Co-cultures of fungus and bacteria showed promise in trials on 150kg batches of soil contaminated with creosote.

Cultures and chemistry: a new solution to soil pollution

Research by Flinders Bioremediation points to a promising alternative treatment for PAH contaminated sites. By Richard Stewart *and* Chris Lease

High molecular weight polycyclic aromatic hydrocarbons (PAHs) are widely distributed in the environment and are priority pollutants because of their persistence in the environment and carcinogenic potential.

Clean-up options for PAH contaminated sites are limited by excessive cost (for example, thermal desorption costs up to $100 per tonne) and soil contamination levels are often in excess of the standards that would allow dumping to landfill. PAHs have long been a focus of remediation research, but success in achieving their degradation has been limited.

In 2000, Flinders Bioremediation was awarded an Ausindustry Bioinnovation Fund grant to develop a bacterial-fungal co-culture inoculum that would degrade high molecular weight (PAHs) in soils.

Preliminary investigations showed complete degradation by exploiting the range of enzyme capabilities of the fungi and bacteria. In co-culture, the fungal component achieves partial degradation of the PAH molecule through oxidation, rendering the molecule more water-soluble and more available for degradation by the bacteria. Ultimately this reduces the molecule to its component parts – CO_2 and water.

Flinders Bioremediation has been investigating the approach in the laboratory and at pilot scale. As part of the R&D process, a pilot project trialed the co-culture's ability to treat 150kg batches of soil contaminated with a wood preservative, creosote. This soil was extensively contaminated, with a range of high and low molecular weight PAHs at a combined concentration of 8,000ppm. The presentation of the results led to a prize at the recent 4th International Conference on the Remediation of Chlorinated and Recalcitrant Compounds, held in California.

Over a 26-week incubation period, the co-culture achieved an 82.5 per cent reduction in the total amount of PAHs (from 8,000ppm to 1,400ppm). As was observed in laboratory scale experiments, the more acutely toxic 3 and 4 ring PAHs were degraded before the chronically toxic 5 and 6 ring PAHs, which are the key target given their propensity to cause cancer and birth defects.

VIABLE AND SUSTAINABLE

The results are promising, although degradation is slow due to the low bioavailability (the ability of the microorganisms to access the pollutants to achieve degradation) of the PAHs as a result of their long contact time with the soil.

As a consequence, Flinders Bioremediation is currently investigating the potential use of chemical oxidants in conjunction with bioremediation to achieve speedier results and to address situations where conditions render pollutants less available to biological degradation. The co-culture may then be inoculated into the soil containing the partially oxidised PAHs.

This cutting edge research was a primary focus of the conference in the US. Chemical oxidation as a treatment process is increasingly favoured there for its relative simplicity, time efficiencies and ability to initiate chemical or biological reactions to degrade recalcitrant pollutants. The move towards chemical oxidation has been prompted by the failure of pump and treat technologies and difficulties experienced in optimising bioremediation (although bioremediation is preferred by regulators in Europe and Australia).

Results of the two-stage process suggest it is an economically viable and ecologically sustainable treatment alternative that meets the requirements of regulators and site managers.

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