

research and development. But certain types of combined chemical biological treatment systems will also be ready soon, he says.

These findings were among reports presented at the four-State Lake Michigan enforcement conference held earlier this month in Chicago (C&EN, Feb. 12, page 9). Conferences were also the first to hear from Michigan's department of public health on results of tests conducted last year with Dow Chemical involving use of polyelectrolytes for removing phosphates from municipal waste water. Dow also chose the time of the conference to announce its commercial entry into phosphate removal using polyelectrolytes (C&EN, Feb. 12, page 19).

Alkaline removal with lime and adsorption or precipitation with metallic hydroxides are the two common types of chemical treatment for phosphate removal. They can be applied as tertiary treatment or independently as separate treatment for various waste waters. Typical phosphate removal for either type or combination, Dr. Weinberger says, readily exceeds 90%. Along with phosphate removal there is a reduction in turbidity, in biological oxygen demand and chemical oxygen demand, and in bacterial numbers.

The principal advantage today in chemical treatment, Dr. Weinberger points out, is that plant operation can be kept within close control. Moreover, laboratory data will predict dosage levels for particular phosphate residuals as well as settling rates for clarifier designs. A still further advantage is that chemical treatment can be effective even with fluctuations in the preceding conventional processes and should maintain a more uniform effluent quality than other phosphate removal processes.

Dr. Weinberger provides a cost breakdown for a tertiary chemical process treating secondary effluent. Capital amortization on the basis of cost per 1000 gallons varies with plant size, ranging from 0.97 cent per 1000 gallons for a 1-million-gallon-per-day plant to 0.65 cent per 1000 gallons for a 100-million-gallon-per-day plant. Operation and maintenance likewise vary, depending on plant size. For a 1-million-gallon-per-day plant, they would run 0.41 cent per 1000 gallons, and for a 100 million gallon-per-day plant, 0.08 cent per 1000 gallons.

Other costs are constant. Land amortization runs 0.09 cent per 1000 gallons. Cost of sludge disposal by hauling to land fill (25-mile one-way trip) is .67 cent per 1000 gallons.

More than half the total cost is in chemicals. Lime, at 1.75 cents, and iron salt, at 0.87 cent, add up to 2.62 cents per 1000 gallons. However, a significant savings is possible if sludge is recalcined to recover part of the lime. Dr. Weinberger puts the savings at 0.96 cent per 1000 gallons.

Even without recalcination, however, the total comes in at under 5 cents per 1000 gallons. For the 1-million-gallon-per-day plant, the total is 4.76 cents per 1000 gallons. For a 10-million-gallon-per-day plant, it's 4.31 cents; and for a 100-million-gallon-per-day plant, it's 4.11 cents. For normal plant loadings, 5 cents per 1000 gallons (\$50 per million gallons) is equivalent to about 1 cent per person per day.

Two forms of combined chemical/biological treatment can be used. A precipitant such as lime may be added to the primary tank, where it takes out most of the phosphate with some additional removal in the biological phase. Alternatively minerals can be added directly to the actuator tank, causing slightly soluble phosphorus compounds to form and precipitate. In the latter process, Dr. Weinberger says, additives such as aluminum or iron salts cause no interference in the biological activity, and mixing and residence time provided by the aerator are enough for precipitate to form.

One example of mineral addition is a field study completed by FWPCA at the Xenia, Ohio, waste water treatment plant. Using makeshift equipment and adding sodium aluminate at an aluminum-to-phosphorus ratio of 1.8:1, 85 to 92% removal of phosphate was obtained. Normal removal, which the plant returned to following the study, is 20%. The chemical cost for the test, Dr. Weinberger points out, was 5 cents per 1000 gallons, even though equipment was makeshift and conditions were not the most controlled.

Equipment was makeshift at Grayling, Mich., too, where Michigan's public health department and Dow conducted field tests with polyelectrolytes. Tests were started following bench studies that indicated 90% or more of total phosphates could be removed from raw wastes by plain sedimentation with the addition of about 20 mg. per liter of iron as ferrous chloride, an equal amount of sodium hydroxide, and about 0.5 mg. per liter of an anionic polymer.

Iron and caustic, according to the report, were added to the sewage at the lift station with no formal mixing facilities. Polymer was added at the entrance to the settling tank with crude and temporarily rigged mixing equipment. Moreover, the report says, the plant was grossly overloaded hydraulically at that time because of the city's seasonal influx of tourists.