bluegrass advanced materials

DEVELOPMENT OF SMART FLOCCULANTS FOR THE TREATMENT OF PFAS CONTAMINATED WATER

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NIEHS Virtual Technology Fair

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Grant Number: R44ES032380

THE PROBLEM

PFAS's environmental persistence has been a cause of concern due to potential toxic human health effects due to their bioaccumulation leading to an increase in regulations.

Additional regulations on PFAS will lead to massive quantities of PFAS waste from primary treatment technologies

Currently, incineration is the only approved terminal destruction method for PFAS

Identified need: Concentrate PFAS hazardous waste prior to destruction

Primary PFAS Separation Technologies

PFAS Waste

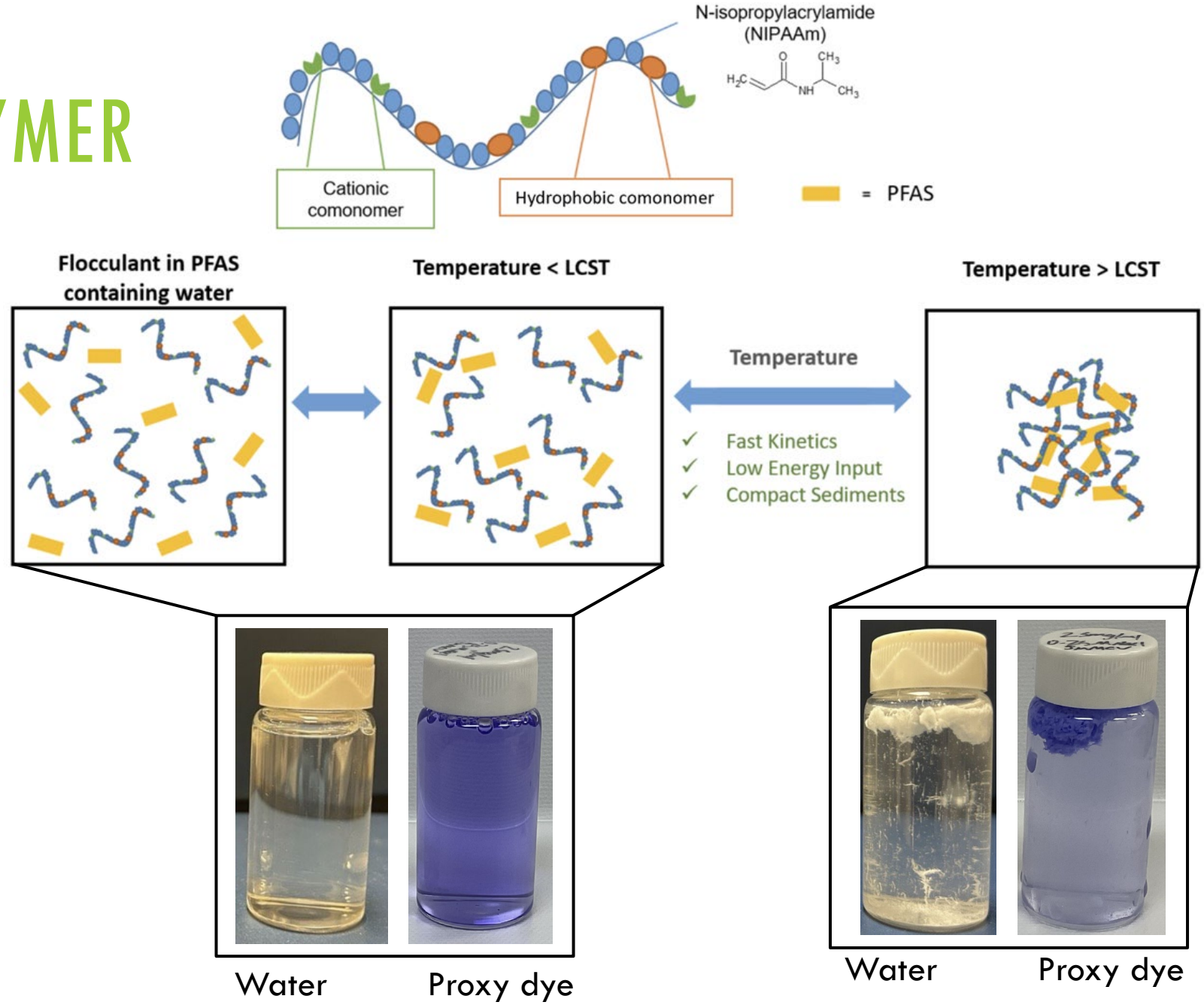
Hazardous Waste Destruction

$$$

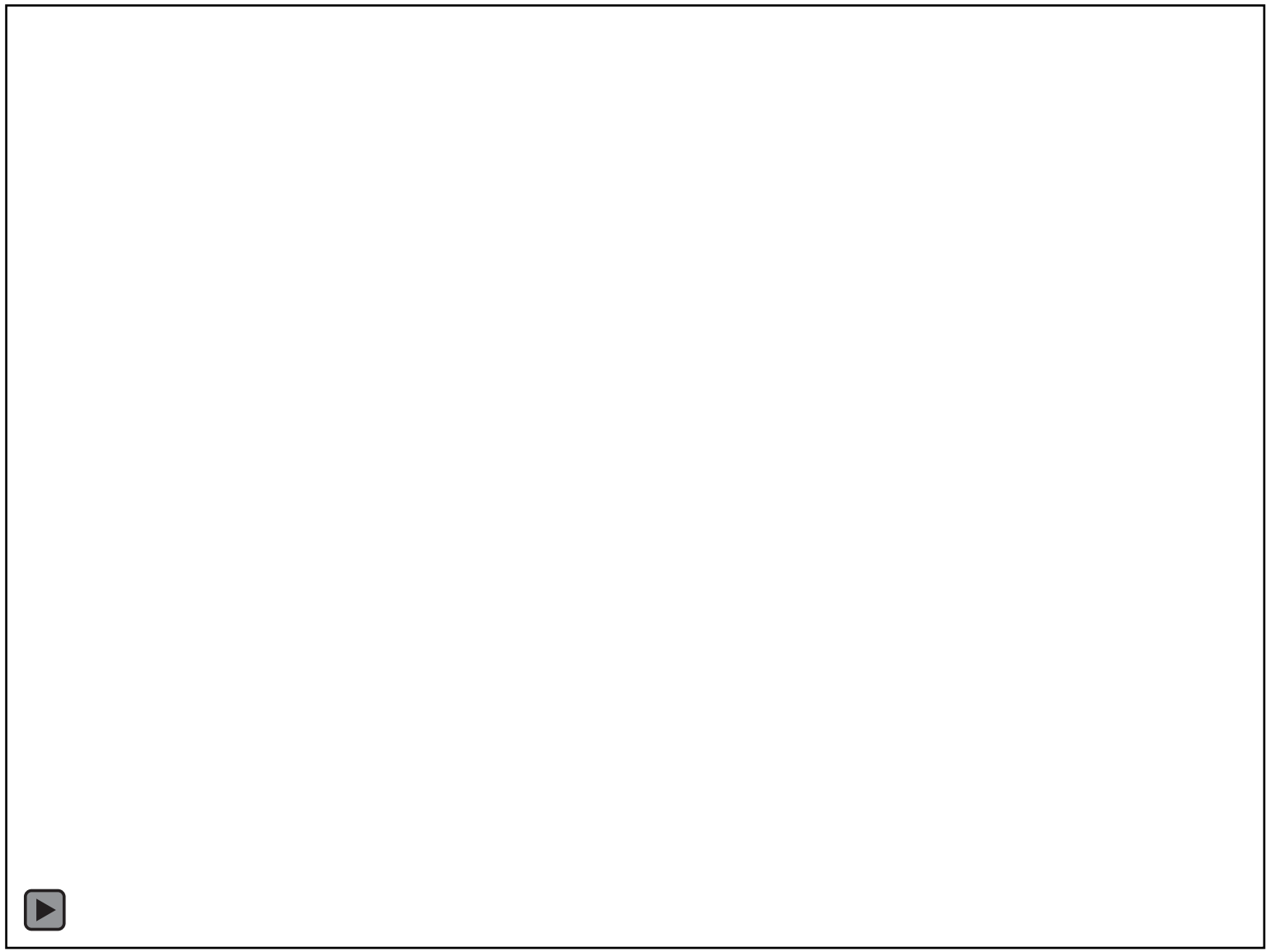
With funds from NIEHS SBIR Phase I & II, BAM has been working on the EnviroFloc System aiming at further concentrating PFAS waste for cost reduction with terminal incineration.

