Evaluation of High Efficiency Mist Eliminators

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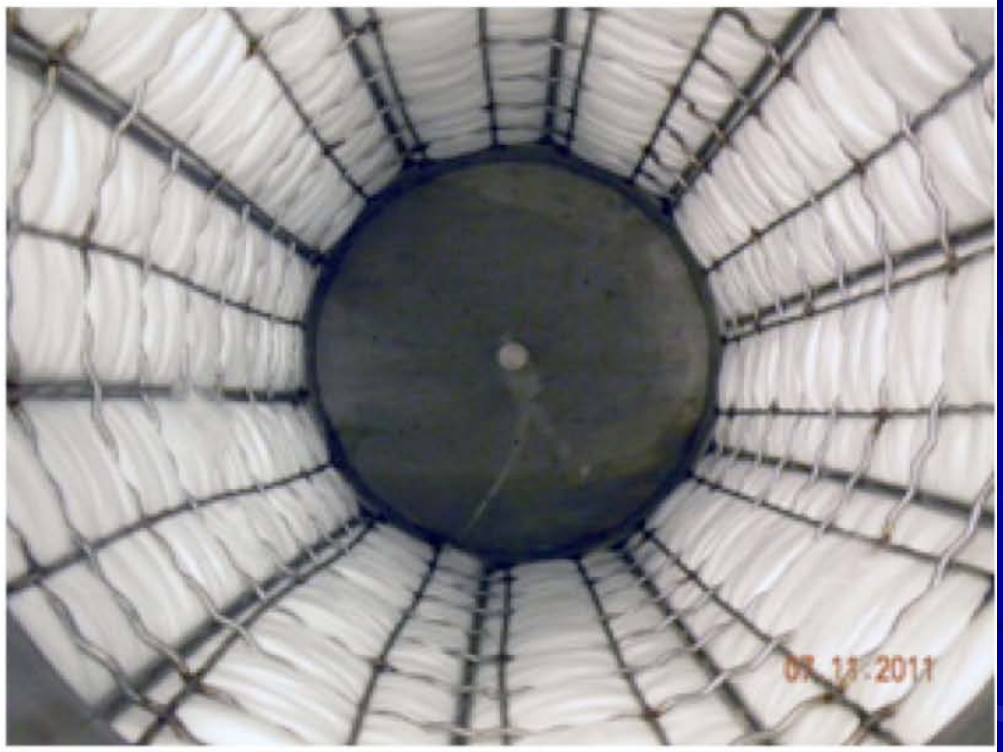
Project Oversight

Technical Working Group Membership

- John Dick – BNI
- Ryan Wilson -- BNI
- Jaimini Dave -- BNI
- Eric Slaathaug - BNI
- Joni Weamer - BNI
- John Shultz – DOE EM-21,
- Werner Bergman– Aerosol Science

Design Characteristics

A



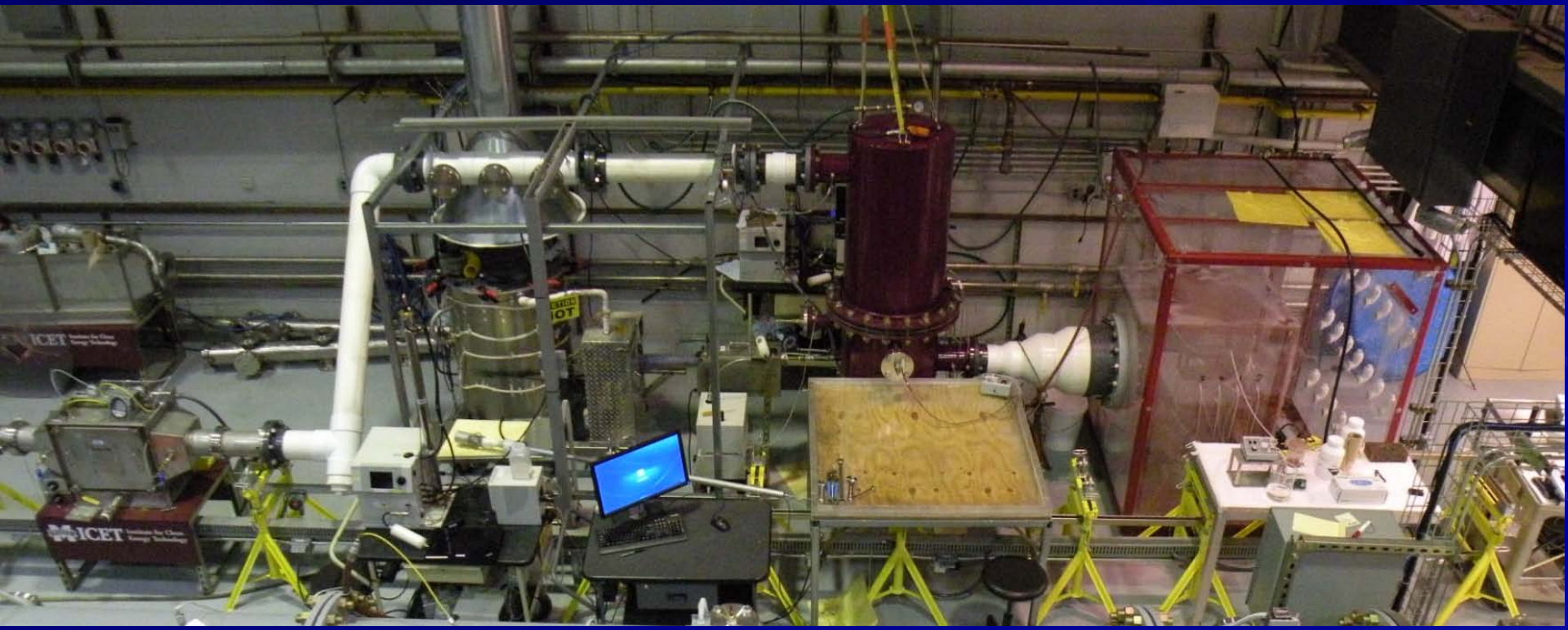
B

HEME Project Test Matrix

Run Number	HEME ID Number	HEME Manufacturer	Media Velocity (ft/min)	Test Flow Rate (scfm)
AMCO-1	AMCO-1	AMISTCO	10	59
CECO-1	CECO-1	CECO Environmental	10	59
MECS-1	MECS-1	Monsanto	10	59
AMCO-2	AMCO-2	AMISTCO	15	88
CECO-2	CECO-2	CECO Environmental	15	88
MECS-2	MECS-2	Monsanto	15	88
AMCO-3	AMCO-3	AMISTCO	25	147
CECO-3	CECO-3	CECO Environmental	25	147
*MECS-3	MECS-3	Monsanto	15	88

