Spectrum

Cheaper, quicker sewage treatment

Mucking about with magnetite one day, Dr Tony Priestley of the CSIRO Division of Chemicals and Polymers made an interesting discovery. Not only could the fine powder adsorb heavy metals, but under some conditions it could also attach itself to most of the organic material in raw sewage.

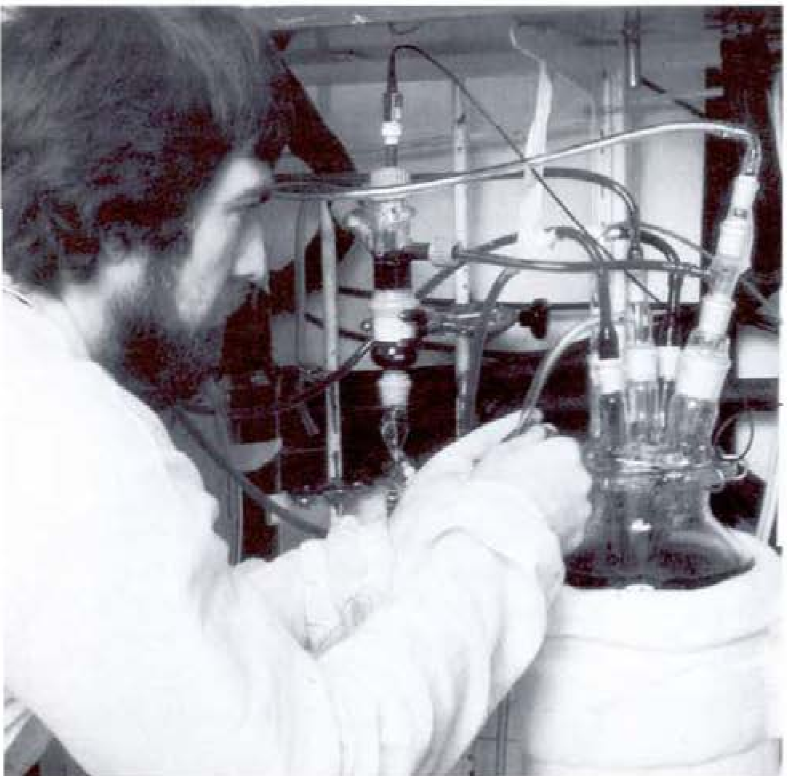
That chance observation has led him and some CSIRO colleagues to develop a promising new way of treating sewage. At present the technique is still at the bench scale, but if successfully upgraded it should result in a radical reduction in the cost of treating sewage. Capital cost could be halved, and the total treatment cost could be two-thirds that of a conventional activated-sludge plant.

Magnetite can clarify raw sewage in about 20 minutes, some 20 times quicker than the conventional technique. A sludge about 40 times more concentrated than raw sewage remains, and this can be speedily digested at elevated temperature in a compact anaerobic digester. The magnetite can be magnetically separated and re-used.

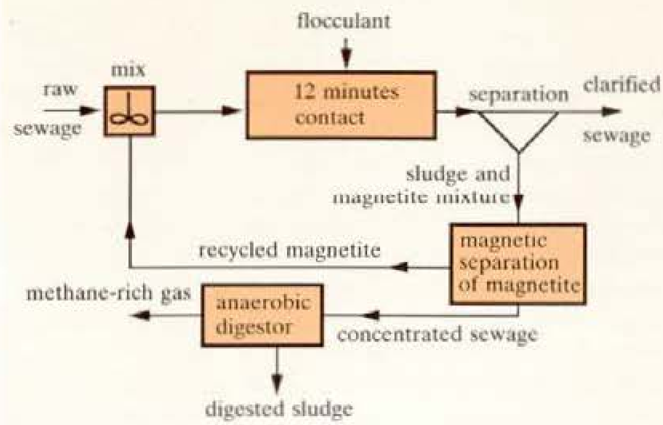
The main aim of treating sewage is to greatly reduce both its biochemical oxygen demand (BOD) and the number of pathogenic organisms. The activated-sludge process (the treatment of choice in urban areas) uses biological oxidation to convert most of the BOD material to biomass, which settles out; it is then thickened to a sludge and stabilised by anaerobic digestion.

