. Undetected mechanical, electrical, or process failures can result in gross pollution (permit violations), equipment and property damage, and public complaints.

The application of remote monitoring of critical equipment components and operational parameters can help alleviate many of these problems. Continuous monitoring of critical equipment and parameters make it unnecessary for operators to visit the remote sites on a daily basis. Except when critical alarms are identified, trips to each facility can be reduced to periodic (e.g., weekly) operations and maintenance visits This mode of operation reduces unnecessary travel between facilities and allows for increased productivity or reduced staffing of operations and maintenance crews. When a failure or malfunction is recognized, the cause of the alarm can be diagnosed from the central monitoring site and appropriate action taken, whether it be the immediate dispatch of a repair crew or logging for maintenance at the next scheduled visit to the plant. This immediate identification of alarms significantly reduces the time needed to respond to plant problems and minimizes damages to plant equipment. This reduced response time should improve reliability of the plant and lead to improved effluent quality overall.

Wastewater Treatment Plant

A low-cost sensor controller and telemetering system was installed and evaluated at the Richmond Park Terrace WWTP, a 198,000 gal/day design capacity extended aeration package facility. Located in the city of Richmond Heights, Ohio, the plant serves an apartment complex with a total of 720 units and a convenience shopping center.

The plant consists of sewage comminutor and wet well with an adjacent lift station, three parallel extended aeration tanks with final settling tanks, a chlorine contact tank, and a sludge holding tank. The lift station has a duplex pumping system consisting of two Gormann-Rupp Model 14 CZ pumps*, each with a capacity of 300 gpm at 24 ft of head.

The wastewater, after comminution, is pumped to a flow splitter box. From there, it flows by gravity to three rectangular steel aeration tanks, each with a capacity of 66,000 gal. Aeration is provided by four Roots-Connersville blowers, each capable of delivering 300 ft^3/min of air. The aeration tank detention time is 24 hr after aeration; the mixed liquor solids are settled in the final clarifier at a minimal overflow rate of 300 gal per ft^2/day. The overall detention time in the settler is 4 hr.

The clarified effluent then enters a chlorine contact tank with 30 min contact time. Chlorine is fed to the tank by a manually set solution feed chlorinator with a capacity of 200 lb/day. After chlorination the effluent flows through a 90° V-notch weir, with its float mechanism signal transmitted to a totalizer/recorder, into a manhole discharging to a creek ultimately flowing into Lake Erie.

Remote Monitoring System

The sensors selected for evaluation and their alarm functions in the remote monitoring system are shown in Table 1. The sensors included personnel safety and security monitors as well as process and equipment monitors. The sensor monitoring and the alarm response system used a Texas Instruments Model 5TI programmable logic controller and a Butler National Corp ADAS II automatic dialer to initiate alarm messages by telephone. The total estimated cost of the experimental system including sensors and installation supplies was $18,961 with an estimated 732 labor hr for installation.

The sensor selection was oriented toward a basic low-cost monitoring concept capable of providing an alarm at a central site that would detect impending plant upset and/or mechanical breakdown. An important objective of the evaluation was to assess which of the sensor alarms were desirable for monitoring and controlling circuit rider operation of small extended air package plants. Remote process control was not considered for this system. The programming approach for the alarm functions and the results of the application of the system are described in the report.

Conclusions

The results of the study produced the following conclusions:

- Programmable controllers provide a flexible, low-cost alternative to conventional hard-wired relay electrical control systems for small package plants.
- An automatic dialer provides a flexible alarm system to contact operators by telephone when emergency service is required at unmanned remote facilities (package plants or lift stations). In conjunction with a programmable logic controller, an automatic dialer provides the capability to identify alarm signals according to type of emergency, priority for service, and/or location of the problem.
- A priority ranking has to be established for sensor signals to distinguish emergency conditions that justify immediate operator response from long-term problems where the required service can be scheduled through normal channels. For the Richmond Park Terrace WWTP demonstration, the following were selected as high priority alarms:

a. Wet well level high (influent pump failure),

b. Wet well level low (influent pump loss of prime),

c. Possible loss of phase in power supply,

d. Low air pressure at aerator (air leak, blower failure, or power outage),

e. Low air pressure at manifold (blower failure or power outage),

f. Not enough blowers on (blower failure or power outage),

g. Break in,

h. Fire, and

i. Chlorine leak.