ENVIROFLOC POLYMER

- Created innovative thermo-responsive polymer flocculant for removal of PFAS
- Below lower critical solution temperature (LCST) polymer is soluble in water, above LCST polymer precipitates out allowing for easy filtration
- Removal of PFAS based on charge interactions with cationic comonomers
- Hydrophobic comonomer added for tighter flocs with low water retention



ENVIROFLOC FLOCCING



PROOF OF CONCEPT IN CHALLENGING WASTE STREAM

In collaboration with Brown and Caldwell, an environmental engineering firm, the EnviroFloc polymer was tested on reverse osmosis (RO) concentrate from landfill leachate

RO Concentrate + EnviroFloc @ RT

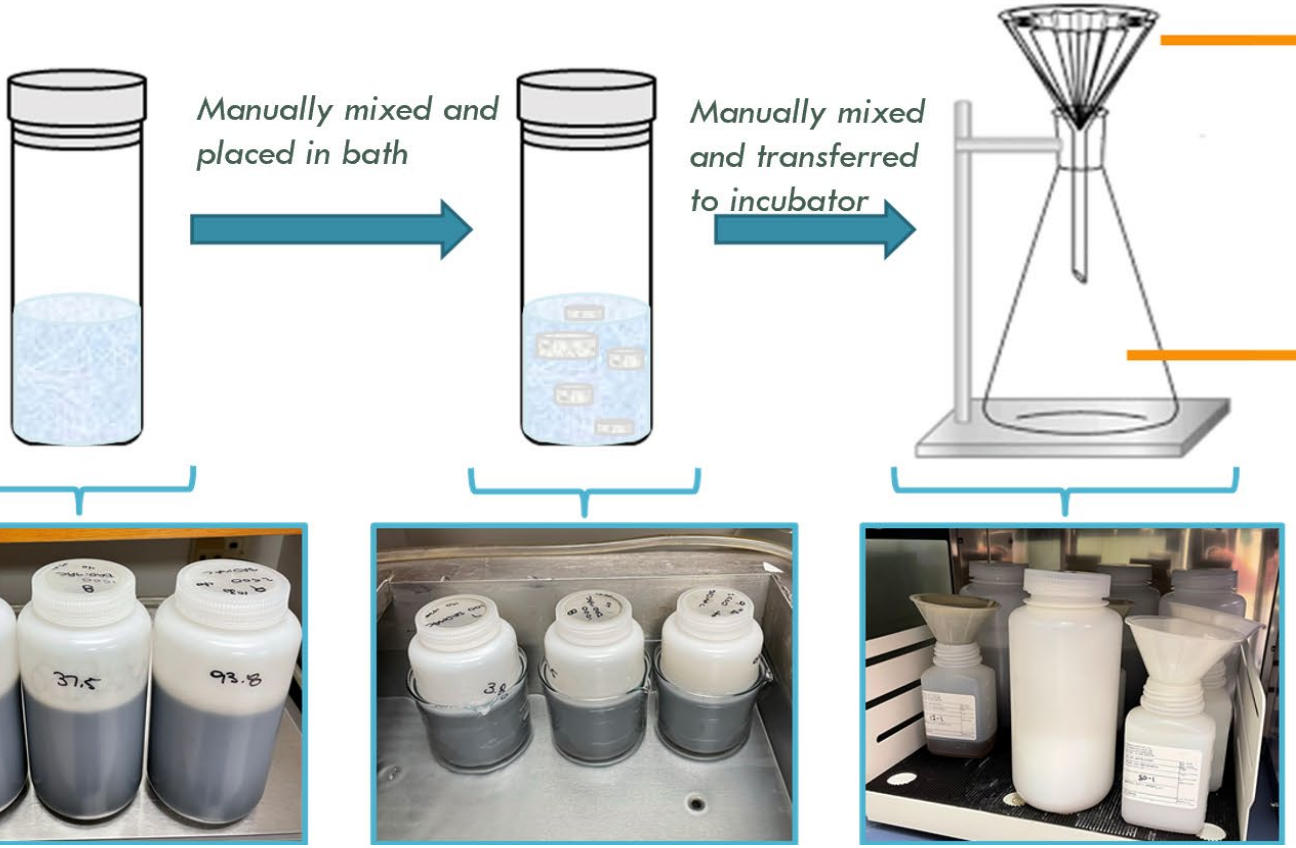
Flocculation Studies @ T = 40°C (T > LCST)

