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Facility for the Biological Treatment of a Complex Chlorophenolic Waste - A Preliminary Report

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A Facility For The Biological Treatment Of A Complex Chlorophenolic Waste

(Preliminary Report)

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ABSTRACT

The City of Jacksonville, Arkansas, is attempting to determine if aeration of a combined domestic sewage — chlorophenolic herbicide waste prior to release into conventional waste stabilization lagoons will be useful in the microbiological oxidation of chlorophenols and chlorophenoxy acids.

Discussion

Industrial waste entering the Jacksonville, Arkansas sewage treatment facility arises from the manufacture of the hormone-type herbicides 2,4-dichlorophenoxy acetic acid (2,4-D) and 2,4,5-trichlorophenoxy acetic acid (2,4,5-T). The waste consists principally of a mixture of chlorophenols and chlorophenoxy acids, and is chemically adjusted to approximately pH 7.0 prior to release from the manufacturing plant.

Consulting engineers concluded that a mechanized aeration basin or lagoon might be useful in the biological degradation of the chlorophenolic portion of the total waste complex. Such an aeration basin was subsequently constructed, and located so as to permit aerating the total flow of the system prior to release into the two existing 22-acre waste stabilization (oxidation) lagoons. With this method, wastes could be aerated before transfer to the stabilization lagoons, and (hopefully) hydraulic and organic overloading of the stabilization lagoons could be avoided. The assumption that this treatment method would promote the bacterial degradation of the chlorophenolic industrial waste was based upon published (1,2,3,6) and private communications (4,5).

The aeration lagoon and its relationship to the original sewage treatment plant and stabilization lagoons is shown in Fig. 1. The aeration lagoon has a 3 to 4 day detention time for an average flow of 2.5 MGD. The lagoon measures 213 ft. by 768 ft., and has a capacity of 8.4 MG at an operating depth of 11.5 ft. The aeration equipment consists of four floating type units positioned in tandem in the long dimension of the lagoon. Each aeration unit consists of a rotating element, 8 feet in overall diameter, made up of 32 cupped steel blades, powered by a 75 HP electric motor. Each unit is supported by a circular, fiberglass, doughnut-type raft, anchored to the lagoon levees by means of cables. Water picked up by the blades of the units is broken up into many sheets and droplets, serving to effect transfer of oxygen to the water at varying rates subject to temperature, atmospheric pressure, and degree of saturation of the water with oxygen. The oxygenation capacity of each aerator can be varied from a minimum of 166 pounds per hour to a maximum of 249 pounds per hour by changing the depth of flotation, and hence that of blade immersion. This is accomplished by the addition of water to (or removal from) each pontoon.

It was agreed that biological, chemical, and hydraulic data should be collected before the aeration system was installed, and these data compared with data obtained during a twelve-month period immediately following completion of the aeration system. The biological study included investigations of the factors that influence the removal of chlorophenolics by the biological system of the treatment plant, and a study of the organisms in various parts of the treatment system and receiving waters. The chemical study included the choice of suitable methods for the identification and determina-

