Use of Rendered Animal Co-Products as Electron Donors in Environmental Remediation

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Background. Chlorinated solvents account for approximately three quarters of all bioremediation sites. The vast majority of these remediation applications are predicated on a simple strategy: amend a high molecular mass electron donor into the subsurface so the necessary microorganisms are stimulated, and the activity is promoted over the long term. To date all long-term electron donors have been derivatives of soybean oil, which is problematic because of: a) limitations in the microbial populations that actually utilize strictly lipid electron donors, and b) competition with foodstuffs in US production. We have developed electron donors from rendered animal co-products, which are combinations of lipid, protein, and minimal carbohydrate. Thus far 30 co-products have been tested, and all stimulate complete dechlorination to a rate and extent, which is better than any current soybean oil-based electron donor. In addition, these materials are fractions of the cost of soybean-based commodity products, on the order of pennies per ton.

Approach. Batch incubations were used to screen 30 animal co-products. Batches were constructed using TCE-contaminated aquifer material, and each electron donor (rendered co-product) was added as the sole electron donor. Each animal co-product was compared to five controls containing common electron donors (lactate, acetate + hydrogen, and one soybean oil-based electron donor) and a sterile and unamended controls. TCE and its degradation products were quantified over time.

Results. The data demonstrate that of the five controls, lactate was able to completely dechlorinate TCE in approximately 45 days, and EVO in 81 days. Lactate was the fastest of the five controls and as a result each animal co-product was compared to it. Of the 30 animal co-products, 20 completely dechlorinated the TCE to ethene at rates faster than lactate or EVO, and four generated ethene at the exact same rate as lactate. In general, the more proteinaceous animal co-products were able to promote dechlorination at a faster rate than the animal coproducts with a higher fat content. All materials reduced TCE to ethene (at a 1:1 stoichiometry) faster than the commercially available soybean-based electron donor (e.g., emulsified vegetable oil). This strategy introduces a new electron donor for TCE bioremediation, which thus far is faster and more cost-effective than any electron donor reported to date. In addition, it provides a novel application for rendered co-products, including the lesser valued materials. Given the exceptionally low cost of these raw materials ($100 to $500 per ton), it is likely that this could disrupt the current marketplace for long-term electron donors, and introduce a much more effective and lower cost technology to the in situ remediation sector.