Filtration in Incubator @ T = 40°C (T > LCST)

Add Polymer vial leachate vial then mix

Manually mixed and placed in bath

Manually mixed and transferred to incubator



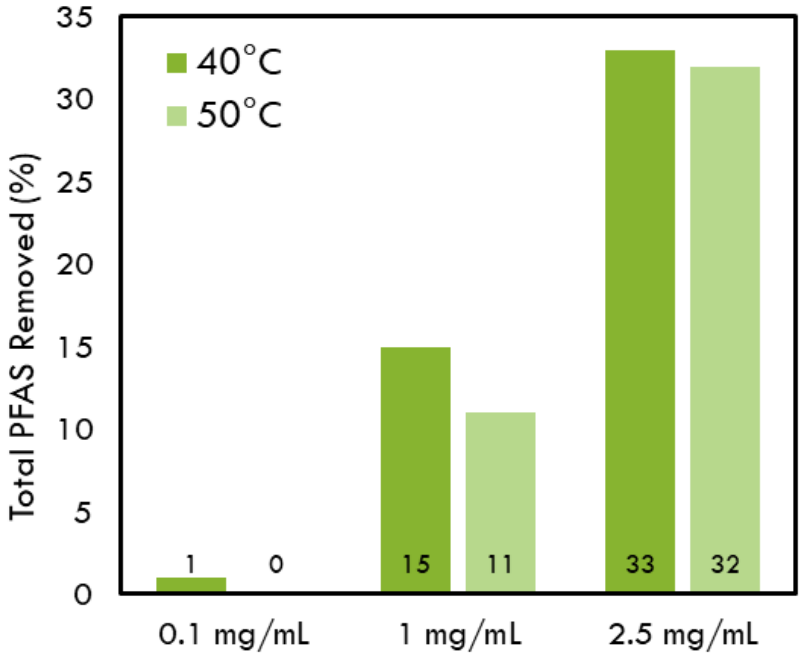
PFAS-Bound Polymer Flocs (spent EnviroFloc)