Test Stand Capabilities

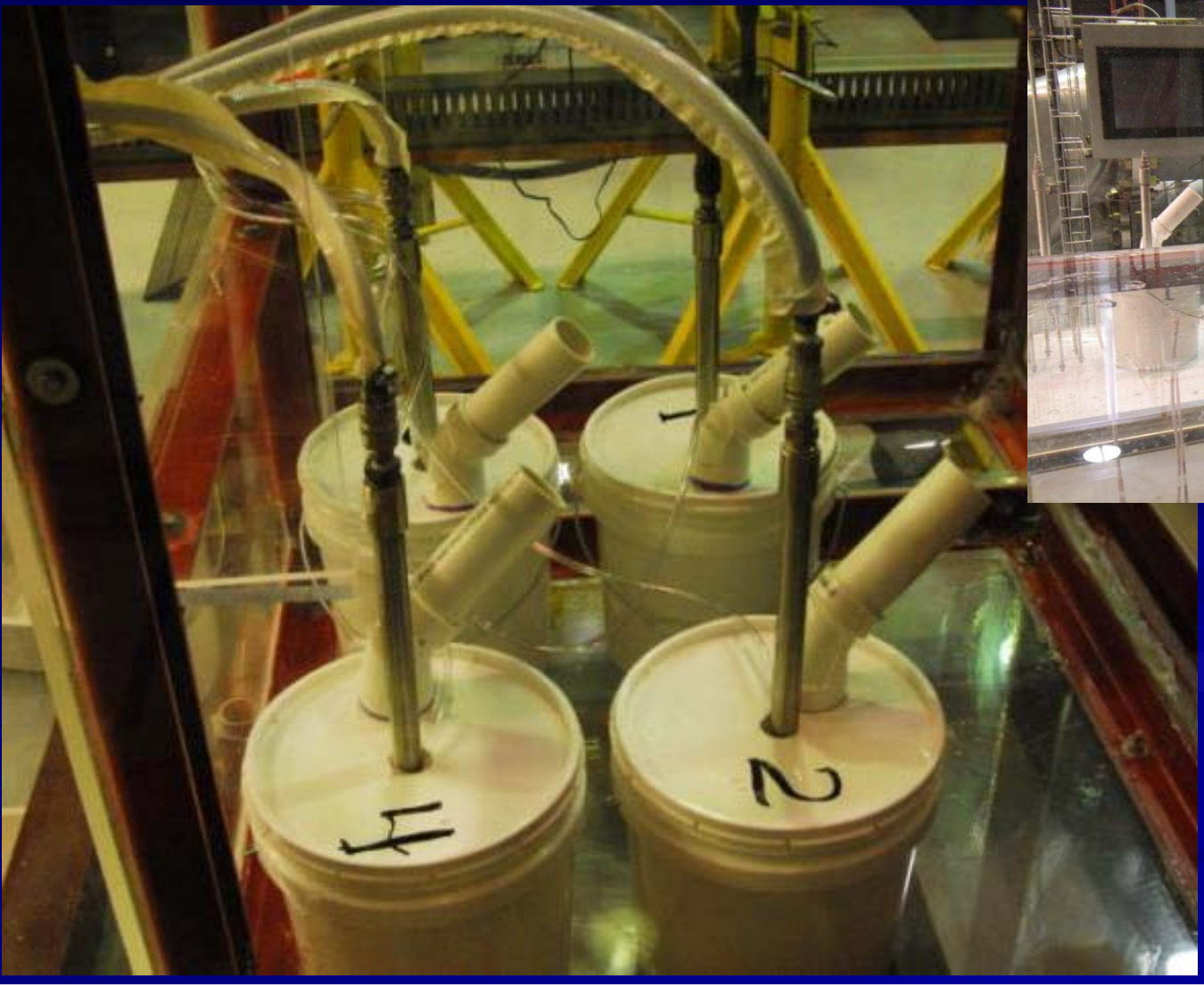
Volumetric Flow Rate	0.7 to 7.1 m^3/min	25 to 250 cfm
Relative Humidity	50 to 99+%	
Filter Differential Pressure	0 to 7.5 kPa	0 – 30” w.c.
Mass Loading Rate (Dry)	200 to 600 mg/m^3	

