Pilot plant used for the Piscataway, Md., experiments.

CUT P FOR LESS MONEY

By G.J. Topol, G.V. Levin, and A.G. Tarnay

Biological process may produce big savings in chemical costs.

WANT TO REMOVE phosphorus for less money?

You can always use direct addition of chemicals to wastewater to remove phosphorus. However, the cost of chemicals and the costs associated with the disposal of additional chemical sludge are relatively high. For this reason, the possibility of using a biological method compatible with the activated sludge process has been explored as a means to reduce phosphate removal costs.

Several pilot plant tests were conducted at different locations with the PhoStrip biological process for phosphorus removal. The results indicate the possibility of more than a ten-fold reduction in chemical cost over existing methods.

The process is based on the ability of microorganisms to take up phosphorus under aerobic conditions and to release it under anaerobic conditions. The basic steps are:

1. In the aeration tank, wastewater is mixed with phosphorus-depleted return sludge. The aerobic environment induces the microorganisms to take up the phosphorus from wastewater. This results in essentially phosphorus-free effluent and phosphorus-enriched return sludge.

2. The return sludge stream is exposed to a period of anaerobic detention in a phosphate stripping tank. During this period, the microorganisms release phosphate in concentrated form which can be consequently precipitated with a minimal amount of chemicals. The sludge, being phosphorus-depleted, is returned to the aeration tank and is again ready to take up the phosphorus from incoming sewage.

The principal advantage claimed for this process is low operating cost. A still further, significant saving in operating cost has been achieved along with a reduction in capital cost for the process. The key innovation is the "split flow return sludge" concept.

Figure 1 shows the flow scheme previously used. It is the classical activated sludge process with the addition of the phosphate stripper in which the return sludge is held for phosphate release. The split flow return sludge mode is shown in Figure 2. Here, only a portion of the return sludge is routed through the phosphate stripper.

Phosphorus cut 90%

In pilot plant tests in a Maryland suburb of Washington and in Chicago, the split flow process sustained approximately 90% removals of total phosphorus from municipal sewage, discharging less than 1.0 mg/l total P. At each location, pilot plants were installed at municipal wastewater treatment plants and operated in both the "full flow return sludge" and the "split flow return sludge" modes.

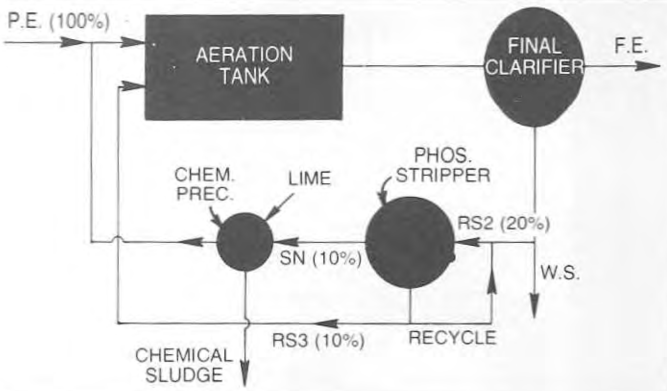
The sewage at the Piscataway plant of the Washington Suburban Sanitary Commission was typical domestic sewage with an average total P of 7.1 mg/l. The full flow return sludge PhoStrip process reduced this to an average of 0.60 mg/l total P. Filtration of the effluent resulted in an average total P of 0.15 mg/l. Results are presented in Table 1. In the split flow return sludge test, only 50% of the return sludge was passed through the phosphate stripper, the remainder being returned directly to the aeration tank. The raw sewage total P averaged 6.6 mg/l for this test period. The final effluent total P was 0.77 mg/l. Filtration reduced this to 0.12 mg/l. Details are presented in Table 2. No impairment in BOD or suspended solids removal over those achieved in the full-scale plant occurred in either test.

Excellent results are produced

The Chicago tests were conducted at the Northside treatment plant of the Metropolitan Sanitary District of Greater Chicago to determine whether the process could meet the Lake Michigan standard of 1.0 mg/l total P. At the time of the test, the ban on phosphate detergents was in effect, but the effluent from the Northside plant consistently exceeded the standard. There was some question as to whether the influent phosphorus concentration might

Mr. Topol is vice president for pollution control; Dr. Levin, president; and Mrs.Tarnay, sanitary engineer, Biospherics, Inc., Rockville, Md.

Reprinted from the October, 1974 issue of WATER & WASTES ENGINEERING



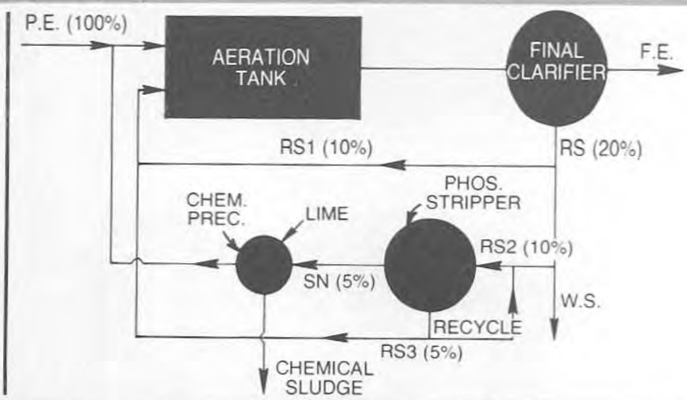


Fig. 1 (left) Classical activated sludge process. **Fig. 2** (right) Split flow return sludge mode.

be too low to sustain the level of metabolism required for efficient phosphorus removal by the biological process. However, the pilot test conducted in the full flow return sludge mode produced the excellent results shown in Table 3. Next, the split flow mode was applied and, as shown in Table 3, the results were equally good. Again, BOD and suspended solids removals compared favorably with those for the full-scale plant.

