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A Proposed Approach to Protect Wastewater Biological Treatment Plants Against Toxic Contaminants

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A PROPOSED APPROACH TO PROTECT WASTEWATER BIOLOGICAL TREATMENT PLANTS AGAINST TOXIC CONTAMINANTS

BY

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I. THE PROBLEM

Today the majority of municipal secondary wastewater treatment plants in the United States utilize some form of biological treatment, the two most common forms being trickling filters and activated sludge systems. But the bacterial action is subject to a reduction or even cessation due to the presence of toxic substances in the wastewater.

As. W. Wesley Eckenfelder, Jr. said, "Since a one-shot dose of certain toxic materials can completely upset a biological treatment process, . . ." (1), it would be desirable for operators of such systems to be able to safeguard their systems against being subjected to such conditions.

However, in most texts on wastewater treatment, sewage systems, etc., the only mention of the subject is normally a statement to the effect that toxic materials should not be allowed to enter the wastewater collection system!

This certainly is an ideal solution but is not always achievable nor is an acceptable answer to an operator with toxic substances already affecting his biological treatment facilities.

On the other hand, some texts ignore the problem to the extent that the words toxicity or toxic materials do not even appear in the index or table of contents (2). The situation was perhaps best summarized by an observation in the Water Pollution Control Federation Journal (3) as follows:

Information Gap On Toxic Metals Noted. A recent University of North Carolina Workshop on the presence and effects of toxic metals in water underscored the need for more information on this subject. The conference, which was sponsored by the Water Resources Research Institute and included industrial, public, and academic representatives, was concerned primarily with the status of knowledge relating to North Carolina waters. But the conclusions were basic enough to have broad implications: present monitoring programs are unsatisfactory; sufficient information on toxic metal use is unavailable; there is no coordination point for information; and maximum safe limits for drinking water are unknown.

Although agreeing that the subject of toxic materials in wastewater has been neglected, ignored, or just "swept under the carpet," a search of the literature has been conducted in an attempt to gain some insight into the problem and hopefully to suggest some steps that might lead to a solution to the problem.

II. TOXIC LEVELS

Almost all references to toxicity levels in the literature are concerned with survival of small fish in flowing streams. However, a few levels of toxicity for bacteria found in trickling filters and activated sludge systems were found and can give an indication of the toxic level for a particular combination of bacteria at one point in time for that observed system.

TABLE 1

Material	Toxic Level	Remarks
Cyanide	0.5 mg/l	Severe inhibition (4)
Mercury	0.1 mg/l	Some biological inhibition (5)
Mercury	>0.2 mg/l	Essentially no oxygen uptake (5)
Copper	5 mg/l	Slight inhibition (5)
Copper	10 mg/l	Complete retardation (5)
Chromium	0.5 mg/l	Somewhat inhibitory (5)
Chromium	≥1.0 mg/l	Very toxic (5)
Chromium	<50 mg/l	No significant reduction in efficiency, in pilot scale activated sludge plant (6)
Phenols	high concentration	Completely knock out bacteria (7)

Also, some general statements on toxicity were found, such as: "Copper-bearing wastes are biologically toxic, precluding biological methods of treatment in the handling of these wastes" (8); "Toxic compounds and metals may be present in sewage, especially industrial waste. These include phenols and aldehydes as well as hexavalent chromium, copper, cadmium, tin and nickel. Above certain thresholds, they are toxic to bacteria. . ." (9); "Due to the large number of variables encountered in such tests, no limits for precision and accuracy are given." (10); "Specially adapted bacteria can metabolize the phenols, but it is best to avoid use of phenols." (11); and "Heavy metals exhibit a toxicity in ow concentrations to biological sludges." (12); "Among the toxic organic compounds are the pesticides used to kill insects, rodents and weeds." (13).

III. APPROACH TO SOLUTION

The levels of toxicity certainly point out that the standard solution to this problem, i.e. don't let it get into the collection system!! would be nice but we have acknowledged the possibility of the occurrence of toxic materials in the wastewater. But what about the approach of not letting the liquid waste containing the lethal (to bacteria) concentration of toxic material enter the treatment plant except under programmed conditions?

If the presence of greater than desired levels of toxic materials can be detected at a point sufficiently far enough upstream from the treatment plant, the influent to the plant could be diverted to a holding tank or pond. The diversion would continue until the concentration of toxic material was below the minimum desired level.

It is a recognized fact that the most desirable method of operating a waste treatment plant is at a constant flow, (14) and this diversion of flow for some period of time violates that concept. However, after flow was resumed, the bacteria would still be alive and able to resume their work rather than being dead as a result of the continuous flow carrying the toxic substances to them.

After diversion to the holding tank or pond, tests would be made to determine the specific toxic material and its concentration. When this determination is completed, there are three courses of action which might be followed.