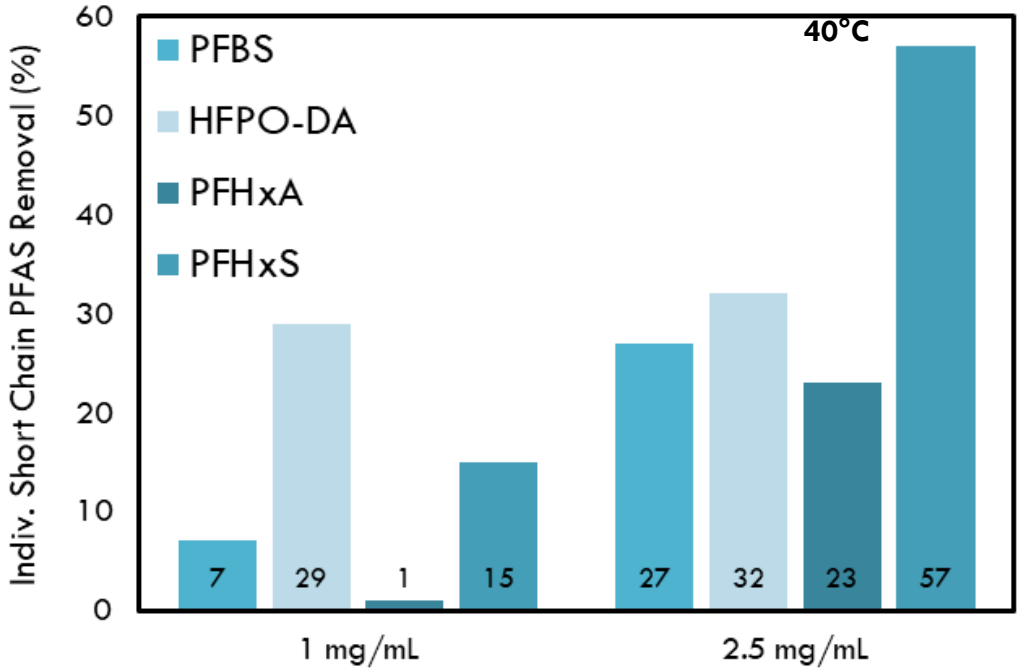
Flocs obtained vary in size/compactness

Filtrate Samples Sent for Analysis by Eurofins

PROOF OF CONCEPT IN CHALLENGING WASTE STREAM

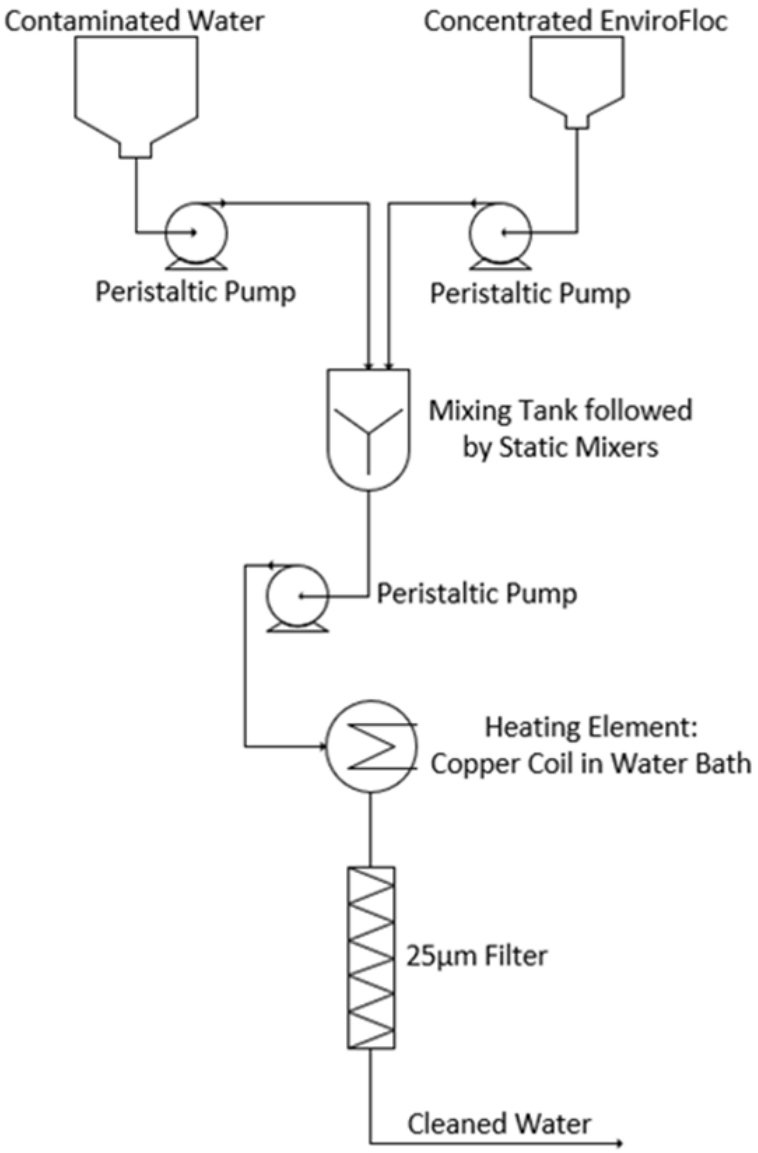
- Dose dependent increased removal of total PFAS in both 40°C and 50°C groups
- Do not need significant rise above LCST for flocculation and removal of PFAS
- Comparable short chain PFAS removal compared to total PFAS removal





