Bioremediation and Sustainable Environmental Technologies—2017. Fourth International Symposium on Bioremediation and Sustainable Environmental Technologies (Miami, FL; May 2017). ©2017 Battelle Memorial Institute, Columbus, OH, www.battelle.org/biosymp. A. Barton and S. Rosansky (Chairs)

Impact of Surface Tension, Zeta Potential, and Droplet Size on Transport of Traditional and Zero Water EVOs

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Background/Objectives. Factory emulsified vegetable oils (EVOs) are widely used as slow release electron donors for enhanced reductive bioremediation (ERB). The current convention is a small droplet size of EVO equates to remedial success through optimized distribution. To the contrary, this is not always true. In recent years, a number of low water content, self-emulsifying materials have been developed. The transport properties of these materials are not well understood. Currently, there is no published information on the transport and retention of these products in typical aquifer materials.

Approach/Activities. Subsurface transport of EVO is governed by two mechanisms; 1) an electrochemical attraction to the aquifer matrix and 2) colloid straining influenced by oil droplet size. To demonstrate this phenomenon on subsurface distribution, a high-shear factory emulsified vegetable oil (d50= 0.8 microns) and a dilution induced self-emulsifying vegetable oil (d50= 5.8 microns) were injected in columns with various sediment types to explore oil retention as a function of droplet size. Data acquired from these columns was then used in several ESTCP emulsion tool kit design models. Each model was performed to optimize substrate dosing and projected over a twenty-year life cycle.

Results/Lessons Learned. There was a substantial retention difference in the presences of high clay content; the self-emulsifying EVO measured greater than an order of magnitude higher than the factory EVO. While the sand rich column showed only a 50% increase in oil retention between the self-emulsifying and factory EVOs. The models revealed that an initial project cost and a lower substrate demand were directly related to an EVO with a small droplet size. However, if groundwater seepage velocity was set at a moderate value (<1 ft/day) in the model and projected out twenty years; an EVO with a larger droplet size had significant project cost savings due to longevity created by the higher oil retention.