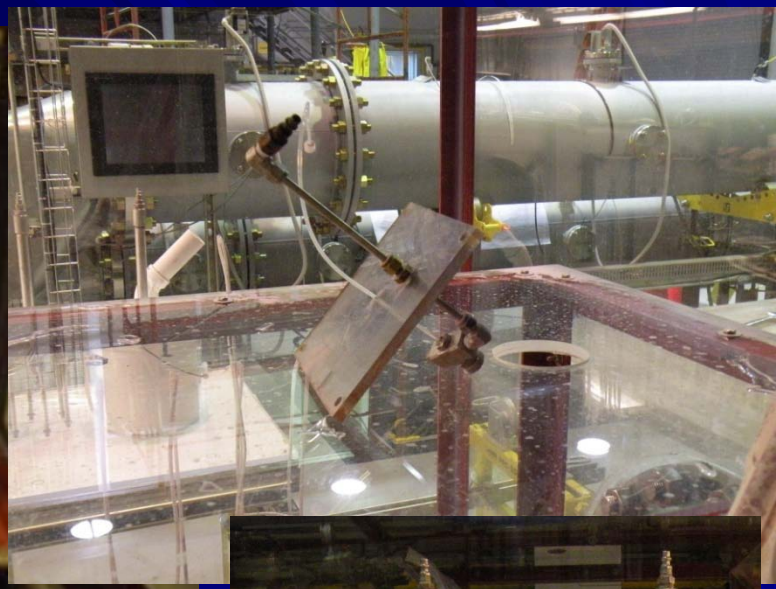


Simulant Used for Aerosols

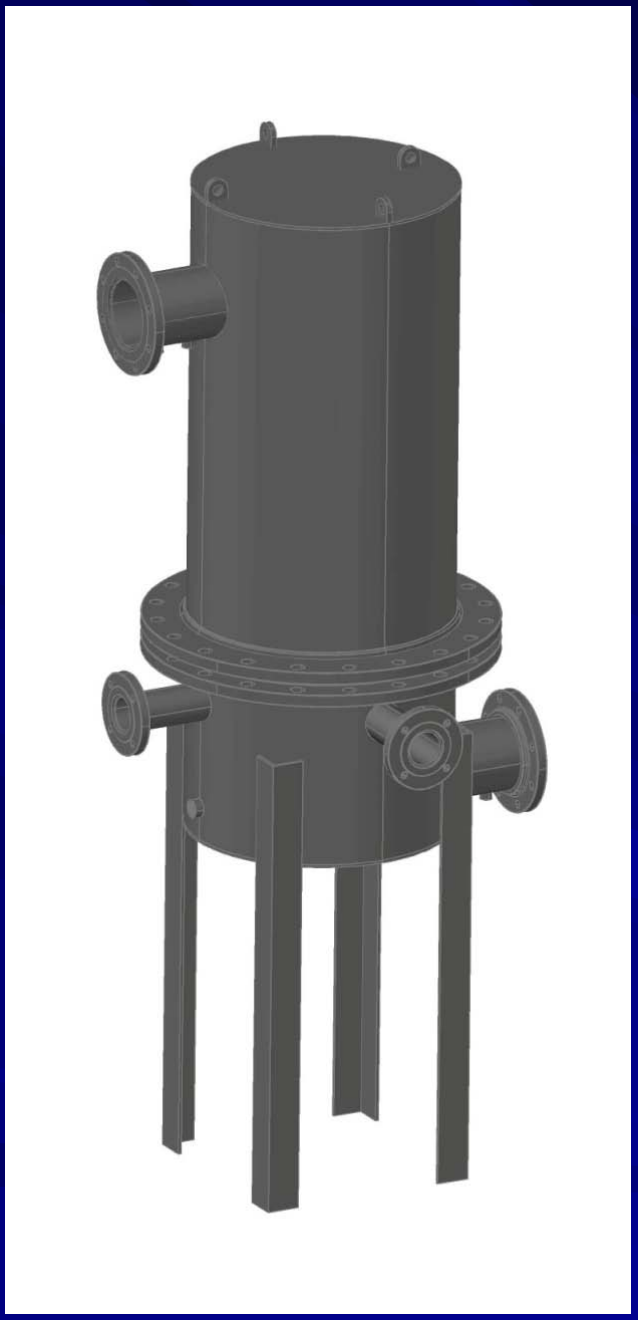
Component	Chemical Formula	Concentration (g/L)	Amount (g) Required to Make 200 L	Total (g)
Sodium Oxalate	$Na^2C_2O_2$	1.9	380	380
Aluminum Nitrate	$Al(NO_3)_3$-$9H_2O$	78	15600	15600
Sodium Phosphate	Na_3PO_4-$12H_2O$	25	5000	5500
Sodium Sulfate	Na_2SO_4	25	5000	5000
Sodium Nitrate	$NaNO_3$	104	20800	20800
Sodium Hydroxide	NaOH	127	25400	25400
Sodium Nitrite	$NaNO_2$	35	7000	7000
Sodium Carbonate	Na_2CO_3	58.57	11714	11714
Alumina	$Al(OH)_3$			29000
Fe(III)				9600
Anti-Foaming Agent				80