For one-week during the Chicago split flow test, lime precipitation of the stripper supernatant was conducted continuously in a miniature precipitator connected to the pilot plant. The supernatant flow was 5% of the primary effluent and the lime feed was 400 mg/l as CaO, equivalent to a dosage of 20 mg/l based on the primary effluent flow. The resulting bulk chemical cost was approximately two dollars per million gallons of sewage treated. Comparative cost for tertiary lime treatment or mineral addition to the aeration tank is up to 30 times higher. This saving in chemicals is accompanied by a correspondingly smaller production of chemical sludge, reducing the appreciable solid waste disposal costs associated with phosphorus removal by chemical means.

Economic advantage is claimed

The split flow return sludge mode of the process performs as well as the full flow return sludge mode. However, the innovation reduces the amount of stripper supernatant into which the phosphorus is concentrated to 5% of the total sewage flow. The smaller volume and increased concentration reduce the required chemical dosage. The size of the phosphate stripper tank is also decreased. The savings in operating and capital costs further add to the economic advantage claimed for the biological process over purely chemical processes for phosphorus removal.

The pilot plant test results of the PhoStrip process were recently verified on a full-scale basis at the Seneca Falls, N.Y. Wastewater Treatment Plant. At this plant, the full flow return sludge mode of the process (Figure 1) was demonstrated at one mgd capacity and produced effluent phosphorus concentration of 0.55 mg/l as P and consumed 24 mg/l of lime as CaO. These results are in a very close agreement with those obtained during pilot plant tests of the same mode of operation. A similar full-scale verification is being contemplated for the split flow return sludge process. □ □

1—PISCATAWAY, MARYLAND TEST PHOSPHORUS DATA—FULL FLOW RETURN SLUDGE

Time Period 1972	Raw Waste Total Phosphorus (mg/l)	Final Effluent Total Phosphorus Unfiltered Removal (mg/l)	(%)	Final Effluent Total Phosphorus Filtered Removal (mg/l)	(%)	Final Effluent Orthophosphate (as P) (mg/l)	Stripper Supernatant Total Phosphorus (mg/l)
Jan 19-25	7.9	0.87	89.0	0.13	98.4	0.08	30.0
Jan 26-Feb 1	7.5	0.67	91.1	0.30	96.0	0.16	20.4
Feb 2-8	7.5	0.73	90.3	0.22	97.0	0.21	17.6
Feb 9-15	7.5	0.54	92.8	0.12	98.4	0.07	23.0
Feb 16-22	7.0	0.40	94.3	0.09	98.7	0.04	28.2
Feb 22-29	5.3	0.37	93.0	0.06	98.9	0.02	32.0
Overall average	7.1	0.60	91.7	0.15	98.0	0.10	25.2

2—PISCATAWAY, MARYLAND TEST PHOSPHORUS DATA—SPLIT FLOW RETURN SLUDGE

Time Period 1972	Raw Waste Total Phosphorus (mg/l)	Final Effluent Total Phosphorus Unfiltered Removal (mg/l)	(%)	Final Effluent Total Phosphorus Filtered Removal (mg/l)	(%)	Final Effluent Orthophosphate (as P) (mg/l)	Stripper Supernatant Total Phosphorus (mg/l)
Feb 9-15	7.6	0.82	89.2	0.15	98.0	0.07	48.4
Feb 16-22	7.0	0.83	88.1	0.12	98.3	0.04	58.2
Feb 22-29	5.3	0.67	87.4	0.08	98.5	0.03	56.4
Overall average	6.6	0.77	88.2	0.12	98.3	0.05	54.4

3—CHICAGO TESTS

Parameter	Averages Full Flow Return Sludge	Averages Split Flow Return Sludge
Mixed liquor suspended solids (mg/l)	2,031	2,504
Aeration rate equivalent (ft^3/gal)	0.58	0.59
Detention in aeration tanks (hr)	5.0	5.0
Detention of sludge in phosphate stripper (hr)	7.8	11.3
Total phosphorus in primary effluent (composite sample) (mg/l)	3.0	2.6
Total phosphorus in final effluent (composite sample) (mg/l)	0.27	0.20
Total phosphorus in filtered final effluent (composite sample) (mg/l)	0.17	0.15
Orthophosphate (as P) in final effluent (grap sample) (mg/l)	0.07	0.17
Phosphate stripper supernatant flow (gph)	0.88	0.40
Total phosphorus in phosphate stripper supernatant (mg/l)	21.3	40.3

EDITOR'S NOTE

Biospherics Inc., and Union Carbide Corp. have signed a letter of intent for a license agreement whereby Union Carbide will provide worldwide marketing of Biospherics' Pho-Strip process.