Activated-sludge processes can consistently produce a high-quality effluent under a wide range of conditions. However, because of the long time required (a residence time of about 8 hours is typical) and the need for mechanical aeration, activated-sludge plants have high capital and operating costs.

Mr Mark Woods experimenting with a laboratory-scale version of the rapid sewage-treatment scheme.



Speedy sewage treatment



The key to the process is magnetite. Finely divided, it quickly adsorbs organic material from sewage. Being magnetic, it can easily be separated from its organic burden by a magnetic drum separator.

The capital cost of a 38-ML-a-day plant, suitable for a city of 150 000 people, is likely to be near $20 million; a typical operating cost would be about 12 cents per kilolitre of sewage. For a 25-year plant life, that means a total treatment cost of about 34 cents per kL. With growing cities, and more stringent effluent standards, sewage-treatment costs have risen dramatically, and there is a big incentive to find cheaper ways of doing the job.

The 'Sirofloc' process for water clarification uses fine particles of magnetite to rapidly adsorb turbidity and colour from water (see *Ecos* 31). Under the right conditions, it can also take heavy metals out of solution.

While studying this behaviour in connection with cleaning up sewage effluents, Dr Priestley noticed how, under certain conditions, the magnetite collected the organic components as well and formed a floc that soon settled out, leaving clear water. An idea was born.

Dr Priestley has worked steadily on his idea for some 2 years now, experimenting to find the optimum operating conditions. He and his colleague Mr Mark Woods find the best procedure is to mix the raw sewage with the magnetite and adjust the pH with acid. Sometimes, adding a flocculant (a polyelectrolyte) may help to improve final water clarity.

After 10–15 minutes, the effluent is drained off, leaving a sludge-and-magnetite mixture. The water, with a much reduced BOD of 30–50 mg per L and a suspended solids level of 10–20 mg per L, may go to polishing ponds for final treatment before discharge, or could be released directly to ocean outfalls. (As a point of comparison, a litre of raw sewage typically contains about 200 mg of BOD and 75 mg of suspended solids; the figures for a well-operated activated-sludge plant are 20 mg for BOD and 30 mg for suspended solids.)

The magnetite can be stripped from its bound organic material by shaking the sludge with a caustic solution (pH 11). This washing step produces a sewage concentrated about 40 times compared with the starting point.

Anaerobic digestion at elevated temperature is well suited to rich feed materials. Because of the speed of operation, the anaerobic digester required for the concentrated sewage would be appreciably smaller than the sludge digester of a conventional activated-sludge plant.

The aim of anaerobic digestion is to greatly reduce the chemical oxygen demand of the sewage concentrate. At the same time, the process releases methane gas, and this can be recovered and used as a valuable fuel. Conventional anaerobic digesters, such as those used industrially to digest cannery or piggery waste, may be suitable, but the key methane-producing bacteria are fastidious eaters, and conditions have to be right.

Dr David Sudarmana has recently joined Dr Priestley and Mr Woods, and they are currently experimenting with a two-stage digester, in which pre-digestion in the first stage produces the desirable acetic acid and formic acid that the methane-making bacteria, in the second stage, thrive on. Both stages operate at 37°C.

The best experimental set-up so far has operated continuously for 5 weeks, consistently reducing BOD by 70–80% and generating methane at a rate of 240 L per kg of BOD removed.

More work needs to be done, but Dr Priestley is hoping that a pilot plant, capable of treating 100 kL of raw sewage a day, will answer most of the outstanding questions. It is currently being assembled at the Division's Lower Plenty site and should start operating this year.

Andrew Bell

A new way to treat sewage. A.J. Priestley, D.L. Sudarmana, and M.A. Woods. *Proceedings, Chemeca '88 Conference, Institution of Engineers (Australia), Sydney, 1988.*

Sewage treatment combining physico-chemical clarification and anaerobic digestion. A.J. Priestley and M.A. Woods. *Water*, 1987, **14**, 13–15.