Recovering metals from industrial effluents

The use of ion-exchange resins to remove metals from industrial effluents is becoming increasingly important for pollution control. It is applicable at much lower metal concentrations than the more commonly used precipitation and solvent-extraction methods and, unlike those methods, need not add new materials requiring disposal.

The usual procedure in ion-exchange is to pass the effluents through columns containing small beads of the resins. Some particularly useful resins that have been developed recently remove the metals by the process of chelation.

Resins suitable for many small-scale applications are available commercially, but existing materials can't handle many types of effluent.

Dr Jonathon Hodgkin of the CSIRO Division of Applied Organic Chemistry in Melbourne recently synthesized chelating resins that show promise as removers of copper present at low concentrations — 200 parts per million (p.p.m.) or less.

At present, mining companies can use commercial chelating agents (via solvent extraction) to remove copper from rain-water leaching through mine dumps; this mine dump effluent contains copper at concentrations of more than 1000 p.p.m. However, producers of more-dilute copper-containing effluents, such as electroplating plants that discharge copper at concentrations of less than 100 p.p.m., have to use other methods. Dr Hodgkin's resins show promise of being able to cope well with this type of effluent.

His invention is a spin-off from research on the Sirotherm process for removing salt from brackish water. Looking for a less-expensive way to produce resins for Sirotherm, he worked with cheap, readily available materials. The resins he produced turned out to be unsuitable for Sirotherm, but some proved to be very good at removing copper from dilute solutions.

A unique, and useful, feature of the resins is that they pick up only two metals — copper and mercury. Some commercially available resins attract some metals two or three times more strongly than others, but not to the virtual exclusion of the others.

Also useful is the fact that the metals taken up by the resins can be easily removed, allowing both the metals and the resins to be used again.

The resins are a cream colour, but they turn deep green to almost black as they absorb copper. If they were used on electroplating effluent, the copper collected could be removed by washing the resins with acid. The wash solution, containing the copper, could then go back into the electroplating process.

Recycling would be more difficult if the effluent being treated contained both copper and mercury, but few effluents fall into that category

The resins pick up dissolved copper from liquids with a pH between 3·5 and 8, and mercury when the pH is between 1 and 8. Mercury cannot be recovered from the resins by washing with acid, as copper can, but both metals can be recovered using a strongly alkaline wash.

Dr Hodgkin has looked at possible uses for the resins other than at electroplating plants. An obvious one is the removal of mercury from paper-manufacturers' effluent, but it seems that the pH is too high for the resins to be effective there. They may work with mercury in less-alkaline effluents from some chemical-manufacturing plants.

Wine-makers have expressed interest in using the resins to remove copper from their product. However, tests showed that wine is even better than the resins at holding copper by chelation, so the resins do not work in wine.

Despite these failures, the resins have many possible uses, and CSIRO has applied for a patent to cover them. They are much simpler and cheaper to make than most now available, and their selectivity in picking up only copper and mercury is an advantage recognized by a number of researchers overseas who are attempting to develop resins with similar characteristics.

Part of the reason for their high selectivity may be the simplicity of the manufacturing process. The usual approach to the production of selective resins is to chemically alter existing polymers. Many reactions are required and, because of incomplete reaction, some defects inevitably appear in the resulting resins, limiting their selectivity. Dr Hodgkin's process avoids this problem, as it involves the production of a polymer from simple constituents, not changes to an existing polymer.

Dr Hodgkin is continuing his research to see whether similar resins can be developed that will take up other metals — particularly zinc, which is a problem in many industrial effluents.