

## **Pamela Schultz Birak**

### Rheological Characteristics of Manufactured Gas Plant Tars and Implications for Remediation

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Thousands of former manufactured gas plants (MGPs) are located across the U.S. At these sites, one of the most significant sources of contamination is by-product tar. The viscosity of MGP tars can vary several orders of magnitude and plays an important role in affecting the migration and distribution of these dense non-aqueous phase liquids in the subsurface. Understanding the flow or rheological behavior of a particular tar is critical for designing effective pumping strategies and for understanding potential further migration of subsurface tar plumes. In this work, we conducted a rheological analysis of tars recovered from two former MGPs, as well as a recently produced coal tar.

Viscosity was measured using a rotational viscometer, where both temperature and shear rate can be controlled. Data from the rotational viscometer were fit to standard functions to allow for the prediction of viscosity for various temperatures and shear rates. At low shear rates and temperatures relevant to subsurface systems, tars were found to be non-Newtonian such that the viscosity was no longer constant and increased with decreasing shear rate. Thus, the movement of a creeping tar plume could be over-predicted by relying on viscosity measurements in the Newtonian range. Viscosity was also found to be very sensitive to temperature and decreased by orders of magnitude from 5 to 80 degrees C. This decreased viscosity could be useful for thermal approaches to remediation when the mobilization of trapped residual is a desired effect.

## Kayleigh Dunnett

Biodegradation of Tert-butyl Alcohol (TBA) using Biological Granular Activated Carbon (Bio- GAC)

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Tert-butyl alcohol (TBA), a metabolite of the gasoline additive methyl tert-butyl ether (MTBE), is a common groundwater contaminant encountered at petroleum remediation sites. This work explored the capability of YZ2, a novel pure culture, to completely degrade TBA aerobically in both batch studies and in continuous-flow columns containing biologically activated granular carbon (bio-GAC), simulating an ex-situ remedial system. YZ2 mineralized TBA from 0.5mM to 50mM, which is significantly higher than previously reported cultures. The level at which TBA limited the cellular activity was 45mM; however, mineralization still proceeded up to 50mM. YZ2 growth and corresponding TBA oxidation rates within saturated activated carbon were compared with rates quantified in pure aqueous media; results demonstrate that GAC decreases oxidation kinetics for TBA. Batch studies quantified the kinetics of abiotic TBA sorption to activated carbon versus biological TBA oxidation using bio-GAC to compare the rates and efficiencies of physical removal processes to biological strategies. Data demonstrate that adsorption may be more efficient at high TBA concentration, and that previously reported KOC values for TBA were underestimates. In addition, pH levels increased to as high as 10.2

once activated carbon was added to solutions containing TBA, which inhibited microbial growth.

The continuous-flow bio-GAC columns mimicked a field bio-GAC unit and focused on different potential inoculation strategies and the long-term capabilities of YZ2 to degrade TBA as a continuous culture. Current data indicate lower effluent TBA concentrations within the bio- GAC column for 70 days, compared to a sterile GAC control column. However, the overall stoichiometry of the mineralization pathway indicates that dissolved oxygen concentrations in influent water may limit TBA degradation in the bio-GAC column, preventing complete degradation. We are using these data to develop a strategy for biological regeneration of GAC, which may be the most effective use of inoculated, TBA degrading cultures.

## **Laura Nicklaus**

### **Magnesium Corrosion and Stabilization/Solidification Effectiveness Using the Toxicity Characteristic Leaching Procedure**

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Stabilization/Solidification (S/S) is designated by EPA as the “Best Demonstrated Available Technology” for 68 waste codes described by the Resource Conservation and Recovery Act, and it is the second most-used technology at Superfund sites. Binders for S/S are frequently proprietary, but they often include Portland cement and pozzolans such as fly ash. The advantages of using fly ash are twofold: a reduction in cost of materials as the waste fly ash partially replaces cement, and an improvement in the microstructure of the binder as the pozzolan reacts with calcium hydroxide to create additional calcium silicate hydrate (CSH). CSH represents about 65% by volume of normal completely-hydrated cements. CSH is largely responsible for concrete strength and impermeability. These potential improvements are offset by deleterious elements frequently found in hazardous wastes. Past research in S/S has focused on regulated metals and their effects on cement microstructure. However, less dangerous metals such as magnesium frequently found in hazardous wastes have not received the same level of scrutiny. In recent years, research in cement has investigated the mechanisms of magnesium corrosion; magnesium reacting with CSH and destroying its durability. Relatively high levels of magnesium may be found in certain cements, or it may penetrate cements from seawater or soils. Magnesium is especially harmful in conjunction with sulfate, another common industrial waste component. Recent research indicates that magnesium corrosion may be less harmful for cements without pozzolans. This research investigates how magnesium and fly ash addition impacts S/S treatment effectiveness after short and long-term curing.