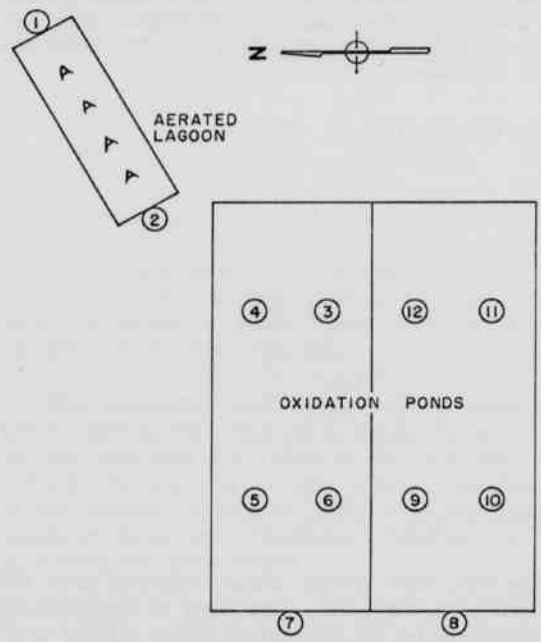

FIG. 1

BIOLOGICAL STUDY
SAMPLING POINT LOCATIONS

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tion of the chlorophenolics encountered and, where feasible, to apply the methods to determine the relative rates of biochemical degradation. The hydraulic study was to obtain necessary quantity and quality data of the various wastes flowing into the sewage treatment plant including the effluent of the industrial plant and the waste waters within the plant, to permit better evaluation of the project. The overall project study was to permit evaluation of the feasibility and performance of the joint treatment of herbicidal-domestic waters, and pollution abatement of receiving waters as a result of this treatment. Since the biological study was carried out by the writer, this paper will be concerned primarily with that aspect of the project.

PROCEDURES

Time Period Covered

A preliminary biological survey was carried out during the summer of 1968, prior to construction of the aeration system. Following completion of the system, biological sampling and analyses were carried out during the period of June 6, 1969 until June 29, 1970. Approximately 100 samplings at each of 12 sampling points were made during this time, which included four seasonal intensive sampling periods of two weeks each, during which samples were taken at all sampling points each day. At other times weekly samples were taken at all twelve points.

Sampling Procedure

The aeration lagoon was sampled at the influent and effluent on each sampling day. Five samples were taken at each oxidation lagoon during each sampling day: four at grid points, and one at each effluent (Fig. 1). Water and air temperature, pH, and dissolved oxygen values were determined at all sampling points at the time of sampling. All samples were analyzed for total and fecal coliform bacteria and for plankton organisms. Intermittent bottom sampling produced virtually no benthic organisms.

Analytical Methods

Plankton. Plankters were identified and counted by means of a Sedgwick-Rafter all-glass counting chamber. Most plankton samples were of such a density as to require no concentration; but those which did require it were concentrated by passing the water sample through a membrane filter of pore size 0.45 μ. Total chamber counts were made, and the appropriate concentration factors applied whenever necessary in order to determine the number of organisms per liter.

Coliform Organisms. Total coliform counts were obtained by the familiar membrane filter procedure. Three filtrations of each sample (0.1, 1.0, and 10.0 ml) were made, and the average number of coliform organisms per 100 ml water sample obtained by noting the number of colonies exhibiting a "golden sheen" that grew during each incubation, converting this to numbers per 100 ml, and then averaging the counts for the three dilutions.

Counts of fecal coliform organisms were obtained in a manner similar to that employed for total coliforms, with notable exceptions. Difco mFC BROTH BASE was used, and the medium rehydrated by suspending in distilled water and adding 1% rosolic acid solution according to the directions of the manufacturer of the medium. Membrane filters through which water samples had been passed were encased in small water tight petri dishes and incubation carried out by submerging the dishes in the inverted position in a water bath maintained at a temperature of 44.5°C $\pm$ 0.5°C for 24 hours. Dark blue colonies are indicative of fecal coliform organisms, and averages per 100 ml were obtained as in the method for enumerating total coliform bacteria.

pH. Determination of pH was made immediately upon sampling by employing a Hach Model 1975 battery-operated pH meter, calibrated frequently by means of standard buffer solutions.

Dissolved Oxygen. Dissolved oxygen in parts per million and water and air temperatures in degrees centigrade were obtained as soon as each sample was taken, by means of a Model 54 Oxygen Meter (battery operated), manufactured by the Yellow Springs Instrument Company. The meter was calibrated periodically against the Winkler method for the determination of dissolved oxygen.

Conclusions

Data accumulated during the preliminary survey and during the twelve-month period of sampling following completion of the aeration system have not yet been released for publication by the Arkansas Pollution Control Commission and the City of Jacksonville; therefore, no firm conclusions as to the efficiency of the treatment method under discussion can be presented at this time. However, the following general statements can be made:

1. Removal of chlorophenols by the aerated lagoon alone ranged from 55 to 89%, while the overall removal of chlorophenols by both the aerated lagoon and stabilization ponds ranged from 87 to 94%.

2. Removal of chlorophenoxy acids was less than that of chlorophenols, ranging from approximately 30 to 70% within the lagoon and 49 to 80% by the lagoon and oxidation ponds.