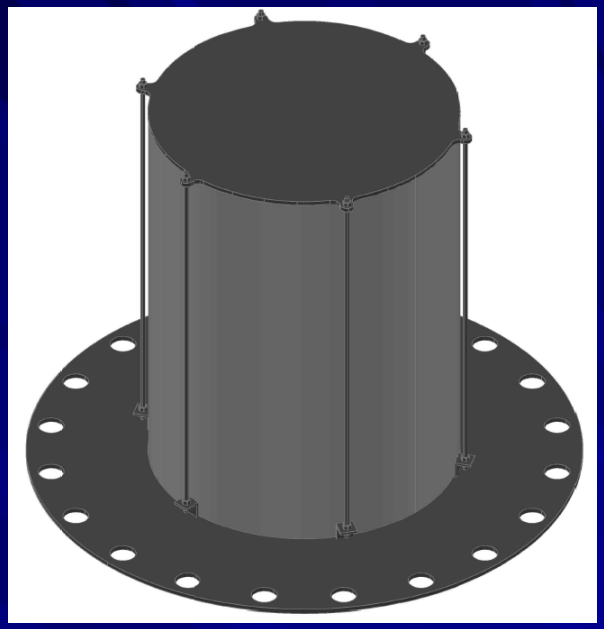
Large & Small Aerosol Generation

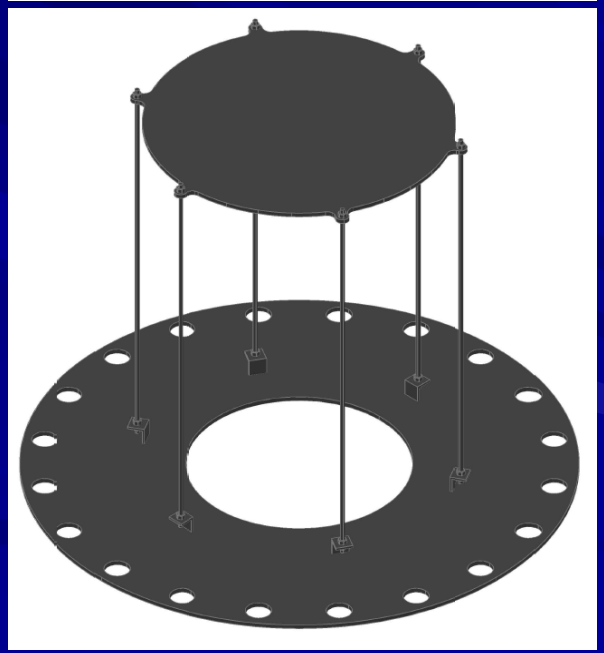




Humid Conditions

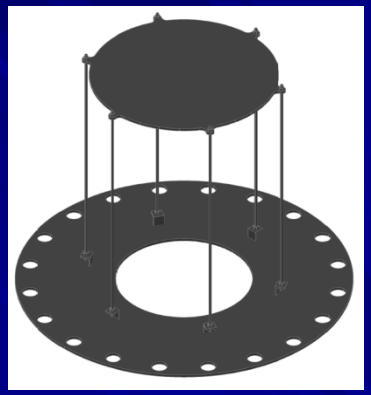


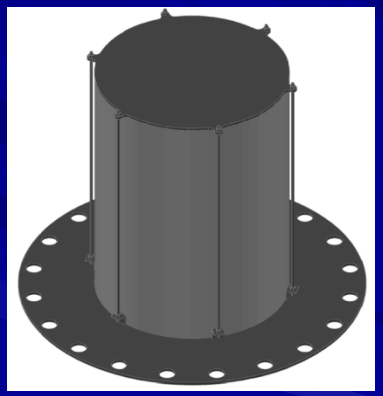




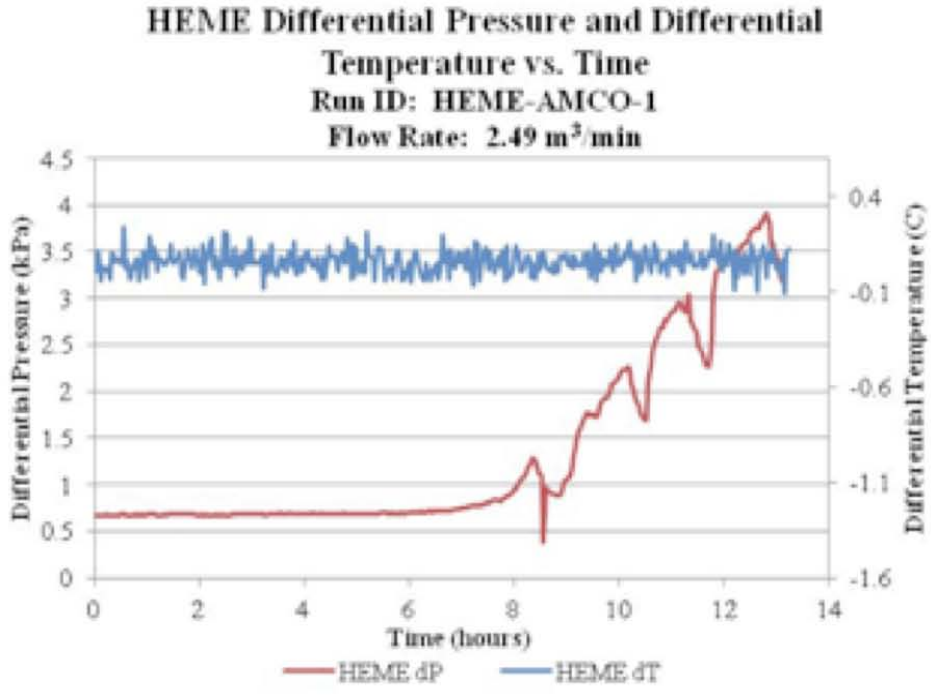
Test Protocol

- Collect Initial Dry FEs
- Hydrate HEME
- Collect Initial Wet FEs
- Load to Intermediate dP
- Collect Intermediate FEs
- Hydrate HEME
- Repeat Intermediate Step 2x
- Collect Final FEs





Typical Test Data



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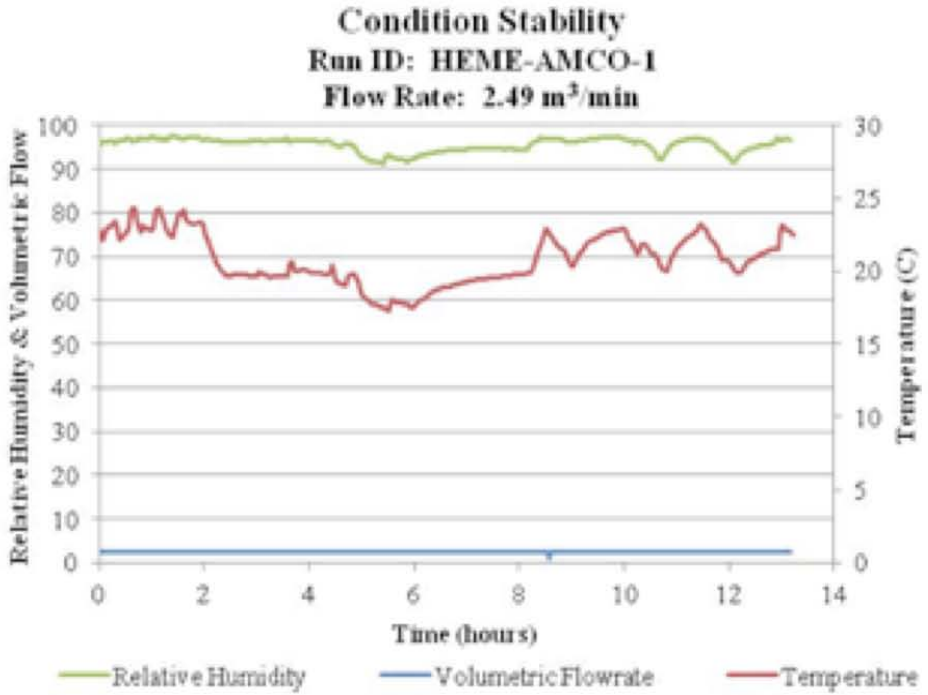