PFAS Species in RO Conc.	Carbon Chain Length
PFDA	C10
PFNA	C9
PFOA	C8
PFOS	C8
NEtFOSAA	C8 (ethyl substituent)
NMeFOSAA	C8 (methyl substituent)
PFHpA	C7
PFHxS	C6
PFHxA	C6
HFPO-DA	C6-branched
PFBS	C4

CONTINUOUS FLOW SYSTEM



EnviroFloc Polymer Solution

Initial Wastewater Solution

Mixing Container

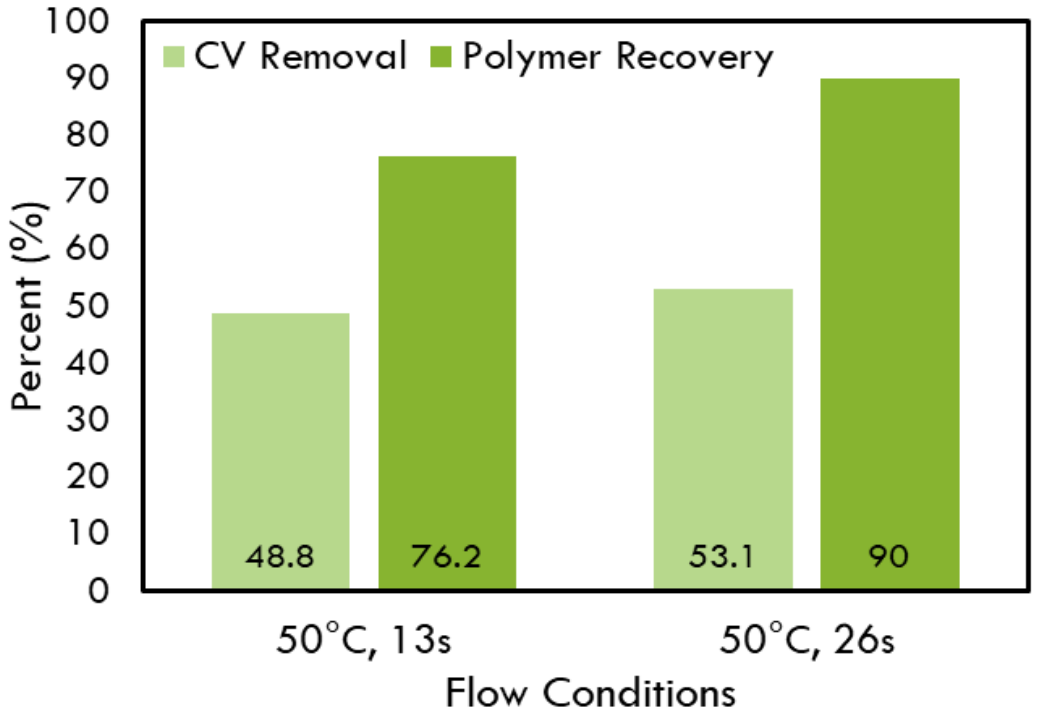
2X Immersion Heaters 1200W Each

Static Mixer

25um Sock Filter

Cleaned Water

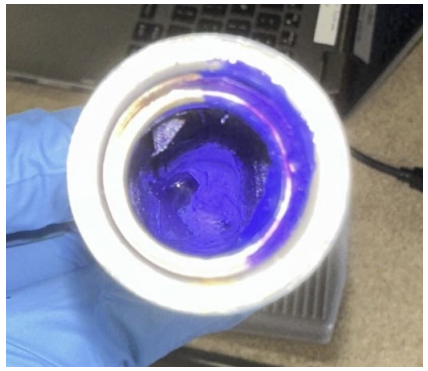
CONTINUOUS FLOW SYSTEM



- Wastewater contained 5 µM Crystal Violet (CV) and 0.2 M NaCl
- Wastewater was treated with polymer at a 1g/L concentration
- Time shown is residence time in heated copper tubing

