Tiny beads remove temporary hardness

This country is rich in many resources, but water isn't one of them. If we are to have adequate supplies of good-quality water in the future, then purification of second-rate water, such as that from bores and brackish streams, will become increasingly important.

Unfortunately, existing purification processes are generally expensive, so the research goals at the CSIRO Division of Chemical and Wood Technology include devising new treatment processes that reduce the cost involved.

Dr Brian Bolto, Mr Bob Swinton, and their colleagues at the Division are looking at ways of accelerating the reaction rates of purification processes so that the size (and cost) of the plant required can be scaled down.

In one approach they are exploring with gratifying success, they speed up the working of ion-exchange resins by making them smaller. They have discovered that tiny resin beads 1–10 μm in diameter can be conveniently handled, despite their microscopic size, if they are given a permanently magnetic core, which causes them to clump together. They then settle quickly, just like large particles, but the beads exhibit the enhanced surface area (and reaction speed) of small ones because the clumps can be broken up when stirred.

This form makes them ideal for use in countercurrent ion-exchange systems, where they must settle against an upward water flow.

Magnetic properties are given to the resin beads by incorporating iron oxide, typically the same sort that is used in audio tape. A strong magnetic field permanently magnetizes the beads at the time of their manufacture.

A related technique is the Sirofloc process for removing colour and turbidity from water, where reagent particles given temporary magnetism (magnetite) undergo clumping (flocculation) at the command of a magnetic field. *Ecos* 31 described the Sirofloc treatment plant, handling 35 ML per day, installed at Perth, W.A.

Permanently magnetized resins have worked well in upgrading water from a limestone aquifer to a quality

Inside the pilot plant.

suited for town supplies. Last year at Singleton, N.S.W., a pilot plant housed in a shipping container removed alkalinity and temporary hardness from bore water at the rate of 65 kL a day.

The 'magnetic dealkalization' process removes temporary hardness, which is due to calcium (or magnesium) bicarbonate. (It's called temporary because it can be removed by boiling, which precipitates calcium carbonate as a scale. Permanent hardness is due to the presence of sulfates.)

Unlike softening, in which the calcium ions causing hardness are merely replaced by sodium ions, dealkalization removes the calcium ions (and an equivalent amount of bicarbonate). Regeneration of the spent resin occurs with sulfuric acid, producing calcium sulfate. After rinsing, the resin is ready for re-use.

The Singleton demonstration, which extended for more than a month, showed that the magnetic process used only about one-sixth the volume of resin (median bead diameter 250 μm) to treat the same volume of water as the conventional fixed-bed process (600-μm beads), alongside which it operated.

The Municipality of Singleton has operated an ion-exchange plant dealkalizing 10 ML a day since 1967, and this uses 7·7 kL of resin. A magnetic equivalent would use less than 2 kL of resin, reducing capital cost substantially.

The major operating cost of dealkalization is the consumption of acid for regeneration. The test plant used acid as efficiently as the installed plant, or slightly more so. Furthermore, the new technique yielded about 95% of product water, compared to the 93·5% typical of its stable-mate.

Best of all, Mr Swinton points out, is that the magnetic process is truly continuous, unlike the batch or semi-continuous operation of other processes. This simplifies the equipment and its operation, and minimizes the work of the operator. No great skill is required to run the plant, suiting it to operation in remote localities, where it will just about run itself.

In a number of townships — particularly in South Australia, western Victoria, and the north-west of the continent — limestone aquifers could be usefully tapped through cheap dealkalization.

With magnetic dealkalization, prior clarification of the water to be treated is not necessary. It is therefore suited to treating slurries and sludges. For example, another application is cleaning up waste water from lime-treated sewage — an earlier pilot plant did just that for a period of 6 months.

While ICI Australia manufactures the resin involved, AUSTEP is responsible for engineering design. The Australian Industrial Research and Development Incentives Board assisted financially in the construction of the demonstration plant, which forms part of the National Water Treatment Systems Development and Demonstration Centre.

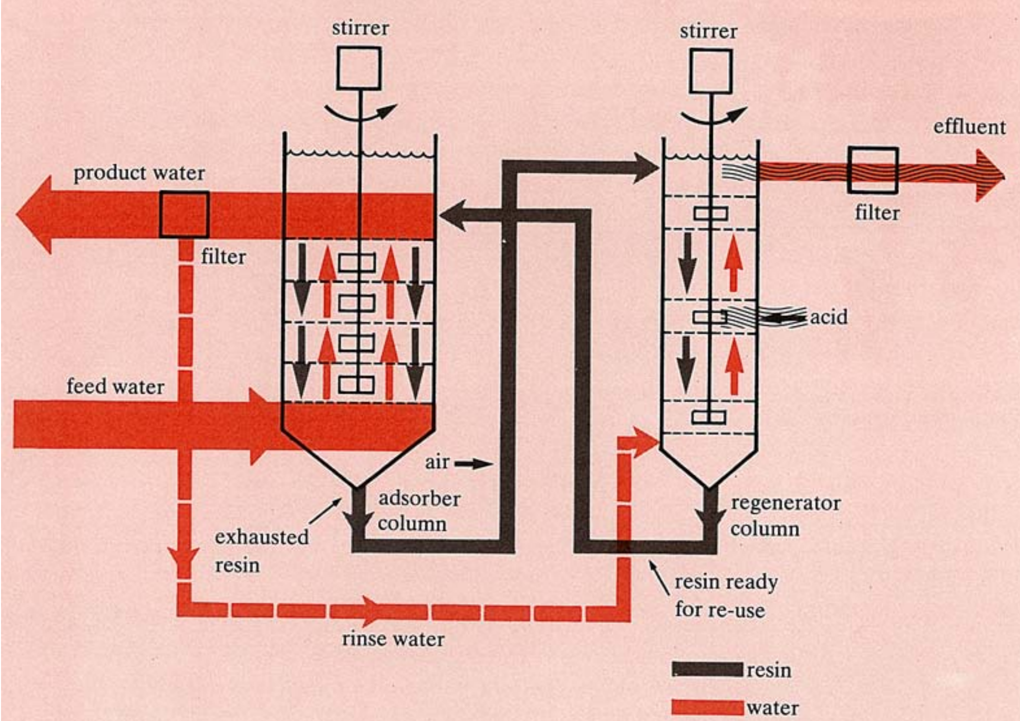
Dr Bolto believes that commercialization of continuous magnetic resin techniques is close at hand, as the concept is applicable to any adsorption reaction. Its special features are particularly relevant to product separation problems in the fields of hydrometallurgy and biotechnology, as well as to water and waste-water purification.

Andrew Bell

Continuous ion exchange using magnetic microbeads — field trials of a transportable pilot plant. E.A. Swinton, P.R. Nadebaum, P. Monkhouse, and A. Poulos. *Technical Papers, Tenth Federal Convention of the Australian Water and Waste-water Association, Sydney, April 1983.*

Development of a multi-stage contactor for magnetic micro-resin applications. E.A. Swinton. *Division of Chemical Technology Research Review,* 1981, 63–72.

How magnetic dealkalization works



Water is purified in the absorber column, and resin is reactivated with acid in the regenerator column. The process goes on continuously.