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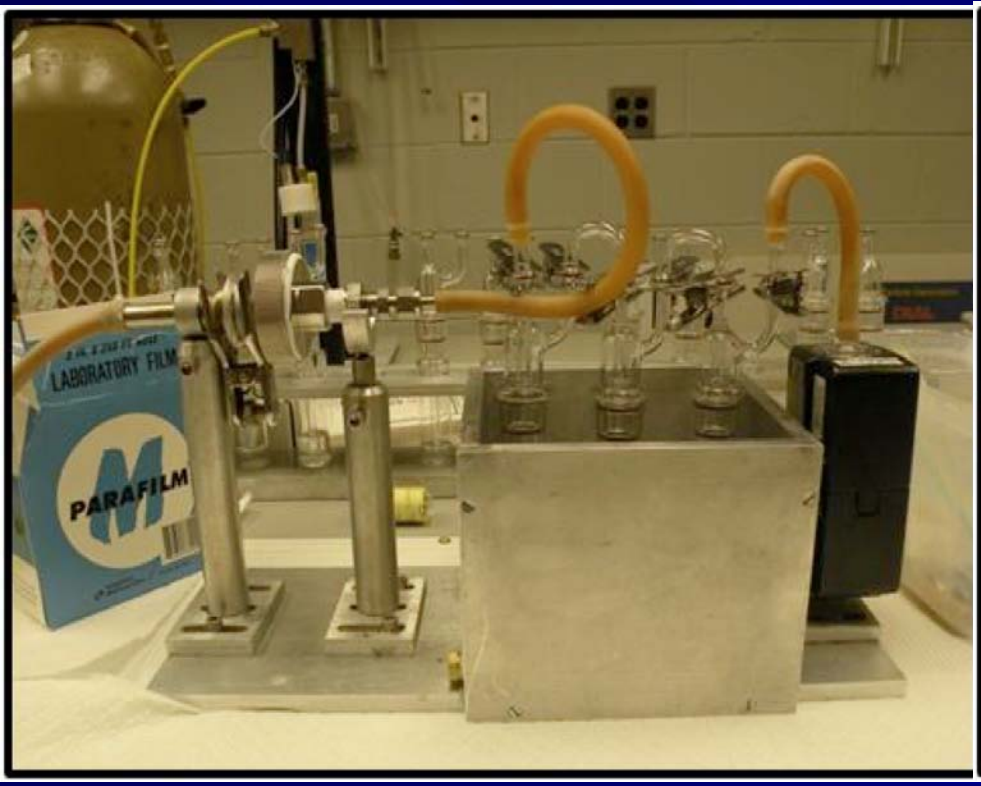
Wet Aerosol Measurement



Typical HEME Test Results

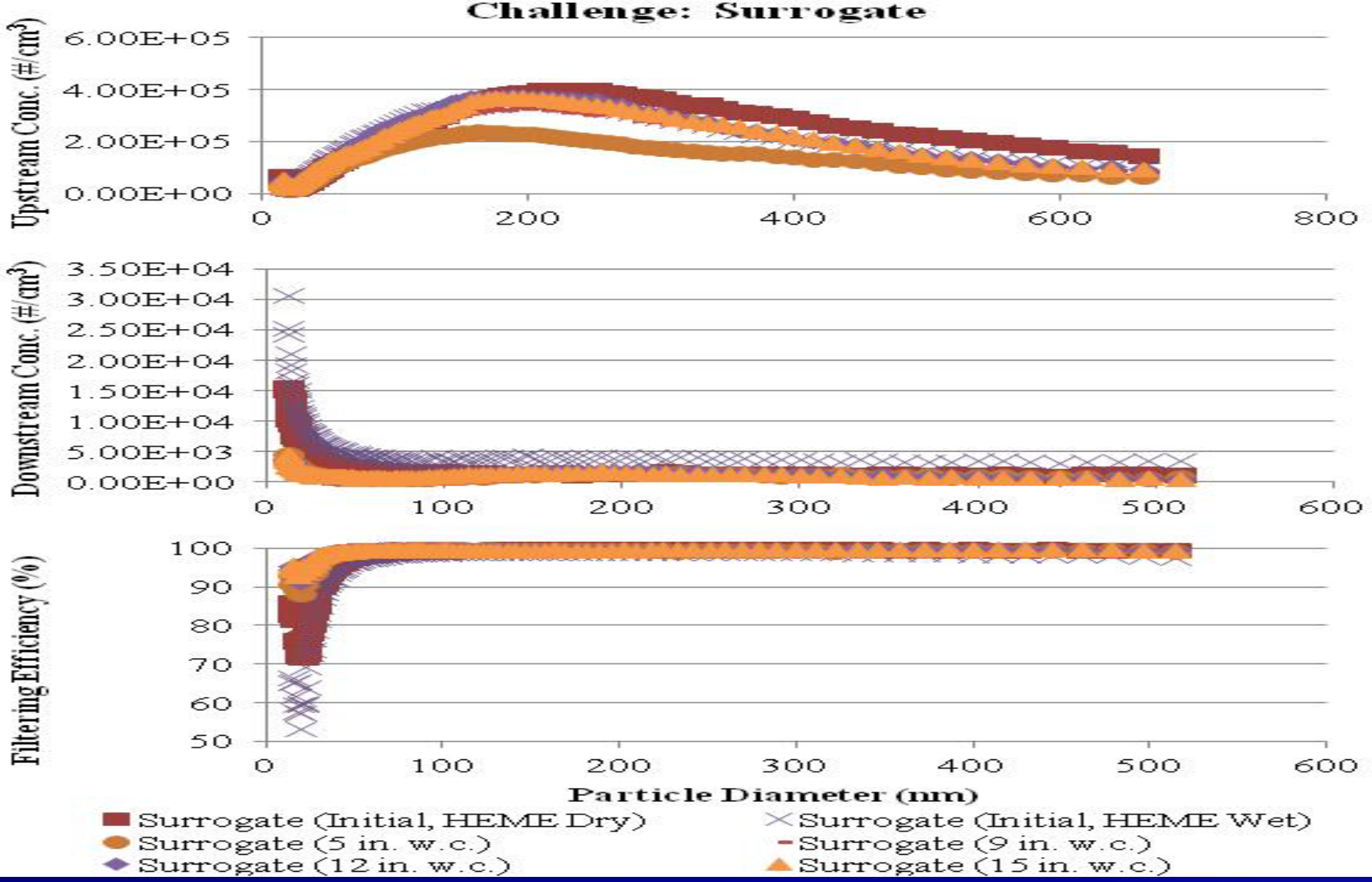
As Received Mass	**66.7 lb**
Dried (Tare) Mass	66.7 lb
Final Wet Mass	76.2 lb
Final Dry Mass	68.3 lb
Total Dry Mass Loading	1.6 lb
Average FE for DOP	98.67%
Average FE for Dry Surrogate	96.4%
FE for >50 nm DOP	99.78%
FE for Particles >50 nm Dry Surrogate	99.31%
Wet Mass Concentration (Filter Method)	2012.26 mg/m_3
Wet Mass Concentration (Impinger Method)	2009.70 mg/m_3
Dry Mass Concentration (Filter Method)	392.83 mg/m_3
Dry Mass Concentration (Impinger Method)	578.22 mg/m^3