The following sensor signals were specified as lower in priority, indicated possible need for scheduled maintenance.

a. Bearing temperature too hot (impending bearing failure on a pump, blower, or driving motor).

b. Sludge blanket level high in final clarifier.

c. High air pressure at manifold (pressure buildup, due to sludge deposits in the diffusers).

d. Comminutor failure.

- Monitoring for air pressure can detect alarm conditions for low pressures due to power outage, or leaks in the air distribution system. It also detects patterns of slowly increasing air

*Mention of trade names or commercial products does not constitute endorsement or recommendation for use.

Table 1. Monitoring Sensors for Small (Package) Wastewater Treatment Plants

Location	*Sensor Type*	*Protect Against*
Gates and Doors	*Security*	*Intruders, Vandalism*
Buildings	*Smoke*	*Fire*
Chlorine Room	*Chlorine Leak Detector*	*Hazardous Atmosphere*
Lift Station Wet Well	*Low Level* *High Level*	*Loss of Pump Prime* *Flooding*
Lift Station Pumps	*High Bearing Temperature* *Power Demand*	*Loss of Lubrication* *Power Outage*
Blowers	*Low Pressure* *High Bearing Temperature* *Power Demand*	*Leak in Air Headers* *Loss of Lubrication*
Clarifiers	*Sludge Blanket Level*	*Washout of Sludge*
Return Sludge Pumps	*High Bearing Temperature* *Power Demand*	*Loss of Lubrication* *Power Outage*
Sludge Scraper Drive	*High Torque* *Power Demand*	*Motor Overload* *Power Outage*
Aeration Tank	*Dissolved Oxygen, Low DO Alarm*	*Shock Load Oxygen Demand*
	Dissolved Oxygen, High DO Alarm	*Excessive Blower Power*
Settling Tank	*Sludge Blanket Detector, High Level Alarm*	*Loss of Activated Sludge Solids by Hydraulic Washout or Bulking*
Chlorine Contact Tank	*Residual Chlorine High Level Alarm*	*Excessive Chlorine Usage*

pressure, which indicate a need for cleaning of diffusers.

- Phase sequence monitors provide low-cost and effective means to detect conditions of no power to a three-phase motor for blowers or pumps. They can also detect phase loss in the electrical distribution system, and thereby avoid considerable potential damage.
- Monitoring for the bearing temperatures using externally mounted thermocouples can show impending bearing failure as a pattern of slowly but steadily rising temperatures relative to local ambient conditions.
- Ultrasonic sludge blanket detectors, although free from fouling by biological growth, may not be sufficiently accurate for use in controlling biological waste treatment systems.
- Based on the results obtained, the following basic sensor-controller-telephone alarm system was recommended for installation in package plants:

a. Programmable controller,

b. Automatic dialer,

c. Pressure switches,

d. Wet well level indicator,

e. Chlorine leak detector, and

f. Power demand sensors.

The cost of the recommended basic system including installation supplies was $10,994 with an estimated 360 labor hr need for installation.

The full report was submitted in fulfillment of Grant No. R-806333-01 to Cuyahoga County under the sponsorship of the U.S. Environmental Protection Agency.

Irwin J. Kugelman is now with Lehigh University, Bethlehem, PA 18015; and the EPA author, **Michael D. Cummins**, is with the Technical Support Division, Office of Water, Cincinnati, OH 45268.
Walter W. Schuk was the EPA Project Officer (see below for present contact).
The complete report, entitled "Centralized Management of Small Treatment Plants Using Instruments and Remote Alarms," (Order No. PB 88-147 798/AS; Cost: $14.95, subject to change) will be available only from:

National Technical Information Service
5285 Port Royal Road
Springfield, VA 22161
Telephone: 703-487-4650

For further information, **Dolloff F. Bishop** can be contacted at:

Water Engineering Research Laboratory
U.S. Environmental Protection Agency
Cincinnati, OH 45268

United States
Environmental Protection
Agency

Center for Environmental Research
Information
Cincinnati OH 45268

EPA/600/S2-87/108

0000329 PS

U S ENVIR PROTECTION AGENCY
REGION 5 LIBRARY
230 S DEARBORN STREET
CHICAGO IL 60604