Proxy Wastewater before treatment

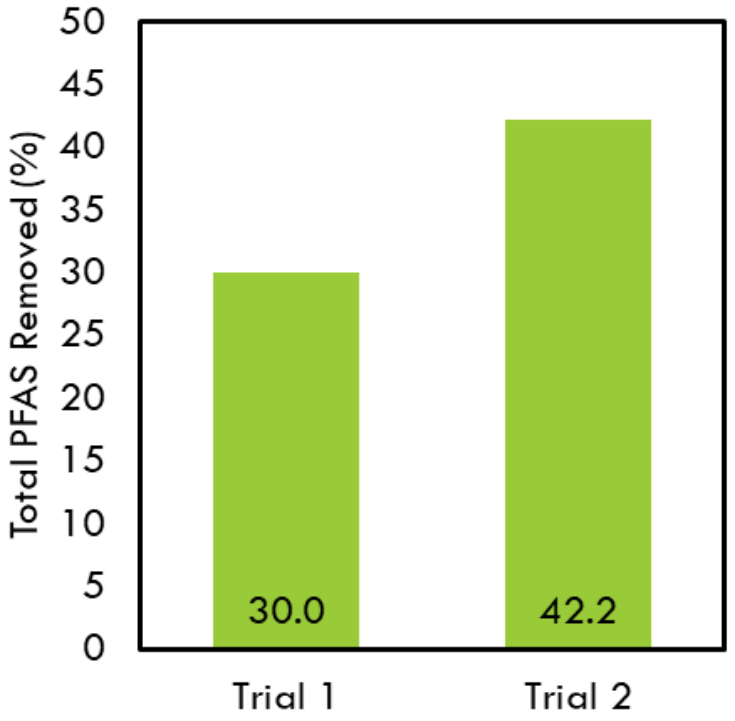
Proxy Wastewater after treatment



Crystal Violet containing flocs captured by the sock filter

PRELIMINARY PFAS REMOVAL UTILIZING THE CONTINUOUS FLOW SYSTEM

- Spiked PFAS samples at 100 ppb treated with 1 g/L polymer with 8 different PFAS
- Residence time of 32.5 s in the heated copper tubing
- Saw over 90% removal with PFOS and 86% removal with PFDA
- Future testing for a triplicate sample as well as testing with more short chain PFAS