Upstream PSD, Downstream PSD, FE

Run ID: HEME-AMCO-1

Flow Rate: 88CFM

Challenge: Surrogate

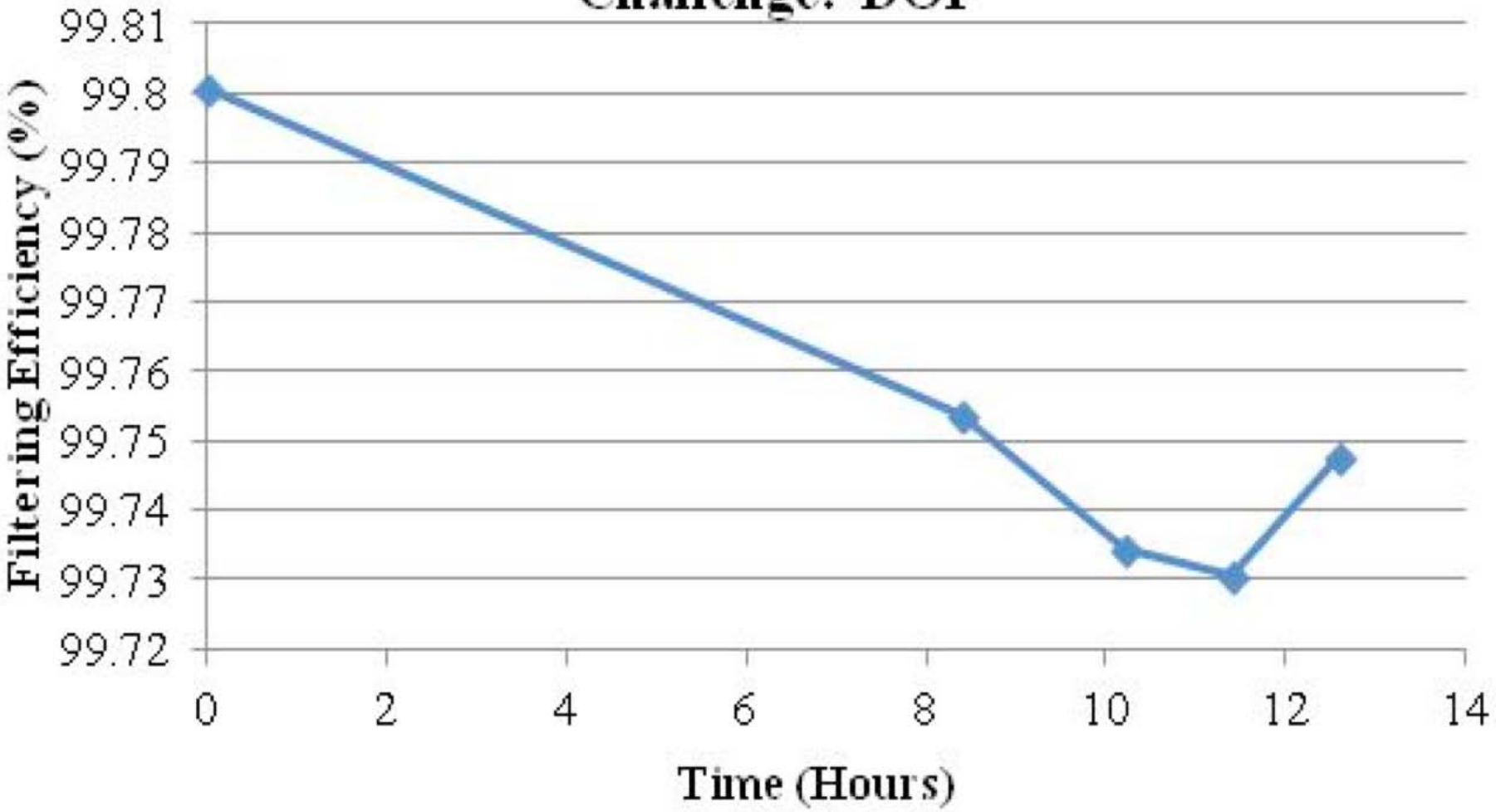


Filtering Efficiency vs. Time

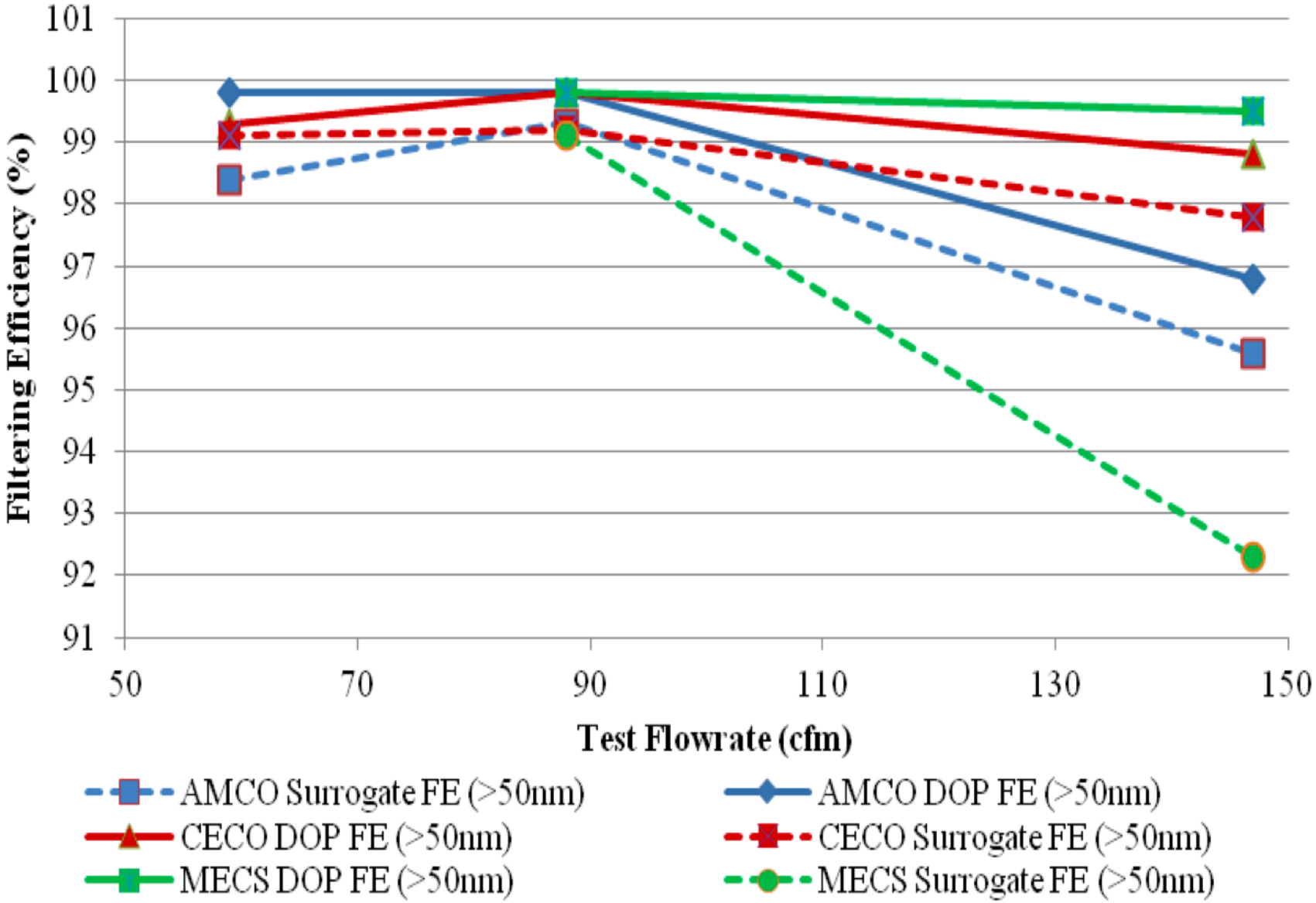
Run ID: HEME-AMCO-1

Flow Rate: 88CFM

Challenge: DOP



HEME Filtering Efficiency versus Testing Flow Rate



Moisture on Tube Sheet

Wicking Through Medium

HEME Filtering Efficiencies

		Filtering Efficiency (%)			
		DOP		Surrogate	
Filter ID :	Flow Rate	All Diameters	Diameters > 50 nm	All Diameters	Diameters > 50 nm
AMCO-1	88 cfm	98.7	99.8	96.4	99.31
AMCO-2	147 cfm	93	96.8	90.3	95.6
AMCO-3	59 cfm	96.4	99.8	92	98.4
CECO-1	88 cfm	98.3	99.8	96.9	99.2
CECO-2	147 cfm	97.4	98.8	93	97.8
CECO-3	59 cfm	98.9	99.3	98.1	99.1
MECS-1	88 cfm	98.8	99.8	95.7	99.1
MECS-2	147 cfm	92.8	99.5	81	92.3

Mass Loading and Times

	Loading Times (hr)		
Filter Manufacturer:	59 cfm	88 cfm	147 cfm
AMCO	6.88	6.06	4.81
CECO	8.08	6.68	5.47
MECS	N/A	2.23	2.56

	Mass Gained		
Filter Manufacturer:	59 cfm	88 cfm	147 cfm
AMCO	0.9	1.6	1.5
CECO	1.3	1.5	1.2
MECS	N/A	0.7	0.6

