Overcoming Water Treatment Challenges for 1,4-Dioxane Using AMBERSORB™ Resin

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Background/Objectives. Historical operations at a former manufacturing site in Maryland included the use of 1,1,1-trichloroethane (1,1,1-TCA) for metals degreasing and 1,4-dioxane as a solvent stabilizer. Releases of these chemicals have impacted the groundwater quality in the surficial and underlying semi-confined aquifers at the site. VOCs leaching to the semi-confined aquifer have migrated to off-property residential areas and affected private (residential) water supply wells. Concentrations of 1,1,1-TCA, its degradation products, and 1,4-dioxane are present in the multi-aquifer system at levels posing a human health risk.

Approach/Activities. Hydraulic containment using groundwater recovery wells combined with ex situ treatment of the extracted water was selected to control VOC and 1,4-dioxane migration and remove contaminant mass from the multi-aquifer system. The approved option for management of the treated water was discharge into a tributary of the Chesapeake Bay. Stringent discharge limits were applied by the regulatory agency in support of the bay restoration initiatives.

The chemical properties of 1,4-dioxane, including low volatility and high mobility, presented water treatment challenges. Air stripping and granular activated carbon (GAC), two standard approaches for VOC removal in water treatment systems, were incapable of meeting the 1,4-dioxane treatment goals. HiPOx, an established treatment method using ozone and hydrogen peroxide, was capable of meeting the treatment goals VOC and 1,4-dioxane. However, this option was expected to incur relatively high maintenance costs, and required the use of chemicals for operation. A recently emerged process designed by ECT using the synthetic resin AMBERSORB™ 560 was evaluated as an alternate approach. The resin, manufactured by The Dow Chemical Company, has a high affinity for organic compounds and has demonstrated success for VOC and 1,4-dioxane adsorption in water treatment applications. Once the resin reaches its adsorption capacity, steam regeneration is applied to strip off the contaminants, which discharge to ambient air. The regeneration process may be repeated thousands of times without noticeable loss of adsorption capacity. Although the capital cost for the resin was significantly higher than HiPOx, the technology has a lower life cycle cost due to decreased operations and maintenance requirements. The synthetic resin was selected for water treatment based on the ability to meet treatment goals, provide overall cost savings, and limit the use of chemicals.

Results/Lessons Learned. The synthetic resin system operations were initiated in March 2017. Surfactants, potential resin foulants, were identified in pre-startup groundwater samples from the extraction wells. The surfactants were attributed to detergent residue from the decontamination of well development and sampling equipment. GAC was temporarily installed during the initial 18 days of operation to remove the surfactants upstream of the resin, and taken offline once surfactant concentrations were no longer detected.

The resin system has been continuously operating near the design flow rate of 80 gallons per minute. Based on the mass loading, steam regeneration of the media occurs twice per week without operational down time. VOC and 1,4-dioxane concentrations remain below laboratory detection limits in discharge samples, confirming treatment goals are achieved and supporting the bay restoration efforts.