PFAS Destruction

Test Series 1

October 2023

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OVERVIEW

Bay West leads new research in the destruction of per- and polyfluoroalkyl substances (PFAS) compounds. The research, awarded by US Army Engineer and Research Development Center (ERDC), targets the effective ranges and operating costs of supercritical water oxidation to break PFAS carbon-fluorine bonds, resulting in treated effluent of water, carbon dioxide, and inorganic salts. Bay West selected the General Atomics' (GA) Industrial Supercritical Water Oxidation (iSCWO) system for a series of static and mobile tests. The team recently completed Test Series 1 using five gallons of concentrated waste provided by the Minnesota Pollution Control Agency (MPCA). Bay West researchers designed test conditions to evaluate PFAS waste processing through GA's proprietary iSCWO reactor in San Diego, CA. **During two sets of test conditions, the reactor demonstrated up to a 99.94% reduction in PFAS mass. Initial research results indicate increased destruction efficiencies with increasing waste stream concentrations.**

iSCWO demonstration unit at GA

SCWO is an evolving yet well-documented technology that utilizes an aqueous waste stream in a supercritical state (above 374°C and 218 atmospheres), and combines it with an oxidant to achieve rapid and complete oxidation of all organics. GA's full-scale iSCWO units have been used and proven in industry for over 30 years to destroy numerous recalcitrant contaminants.

The waste stream used for Test Series 1 of the PFAS destruction research was the five gallons of SAFF (surface active foam fractionation) provided by MPCA. Due to the limited volume and the time needed to complete the research design, for the first of two sets of test conditions the research team diluted 2.5 gallons of SAFF to a total mixed volume of 181.6 gallons. During the second set of test conditions, an additional 2.5 gallons of SAFF material was fed directly into the influent stream of the remaining first mixture.

The research team coordinated collection of multiple aqueous and air samples throughout the iSCWO system process. Sampling points included diluted process influent, quench water, process effluent, condensate, ambient air, and effluent air. The team also evaluated the process in terms of energy use, fuel use, and water use.

Waste influent preparation

Sample collection

Bay West

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Test Series 1 continued

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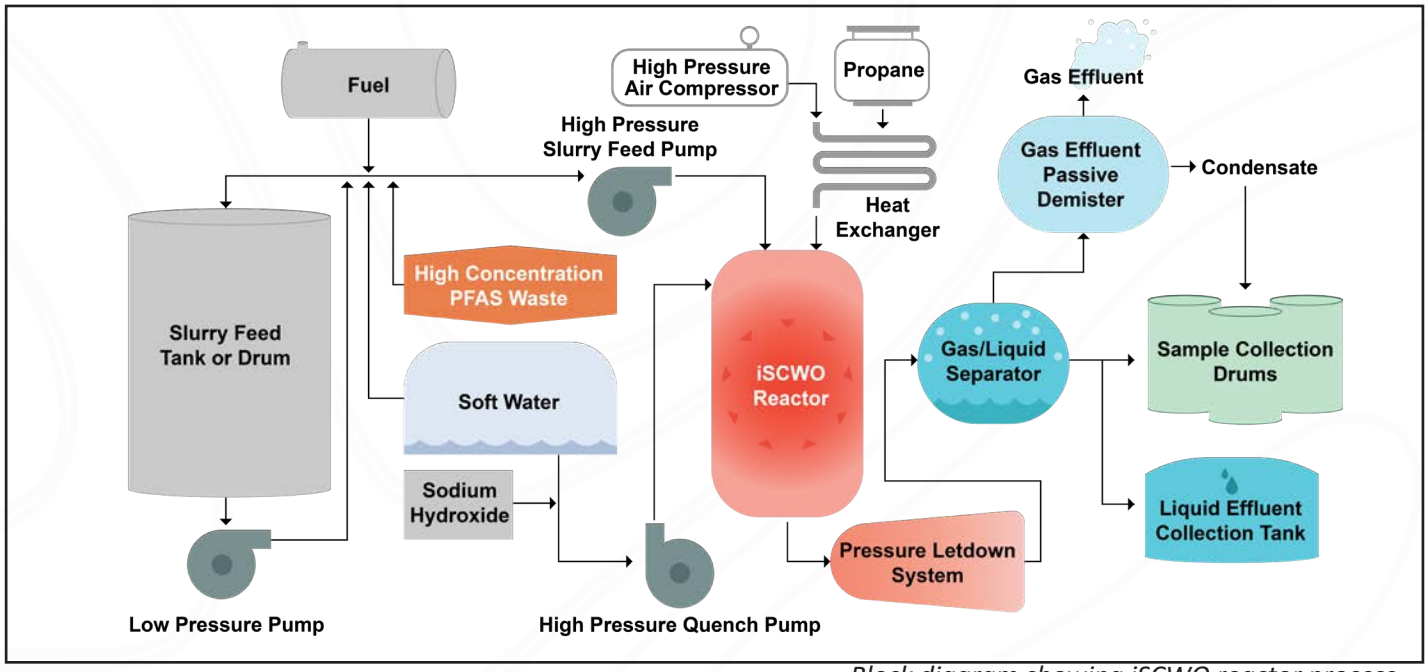

Block diagram showing iSCWO reactor process

EVALUATION AND INITIAL RESULTS

Test Series 1 results demonstrated > 99.9% reduction in PFAS compounds and also indicated that destruction efficiencies increase with increasing waste stream concentrations.

The primary resources and energy required for iSCWO system operations include water, fuel, and electricity. Resource usage was documented using the existing system sensors and meters. Due to the time and volume limits, the SAFF concentrate was diluted as planned during each set of test conditions to meet the 1 gallon per minute minimum system flow rate. Our team observed that costs associated with the research testing of this waste stream were higher on a per-unit mass destroyed basis due to the additional energy required to bring the total feed volume to supercritical conditions. For full-scale treatment conditions with a greater available volume of undiluted feed material, treatment costs per unit mass of PFAS destroyed are expected to decrease and become more economical. Based on these constraints, the Bay West team calculated utility and resource costs on a per-hour basis, then multiplied across the total test time to determine the total treatment cost. The Bay West team conducted Test Series 2 in early 2024 to further test other PFAS waste streams, destruction efficiencies, and optimal operating conditions of the iSCWO system. Results of Test Series 2 and 3 will be reported in separate summaries.

Parameter of Test Efficiency	iSCWO Primary Input - Resources & Energy				
	Water	Diesel	Propane	NaOH	Electricity
Rate	0.46 HCF/hr	21.48gal/hr	~5 gal	0.12 kg/hr	423kW
Price [a]	$4.10/HCF	$3.827/gal	$1.865/gal	$50.40/kg	$0.17/kWh
Hourly Cost	$1.88/hr	$82.22/hr	$9.33	$6.22/hr	$71.88/hr
Total Hourly Cost	**$162.19/hr**				
Total Cost [b]	**$692.03 + $9.33 = $701.35**				

gal=gallon; HCF=hundred cubic feet; hr=hour; kg=kilogram; kW=kilowatt; kWh=kilowatt-hour, NaOH=sodium hydroxide
a = Prices from government-based resource websites as of November 2023 to January 2024 for Minneapolis, MN.
b = Total cost based on total SAFF Test time (including start-up & shutdown) of 4.27 hours.