Making light of heavy metals

Treating industrial trade waste is a complex issue and most methods produce sludge loaded with hazardous chemicals. New technologies can now mitigate this problem, says Virotec International's Dr Lee Fergusson.

A variety of conventional treatment methods are available to try to remedy metals-contaminated industrial effluent, including chemical additives, liquid-solid separation, the dewatering and disposal of solids, or the discharge of treated effluent. However, the chemical additives used in these methods, such as aluminium sulphate and sodium hydroxide, are mostly unsuitable when placed in the context of a sustainable future.

These conventional treatments almost always produce trade waste with elevated metal loadings that is only fit for discharge to the sewer, and always produce large volumes of unstable "hazardous" or "prescribed" sludge that can only be removed by specialist companies to licensed landfills at considerable expense. When compounds including known carcinogens like chromium and lead are present and mobile in the hazardous sludge, this conclusion is even more significant for both the environment and the surrounding population.

If sustainable ways of treating trade wastes are to be found, more effective and efficient methods for dealing with industrial effluent must be developed. Considering Sydney alone has more than 14,000 point sources of trade waste, this imperative becomes even more evident.

In recent years, Virotec International has explored more effective ways of treating industrial effluent from electroplating and metals finishing industries, minerals processing, tanneries and timber treatment plants. This work has considered not only efficiencies in dealing with heavy metals and acidity in wastewater – a problem common to all these industries – but also with ways to bind heavy and trace metals more tightly and produce lower volumes of waste sludge.

Virotec has developed a range of reagents typically composed of fine grained particles derived from alumina refinery residue, commonly called "red mud". The reagents trigger a chemical reaction with heavy metal contaminants, sequestering them within the fine particles of the reagents as insoluble minerals. The reagents simultaneously neutralise any acid in the soil or water.

Reagents made from alumina waste have produced excellent results in tackling metals-contaminated industrial wastewater.

All the products are derived from Virotec's Bauxsol Technology for neutralising the red mud, which is itself a hazardous waste because of its pH of 13. The mud is neutralised by physically and chemically modifying it so the pH drops below 10, which enhances its acid neutralising capacity and binding properties, and is then blended with other natural additives.

APPLICATION #1: KOPPERS LOG, TASMANIA

Copper chrome arsenate (CCA) is a well-established wood preservation technique widely used throughout Australia. The copper and arsenic are used as fungicides and insecticides, while chromium fixes these chemicals into the wood.

The potential hazards of such treatment, along with the risks to timber

Chromium, sulphates, biological and chemical oxygen demand (BOD) were slashed at the Tasman Sheepskin Tannery.

Parameter	Raw Leachate	Leachate Quality After ViroBond Addition
Arsenic, Pond SW3	0.091 mg/L	0.029 mg/L
Arsenic, Pond SW6	0.124 mg/L	0.009 mg/L
Chromium, Pond SW3	0.096 mg/L	0.015 mg/L
Chromium, Pond SW6	0.498 mg/L	0.060 mg/L
Copper, Pond SW3	0.076 mg/L	0.010 mg/L
Copper, Pond SW6	0.142 mg/L	0.010 mg/L

Pre- and post-treatment results for CCA leachate collection ponds at Koppers Log.

workers, are linked to findings that arsenic – a toxic element and known carcinogen – leaches out over time and residues can be found on the surface of the wood.

"There is also evidence ... contamination of the soil and vegetation can extend to the area beyond the immediate boundaries of (treatment) sites, something that has been attributed to wind erosion, percolation, and surface drainage, as well as on-site incineration of wood waste," says the European Commission's Scientific Committee on Toxicity, Ecotoxicity and the Environment.

For these reasons, the practice has been banned in some countries and may, after a recent US initiative, be phased out in Australia for timber used in residential building, although the commercial construction sector will likely continue due to its cost-effectiveness.

Virotec treated two CCA leachate collection ponds at Koppers Log timber treatment plant in Longford, Tasmania. The plant consumes approximately 105 tonnes of CCA per year. Leachate ponds SW3 (300kL holding capacity) and SW6 (500kL) are designed to collect any seepage that may occur while logs are drying in a holding bay.

Virotec directly applied its ViroBond reagent to remove CCA from the ponds. In pond SW3, ViroBond was effective in removing up to 68 per cent of the arsenic, 84 per cent of the chromium and 86 per cent of the copper. In SW6, it removed 93 per cent, 88 per cent and 93 per cent respectively. Water turbidity and clarity also improved markedly and further work is being undertaken to quantify other water quality improvements (see table).

APPLICATION #2: TASMAN SHEEPSKIN TANNERY, QUEENSLAND

Tasman Sheepskin Tannery in south-east Queensland is one of the largest sheepskin tanneries in Australia, specialising in the production of lamb and sheepskins for decorative floor rugs, car seat covers, baby care rugs, and boot and coat manufacturing. Tasman processes about 6,000 hides per month and generates 350kL of trade waste per week.

The existing wastewater treatment system consisted of five settling dams. Lime and aluminium sulphate were added to the waste stream, mostly to precipitate trivalent chromium. ViroFlow Technology was introduced, without major capital upgrades, to remove chromium and also lower biological oxygen demand (BOD), chemical oxygen demand (COD) and sulphates. A major side benefit is reduction of objectionable odour.

Lime and alum were replaced with the patented ViroChrome reagent, designed specifically for treating tannery effluent, with good effect. In addition to neutralising acid, ViroFlow Technology reduced chromium from an average of 75mg/L to 0.3mg/L, BOD from an average of 1,500mg/L to 222mg/L, COD from an average of 2,500mg/L to 350mg/L, and sulphates from an average of 750mg/L to 55mg/L.

APPLICATION #3: AUSTRALIAN PAPER, TASMANIA

A limited number of techniques are available to industry for removing mercury from wastewater, and these are extremely expensive. Techniques include dilution and evaporation, but power costs associated with heating the vast amounts of water needed to get mercury levels low enough are often prohibitive. Virotec has developed a viable and cost-effective treatment for mercury-contaminated effluent.

A redundant mercury cell plant at Australian Paper's Wesley Vale Mill in Tasmania had been decommissioned for more than 10 years. The site is classified as contaminated, partly due to the presence of a steel vessel containing approximately 80,000 litres of mercury-contaminated water. The vessel was showing signs of corrosion.

Virotec's scope of work included a full characterisation and treatment of the wastewater, validation of the treated water quality before disposal, release of the treated water into process water and discharge via a clarifier, encapsulation of the sediment, and liaison with regulatory authorities.

Mercury levels in the water were 1.44mg/L before treatment; at this level, mercury poses a significant risk to human and aquatic life if released in an uncontrolled manner. After treatment with the two-stage ElectroBind reagent, the mercury levels were reduced to 0.017mg/L.

In each of these three applications outlined above, discharges met regulatory guidelines. Moreover, the volumes of solids created as a result of treatment were reduced by approximately 40 per cent. While none of these applications needed to dispose of or reuse solids, data from other Virotec projects indicates the resultant sediment can be re-classified from a hazardous material to an inert or solid waste, further lowering the cost of waste management.

More from Dr Lee Fergusson on (07) 5530 8014 or at leefergusson@virotec.com ■