PROJECT ID:
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XCPC Solar Thermal Evaporation for PFAS-Impacted Wastewater Minimization

The XCPC system. (Photo Credit: Winston Cone Optics)

OBJECTIVE

The goal of this project is to demonstrate and evaluate a solar thermal evaporation system comprised of commercial off-the-shelf (COTS) thermal evaporators combined with a solar thermal system for the purpose of minimizing per and polyfluoroalkyl substances (PFAS) found in wastewater at Department of Defense (DoD) facilities.

PROBLEM STATEMENT

Accidental and emergency discharges from aqueous film-forming foam (AFFF) fire suppression systems in DoD hangars and mobile units are a large source of PFAS-impacted wastewater, which is a potential environmental liability for DoD facilities. These wastewaters contain elevated levels of compounds which decrease the effectiveness of emerging PFAS treatment technologies. Current practices for AFFF control, removal and disposal, focus on technologies that have major drawbacks. Granular activated carbon (GAC) is capable of removing PFAS under certain conditions but is limited because AFFF wastewater has concentrations upwards of thousands of parts per million (ppm, mg/L), and these concentrations will require too much GAC to make the treatment cost-effective. Therefore, incineration is currently the only option available for high-strength AFFF wastewater. Alternative disposal options are needed.

DESCRIPTION

Evaporation is an attractive option for PFAS-impacted wastewater volume minimization due to the low volatile nature of PFAS. PFAS compounds of interest do not readily volatilize during boiling, thus do not leave the bulk solution in the vapor phase during evaporation. When designed properly, a wastewater evaporation system would not permit any PFAS species to be emitted to atmosphere and would produce a condensate that is suitable for sewer discharge.

The External Compound Parabolic Concentrator (XCPC) is an emerging technology that combines non-imaging optics and metal-glass vacuum tube technology to provide high operating

temperatures from a stationary collector. When paired with a thermal evaporator, it provides a renewable heat source at a levelized cost comparable to natural gas. The XCPC system, when combined with a COTS thermal evaporation unit and a low-pressure steam condenser, is suitable for use as a wastewater volume minimization technology that is capable of achieving volume reductions of greater than 90%.

This project will demonstrate and evaluate an XCPC system combined with a COTS evaporation unit. The first step is selection of a demonstration site in the Southwest region. Assuming an appropriate site is identified, a contract will be awarded, a demonstration plan will be developed, and bench scale optimization and testing will be conducted.

RETURN ON INVESTMENT

Incineration of AFFF-impacted wastewater is costly and energy-intensive, with treatment costs rising as high as $6.00/gallon. Further, costs can vary substantially depending on the region due, in part, to incinerator capacity and the need to ship large volumes of wastewater long distances. The cost savings potential of volume minimization via the XCPC system are enormous. Including the cost of this proposed project and the capital investment of a full-scale system, the payback period is estimated to be 1.5 years of continuous operation—on a break-even treatment volume of 160,000 gallons. Treating the break-even volume would achieve a disposal cost savings equal to the total cost of validation, capital investment and per gallon treatment cost of approximately $0.05/gallon. To put this treatment volume in perspective, the volume of PFAS-impacted wastewater produced from triple rinsing AFFF vehicles is estimated to be 60,000 gallons, or 38 percent of the break-even point, in the Southwest region alone.

NAVY BENEFITS

As described above, reduced energy, storage, transportation and labor costs are prime benefits of the XCPC solar thermal system. Containerizing the XCPC solar thermal evaporation system allows for easy transport and setup to serve other Navy installations as needed.

TRANSITION DESCRIPTION

During the demonstration, EXWC will interface directly with stakeholders and end users to provide training and hands-on experience with the system. Presentation materials, webinars and briefings to working groups will be developed. A peer-reviewed academic paper will be published which documents the results of the demonstration. This publication would be used by facility environmental managers to provide supporting evidence to regional regulators of the scientific validity of using this technique for onsite treatment of PFAS-impacted wastewaters.

CONTACT

For more specific information about this project, contact the Principal Investigator at 805-982-3909.

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 OPNAV N4I Installations 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.

For more information, visit the program's web site at www.navfac.navy.mil/nesdi or contact Ken Kaempffe, the NESDI Program Manager at 805-982-4893, DSN: 551-4893 or kenneth.c.kaempffe.civ@us.navy.mil.