Nozzle 2
Arrangement and Spray Patterns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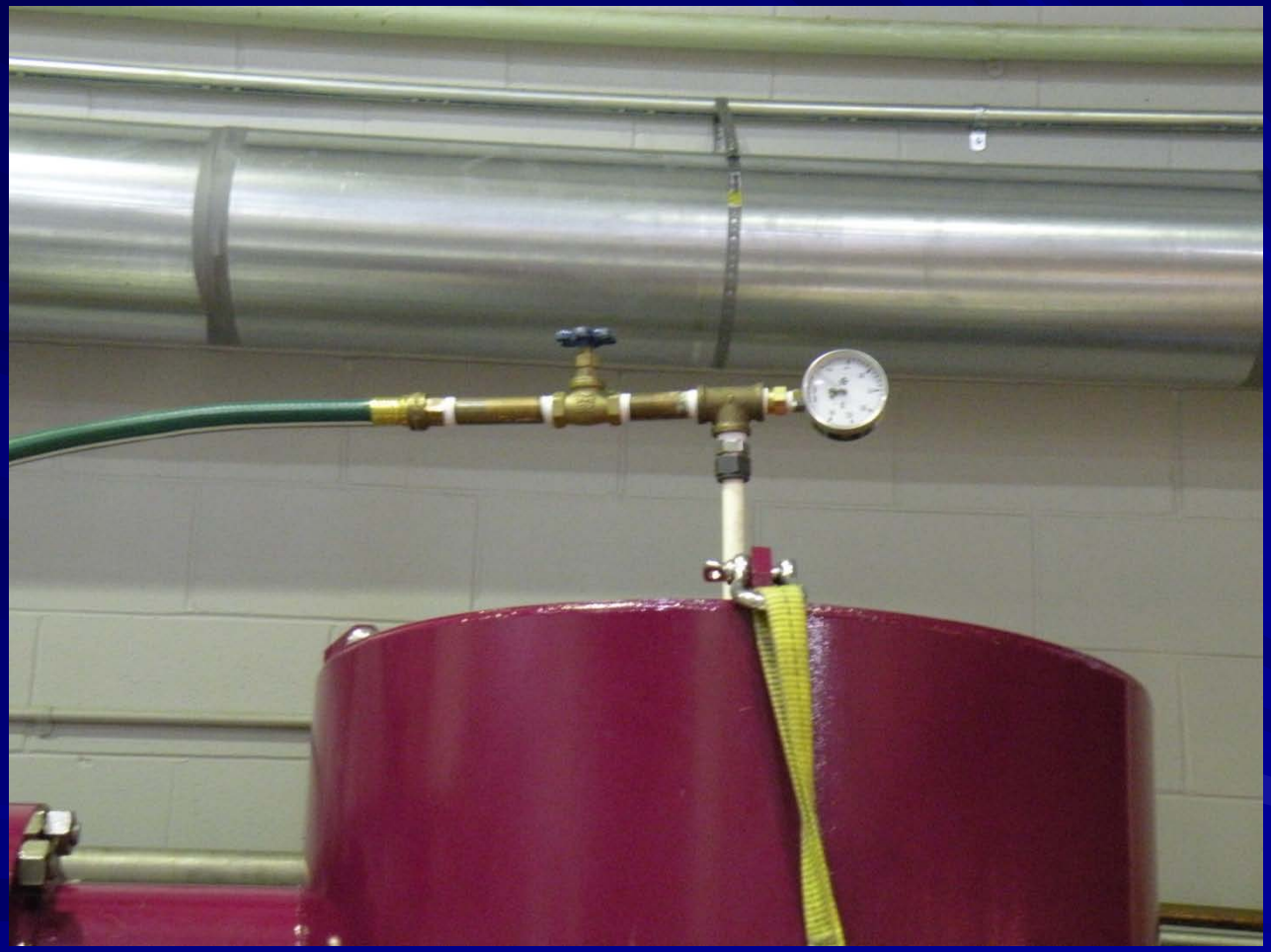
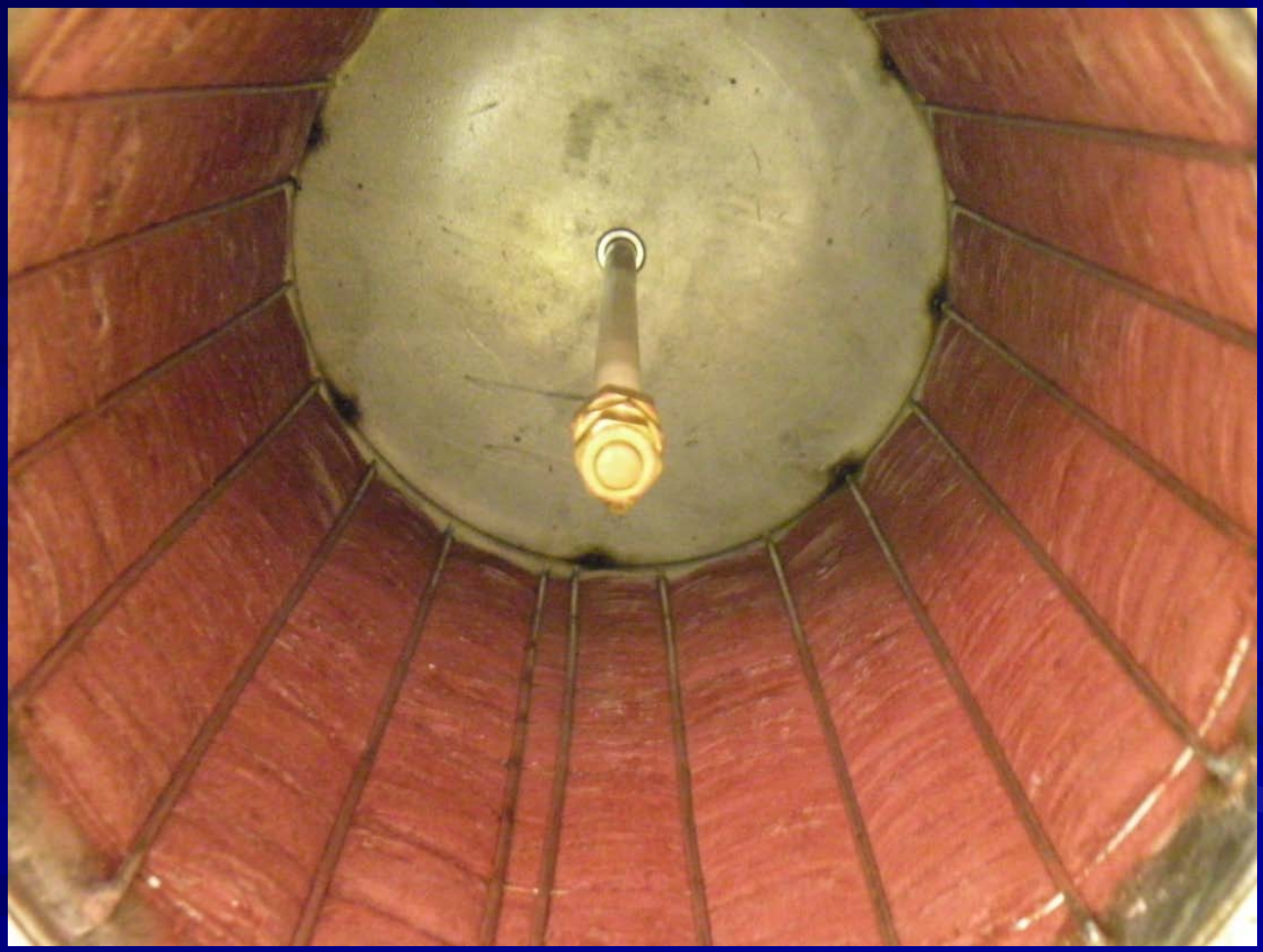
Test Stand Modification



HEME Annulus Post Wash Test



Annular Spray-Wash Test Results

Spray Nozzle 1	
Initial Dry Mass	59.7lb
Initial Dry dP	4.12 in. w.c.
Initial Dry FE (> 50 nm)	99.91%
Initial Wet dP	4.27 in. w.c.
Initial Wet FE (> 50 nm)	99.93%
Spray Number 1 Time	5 min
Spray Number 1 Pressure	30 PSI
Spray Number 1 Total Volume	7.4 GPM @ 15 Psi
Post Spray dP	14 in. w.c. @ 40 CFM
Post Spray dP after drying with fan for 8 hrs	6.7 in. w.c. @ 88 CFM
Mass After 8 hrs Air Drying w/ max 15 in. w.c. dP	85.1 lb
Mass after oven drying 90C for 9 hrs and 120C for 8 hrs	74.3 lb
Mass after last drying for 5 hrs at 140C	70.0 lb
Final Dry dP	4.5 in. w.c.
Final Dry FE (> 50 nm)	99.80%
Final Wet dP	4.87 in. w.c.
Final Wet FE (> 50 nm)	99.81%

Spray Nozzle 2	
Initial Dry Mass	70.0 lb
Initial Dry dP	4.5 in. w.c.
Initial Dry FE (> 50 nm)	99.80%
Initial Wet dP	4.87 in. w.c.
Initial Wet FE (> 50 nm)	99.81%
Spray Number 1 Time	30 sec
Spray Number 1 Pressure	10 psi
Spray Number 1 Total Volume	1.42 gal
Post Spray 1 dP	6.75 in. w.c. @ 88 CFM
Spray Number 2 Time	2 min
Spray Number 2 Pressure	10 psi
Spray Number 2 Total Volume	5.68 gal
Post Spray 2 dP after drip dry for 15 hrs	11 in. w.c. @ 88 CFM
Post Spray 2 dP after drying with fan for 5 Hrs	7.75 in. w.c.
Intermediate FE Before Drying	99.60%
Mass Before Drying	92.1 lb
Mass after Oven Drying	59.6 lb
Final Dry dP	3.99
Final Dry FE (> 50 nm)	99.45
Final Wet dP	4.35

Acknowledgement

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