The simplest is to mix the toxic waste with the normal waste water influent to the treatment plant at a rate which dilutes it to a level at which the bacteria can assimilate it during the regular method of treatment.

The second course of action which might be followed in the case of a toxic substance which is not amenable to the treatment method normally employed, is that the course of treatment might be modified to one more suited to treatment of that particular toxic substance. An example of this would be for cyanide containing wastes which cannot be treated in sludge tanks since the organisms involved cannot exist in the relatively violent conditions in the tank. However, these wastes can be treated in a slow rate filtration process (15).

The third possible course of action would be resorted to if the toxic waste is determined to be one which it is not desirable to subject the plant to at any level. In this case, the waste could be disposed of by hiring a firm which specializes in picking up and treating toxic materials in a specialized plant (Example: Hyon Waste Management Services, Inc.).

Each of these three approaches requires more effort, time and money than just sitting back and letting the toxic waste enter the treatment plant. But the important thing is that the bacteria are <u>now</u> still alive and the plant will not be out of operation for several days or weeks while the daily quota of untreated sewage and wastewater continues to arrive at the plant for treatment.

IV. RECOMMENDATIONS

Determine Toxicity Levels for Particular Bacteria

The bacteria in the biological treatment facilities of each plant are a unique mixture existing only at that plant. The particular combination is determined primarily by the composition of the wastewater influent to the plant. Therefore, each plant must determine the toxicity levels of its bacteria to each toxic material. Different treatment plants will have different toxicity levels. For example, notice the different levels of toxicity reported for chromium in Table 1. The levels should be re-determined periodically in order to stay abreast of any change in the influent wastewater.

Obtain Instrumentation to Monitor and Detect Toxic Materials

The instrumentation is the key to the whole situation. It must be capable of operating unattended for long periods of time protected against a variety of ambient field conditions. Hopefully it should be low cost, as simple as possible, rugged and maintenance free.

Unfortunately, most of the instruments which are used to detect levels of toxicity are too complicated or too slow (up to seven days for some methods) to be used for this application.

Hopefully, this may soon change. A U. S. Department of the Interior report recently recommended that "studies be initiated to devise improved field detection techniques with high detection sensitivities for those substances which cannot presently be detected at critical concentration levels" (16). Also, a recent magazine article reported on ratings of laboratory analytical methods for water pollution. These ratings showed that automated methods for metals (atomic absorption and emission spectroscopy), and ions (coloremetric and specific electrodes) and a partially automated method for pesticides (gas chromatography) are now available (17). Perhaps these will be further developed to the point that they can meet the requirements for monitoring detection devices.

At the present time, Technicon Industrial Systems of Tarrytown, New York markets an Autoanalyzer II system which they report can be adapted for monitoring water pollution. Perhaps this system can be adapted to meet the requirements for a monitoring-detection device of toxic materials.

Install Holding Tanks or Ponds

After it has been determined that suitable instrumentation can be obtained, adequate holding capacity for the wastewater contaminated with toxic materials should be installed.

One economical approach to this might be the use of a pit or a lagoon formed by an earthen dam, lined with a synthetic rubber. The Carlisle Tire and Rubber Division of the Carlisle Corporation advertises Sure-Seal Elastomeric Membranes and Sure-Seal Rubber Membrane for application of this type (18). Of course, for installations storing toxic materials, the lagoon, holding basin, etc. should be surrounded by a suitable fence.

Modify Plant for Alternate Methods of Treatment

When the plans have been completed for the holding tanks or ponds, the treatment plant itself should then be modified to allow alternate methods of treatment. These might include a slow rate trickling filter for use with cyanide waste in place of the activated sludge stage. Or perhaps, the Bio-Carb process of International Hydronocs Corp. could be used in place of either the activated sludge or trickling filter stage. It is described as "particularly useful for treating constituents which are toxic to organixms at moderate concentrations but degradable at low concentrations" (19). Figure 1 shows a plant with all three systems in parallel thus allowing any one of the three to be selected.

Contract for Disposal of Untreated Wastes

After it has been determined what toxic wastes and at what concentration can be treated by the wastewater treatment plant, provisions should be made for treatment and disposal of those wastes which it is not desirable to subject the treatment plant to. One example of these would be cyanide wastes in event of a decision not to provied an alternative to the activated sludge method of biological treatment.

One approach to disposal of untreatable wastes would be to contract for their removal and treatment by one of the companies which specialize in this service (20). One side benefit of this approach might be that in the event of identifying the source of the toxic waste, a major portion of the cost of dealing with it would be on record and scarcely debatable.

