Nanofiltration followed by Electrical Discharge Plasma for Destruction of PFAS and Co-Occuring Chemicals in Groundwater: A Treatment Train Approach

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Background/Objectives. Ongoing assessment of former fire/crash sites at DoD installations has identified concentrations of PFOA, PFOS, and other PFAS in groundwater well above (in some cases, several orders of magnitude above) established health advisory levels. Given the physicochemical properties of PFAS and the fact that they are often commingled with other contaminants, remediation of PFAS-impacted water best lends itself to a treatment train approach with integrated PFAS concentration and destructive steps. Since PFAS plumes are generally dilute (often a few ppb), reliable approaches that concentrate PFAS and co-contaminants for subsequent destruction are needed. This ESTCP-funded project aims to demonstrate and validate an integrated treatment approach using nanofiltration to concentrate PFAS and co-contaminant-impacted water and electrical discharge plasma to treat the concentrate derived from nanofiltration.

Approach/Activities. Approach/Activities. Applying current capacities of these technologies for one day (8-hr): i) nanofiltration can process a minimum of 2,000 gallons of influent water; ii) of this, ~1,800 gallons can be a treated effluent stream (membrane filtrate, ~90% of feed); and iii) ~200 gallons can be treated by plasma (concentrate ~10% of feed) to achieve PFOA + PFOS concentrations < 70 ng/L. Key features include:

- ***Nanofiltration:*** >20x concentration of PFAS-impacted waters can be achieved, thereby increasing the yield of PFAS-free water and decreasing the volume of PFAS-concentrated water requiring additional treatment.
- ***Plasma:*** Demonstrated rapid destruction of PFAS (within minutes) with no chemical addition, no waste generated.
- ***Field-ready:*** Both technologies are field-ready (mobile trailers) and have been tested on various PFAS waters.
- ***Proof of Concept:*** In a recent test, plasma reduced PFOA levels (8000 to < 70 ng/L) in nanofiltration concentrate.

Benefits. The proposed technology offers the DoD a cost-effective and reliable alternative to on-site PFAS treatment using conventional technologies (e.g., granular activated carbon [GAC] and ion exchange [IX]) and costly off-site disposal options (e.g., incineration; $4-10/gallon). Specifically, nanofiltration has been shown to be less energy intensive than other membrane technologies, and closed-circuit desalination (CCD)-nanofiltration allows for high recovery not achievable by conventional nanofiltration systems. Plasma offers substantial cost savings relative to GAC and off-site incineration and, unlike sorptive technologies, it generates no waste, limiting future liability. A critical aim for this project is to calculate life cycle costs for operation of nanofiltration + plasma (treatment train), plasma, and electrochemical oxidation. This will be achieved through monitoring of operational data (e.g., energy usage; flowrate; consumables, equipment replacement costs) during testing of the integrated nanofiltration-plasma system and direct comparison of plasma and electrochemical oxidation under similar operating conditions. This will provide the DoD with solid costs for long-term operation of these systems for various PFAS-impacted water sources.