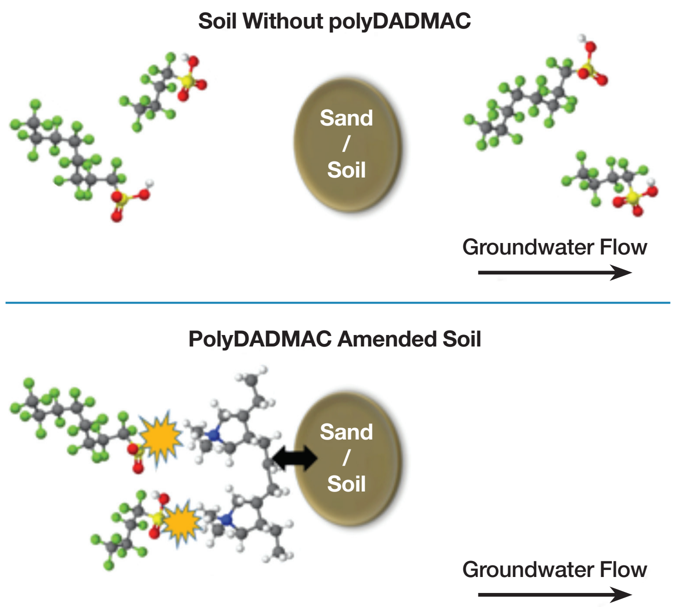
PROJECT ID:
577

Demonstrating the Use of a Novel, Hybrid Polyelectrolyte/Hydrophilic Polymer for In Situ PFAS Treatment Applications



The functionality of the polyDADMAC in situ amendment.
(Diagram Credit: Jovan Popovic)

The high molecular stability of PFAS ultimately limits the number of feasible mechanisms that can be used for its degradation. Thus, the only effective treatment options reported to date are high energy destruction and sorption processes. The most prevalent method at this time is the use of an ex situ pump and treat system with activated carbon filters. However, this process can prove expensive and challenging due to the extremely wide-area, dilute formation of the most common PFAS plumes. Furthermore, it is estimated that the annual expenditure associated with commercially available media replacement alone is in the hundreds of thousands of dollars.

OBJECTIVE:

The goals of this demonstration are to study the use of polydiallyldimethylammonium chloride (polyDADMAC) as a potential PFAS plume retardant for in situ applications and understand any site-specific environmental factors which may influence PFAS binding to polyDADMAC over time.

PROBLEM STATEMENT:

Per- and polyfluoroalkyl substances (PFAS) are a family of human-made chemicals that are found in a wide range of products used by consumers and industry. Unfortunately, the same characteristics that make them ideal for firefighting and plating operations—namely impermeability to grease, water and oil—makes them persistent in the environment. Current evidence suggests that the bioaccumulation of certain PFAS may cause serious health conditions in humans as well. As a result, the U.S. Environmental Protection Agency (EPA) has set lifetime health advisory levels for PFAS.

DESCRIPTION:

Using a low-cost material with high binding specificity for PFAS would ultimately lower operational costs if applied as a plume retardant, especially if frequent filter changeouts and amendments can be avoided. This project is investigating the use of polyDADMAC. This organic polymer has seen ubiquitous use in water and wastewater treatment processes as a coagulant to enhance sludge dewatering, as well as reduce the formation of harmful disinfection byproduct precursors, oftentimes generated in water and wastewater treatment. To date, there is still limited research on its application for the removal of emerging contaminants. Recently, however, preliminary research performed at the University of Minnesota by leading environmental chemists has demonstrated that this material has high specificity for PFAS compounds, even in the presence of interfering compounds contained within an environmental matrix. In addition, this material has the added advantage of being low cost and may be used for in situ treatment operations.

The goal of this project is to demonstrate control of a PFAS groundwater source zone by treating it with polyDADMAC. The demonstration will begin with bench scale testing with site-specific environmental media to understand the various geochemical parameters which may affect the binding performance of polyDADMAC. These tests will be conducted in the presence and absence of powdered activated carbon or other forms of pyrogenic carbon to better optimize PFAS/polyDADMAC binding performance specific to the site's subsurface matrix. Additionally, the radius of influence for the injection will be determined (e.g. slug test) prior to polyDADMAC injection in an effort to better understand adequate amendment dosing. Completion of these tasks will ultimately provide relevant empirical design data for field scale-up, and elucidate the necessary performance criteria required for a field scale demonstration. Assuming a "go" decision is made, a field demonstration will follow. A site with PFAS in the groundwater will be selected and the source zone soils will be treated with polyDADMAC. The hypothesis is that introducing polyDADMAC in this matter will boost retention of PFAS which will reduce the flux of contaminants migrating out of the source zone.

The goal of this project is to demonstrate control of a PFAS groundwater source zone treating it with polyDADMAC.

Samples will be analyzed at a Department of Navy (DoN) laboratory accredited by the Environmental Laboratory Accreditation Program. The primary operational costs for this study will be dependent on the concentration of polyDADMAC required (to be determined during the laboratory investigation). However, it is anticipated that minimal addition will be necessary to retard plume migration. The most decisive criteria of success for this demonstration will hinge upon the ability of polyDADMAC to sequester PFAS within the source zone, and spatial and temporal decreases in PFAS concentrations downgradient of the source zone will be monitored to verify its efficacy.

These efforts will elucidate any factors affecting performance for in situ source zone PFAS sequestration, as well as provide information as to whether or not adjustment of the injection approach may be necessary.

TRANSITION DESCRIPTION:

Data generated in both the laboratory and pilot scale themes of this submission will ultimately be used in the design of full-scale mobilization/injections so that end users across the Department of Defense can easily implement this technology in the field.

All information garnered from this demonstration will be disseminated through conduits such as the Remediation Innovative Technology Seminar and Naval Installation Restoration Information Solution. Final reports and guidance documents will be created to provide direction for subsequent mobilizations across PFAS-impacted DoN sites. Additionally, these data will be published in peer-reviewed scientific literature to inform DoN remedial program managers, environmental restoration subject matter experts, and field practitioners.

CONTACT:

For more specific information about this project, contact the Principal Investigator at 805-982-6081. Contact the NESDI Program Manager at 805-982-4893 for more general information about the program.

ABOUT THE NESDI PROGRAM

The Navy Environmental Sustainability Development to Integration (NESDI) program is the Navy's environmental research and development demonstration and validation program, sponsored by the Chief of Naval Operations Energy and Environmental Readiness Division and managed by the Naval Facilities Engineering Systems Command from the Engineering and Expeditionary Warfare Center in Port Hueneme, CA. The mission of the program is to provide solutions by demonstrating, validating and integrating innovative technologies, processes and materials and by filling knowledge gaps to minimize operational environmental risks, constraints and costs while ensuring Navy readiness and lethality.

Visit the program's public website at https://www.navfac.navy.mil/NESDI for more information.