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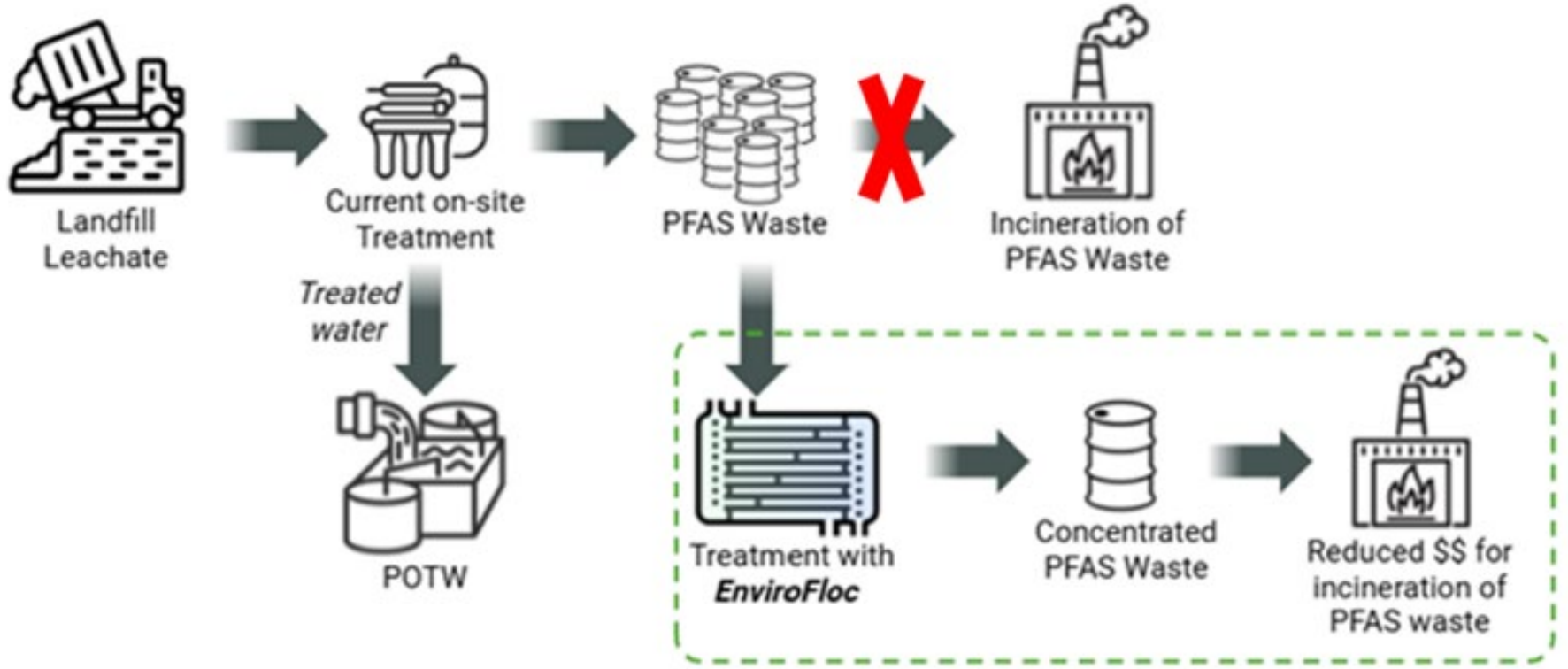
ENVIROFLOC INTEGRATION

- Primarily aiming to be a secondary treatment for landfill leachate or industrial wastewater
- EnviroFloc Skid design will allow for integration for on-site treatment
- Concentration of PFAS waste will reduce costs associated with terminal destruction



NEXT STEPS

- Continue seeking funding through KY SBIR Matching Grant and Commercialization Readiness Pilot
- Test PFAS rich retentate on continuous flow system from collaboration with Three Notch Group
- Design and build a pilot scale skid with help from MXD Process
- Seek out further environmental engineering groups firms to build additional collaborations

QUESTIONS

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Check out our website here:

Many thanks to NIEHS and Brown and Caldwell

NIH National Institute of Environmental Health Sciences
Your Environment. Your Health.

Brown AND Caldwell

Grant Information	**Dr. Claire Rowlands, Development of Smart Flocculants for the Treatment of PFAS Contaminated Water, Bluegrass Advanced Materials,** R44ES032380, **Project Link:** https://tools.niehs.nih.gov/srp/programs/Program_detail.cfm?Project_ID=R44ES032380
Presenter	Dr. Claire Rowlands, Director of Research
Technology Name and Description	*EnviroFloc* System Our novel technology uses flocculation with a thermoresponsive polymer to remove PFAS from contaminated water. The polymer solution can easily be added to contaminated water heated above the polymer's LCST and then filtered out removing the polymer and PFAS.
Innovation	With increasing regulations surrounding PFAS, there will be an increase in PFAS waste which is incredibly expensive to terminally dispose of. Our technology will be used to further concentrate PFAS waste reducing the cost around disposal. Our technology also show promise at removing short chain PFAS which many current technologies struggle with. Our polymer can also be modify to target different contaminants making it a very versatile technology. PCT Application No. PCT/US2021/055274, pending
Contaminant and Media	We are targeting to further concentrate and remove PFAS from ground water, landfill leachate and wastewater.
Technology Readiness Level	4-5, pilot scale by 2026
Site Work	N/A
Main Point of Contact and Social Media	Email: hilt@bgamaterials.com Website: https://www.bgamaterials.com/