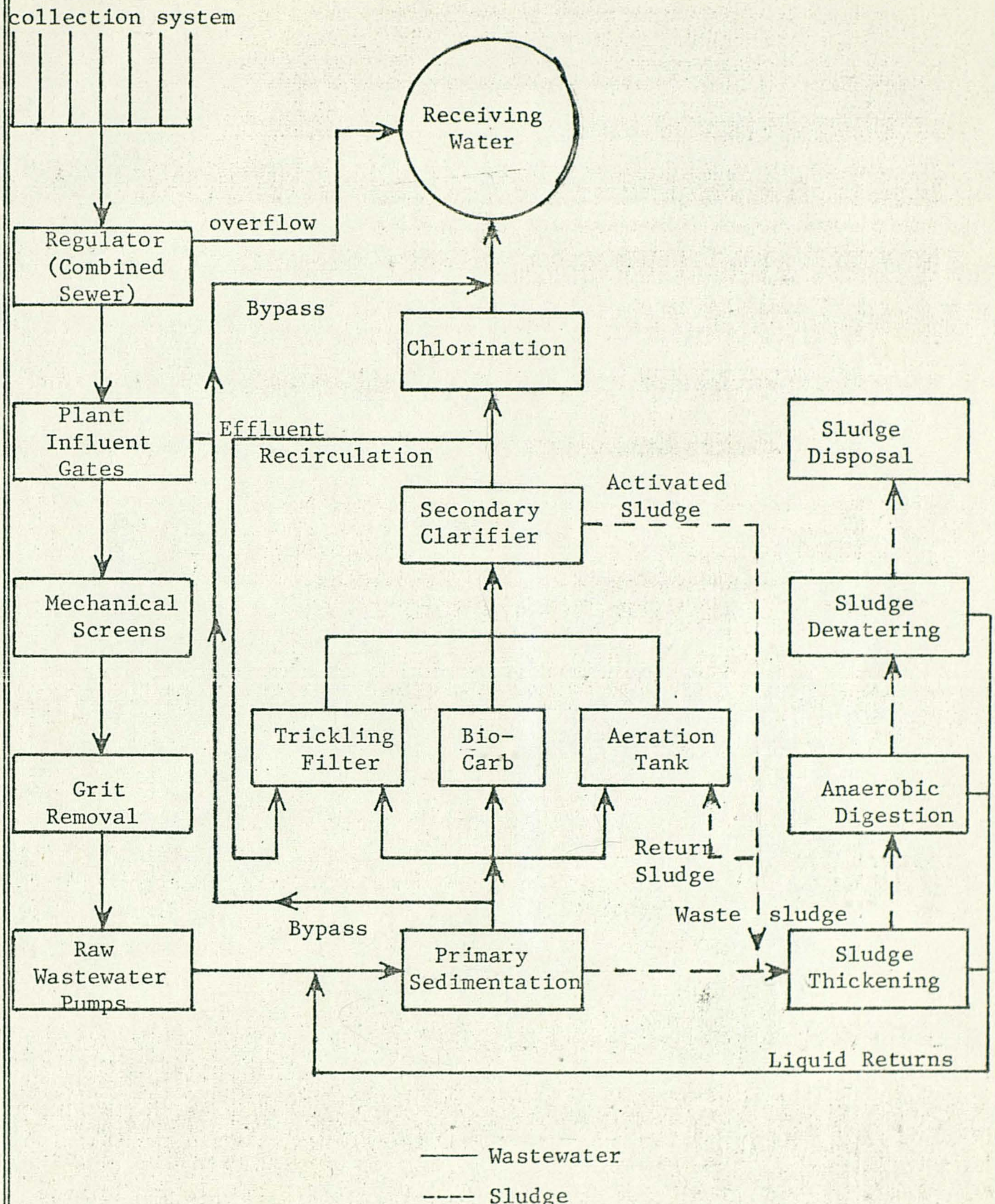

Figure 1.--Common Processes in Secondary Wastewater Treatment

Installation

Once the plant modifications and the construction of the holding tanks or ponds are completed, the monitoring-detection instrumentation should be installed. When these installations are completed and checked out, there remains only two things to do.

Schedule Maintenance and Toxicity Level Redetermination

A preventive maintenance and re-calibration schedule should be established for the monitoring-detection instrumentation. Other portions of the system should be integrated into the regular maintenance schedule of the treatment plant.

Also a program should be initiated to periodically redetermine th the toxicity levels for each toxic contaminant which is being monitored. Any significant changes should be reflected in a new detection level for the instrumentation monitoring that contaminant.

Review Instrumentation Market Periodically

The final step is to periodically review the instrumentation market to determine if any device has been developed or modified to detect any toxic contaminant which is not being monitored by the current system. Of course, any new devices which are available at an acceptable cost should be purchased and incorporated into the system.

V. CONCLUSIONS

The adoption of the system described in this report will protect the biological system of the treatment plant against the particular toxic contaminants for which it is possible to obtain monitoring detection instrumentation.

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