3. During plant operation, the average BOD_5 was 15 mg/1; chlorophenols, 0.1 mg/1; and chlorophenoxy acids, 1.1 mg/1.

4. There appeared to be no significant change in pH or dissolved oxygen values or in types or numbers of plankton organisms one year after operation of the aerated lagoon was instigated.

5. The reduction in numbers of coliform organisms is quite good at the stabilization lagoon effluents, the picture of coliform density adhering quite closely to what one would expect in a "normal" system, exhibiting high summer counts, low winter counts, and intermediate spring and fall counts.

References

1. Mills, R. E., "Development of Design Criteria for Biological Treatment of an Industrial Effluent Containing 2,4-D Waste Water," Report of 14th Industrial Waste Conference, Purdue University, Lafayette, Indiana, pp 340-358 (1959).
2. Faust, S. D., and Aly, O. M., "Studies on the Removal of 2,4-D and 2,4-DCP From Surface Waters," Report of 18th Industrial Waste Conference, Purdue University, Lafayette, Indiana, pp 6-8 (1963).
3. Ingols, R. S., Gaffney, P. E., and Stevenson, P. C., "Biological Activity of Halophenols," Journal Water Pollution Control Federation, pp 629-635, April 1966.
4. "Waste Water Study for Hercules Powder Company, Jacksonville, Arkansas Plant," conducted by Department of Environmental Science, Rutgers University, Brunswick, New Jersey, September 6, 1963.
5. A. W. Bush, Consulting Engineer, Houston, Texas, "A Study of Chemical and Biological Oxidation of a 2,4-D Waste Water," September 1963, report prepared for Hercules Powder Company.
6. Geldreich, Edwin E., Clark, Harold F., Huff, Clifton B., and Lois C. Best. "Fecal-Coliform-Organism Medium for the Membrane Filter Technique," Journal American Water Works Association, pp 208-214, Feb. 1965.
7. "Special Survey in Upper Bayou Meto Basin — 1967," report of the Arkansas Pollution Control Commission.

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Studies of Arundinaria: Experimental Induction of Flowering and Additional Observations in the Field

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ABSTRACT

Arundinaria has been observed for three successive seasons at a site near Amity, Arkansas. In advance of the 1971 flowering period rhizomes were taken from the field, pruned, and placed either in an environmental chamber or in the greenhouse in water or in sandy soil. Flowering occured under each condition, but was most rapid and profuse in transplants growing in sandy soil in the greenhouse. Observations point to the possibility of induction of flowering or to the possible existence of an annually flowering race. Possible economic uses are considered.

In my first paper on the flowering of our native bamboo, **Arundinaria gigantea** (Walt.) Muhl., it was pointed out that this event is of infrequent occurence according to the literature (Marsh 1970). My interest in this phenomenon was stimulated by the account of Fernald and Kinsey (1958, p. 91-2) on the use of the grains as food.

McClure (1966, chapters 2 and 6) has extensively discussed the problems presented by the irregularity in the flowering and fruiting of many of the bamboos. Clayton (1965) stated that although periodicity in bamboos may not differ in principle from that in annual plants, the long cycle involved discourages serious experimental work.

Two well-known botanists of Arkansas, Dr. Delzie Demaree and Dr. Dwight D. Moore have both told me that over the years the flowering of **Arundinaria** has rarely been observed. Dr. Demaree also told me that Dr. E. J. Palmer (deceased) had long sought the flowering plants in the field and considered the occurence to be quite rare.

Since 1967 I have continued to observe the flowering of cane in widely scattered locations in Arkansas. Attention has been especially directed to a site along the Caddo River north of Amity in Clark County. Heavy flowering was first observed in the Amity site on the south side of the river in the spring of 1969. Floriferous culms died during the summer following flowering.

In the spring of 1970 flowering was observed in the same site and on a later trip, flowering was found in a canebrake on the north side of the river. The presence of old dead culms indicated that flowering had probably occurred on the north side in 1969 also.

Profuse flowering was found again on both sides of the river in 1971. In contrast to the previous two springs, a considerable amount of fruit was observed to form and shed out on the ground. Insect attack was