

Characterization of a Test Stand for Evaluating Performance and Qualifying AG-1 FI Metal Media Filters and FO Ceramic Filters Under ASME AG-1

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Initial Test Stand Performance Criteria

■ Multiple Cylindrical Filter Elements

- Metal Fiber
- Metal Powder

■ 200 ACFM Flow Rate

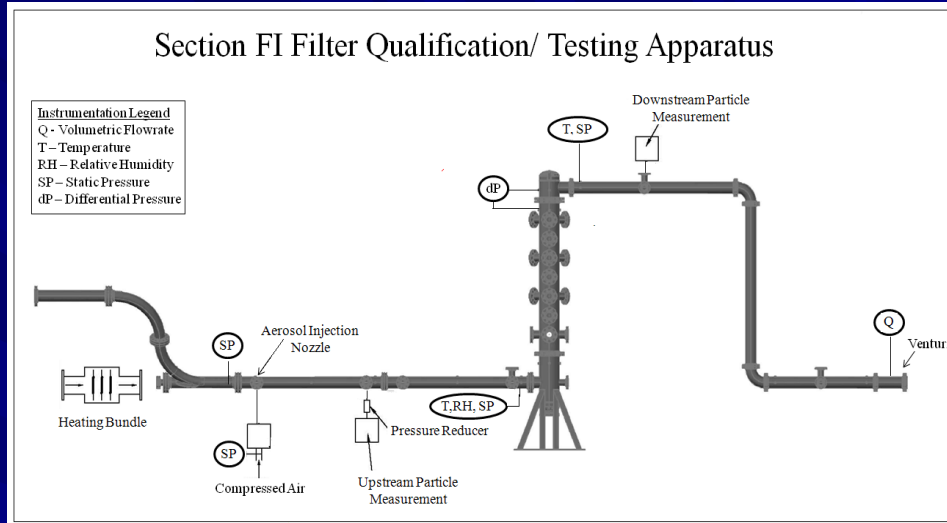
■ Positive Pressure

■ Test Condition Ranges

- 40-60% RH and 60-80° F

■ Aerosol Generation & Measurement

■ High Pressure & High Temperature Testing



Housing

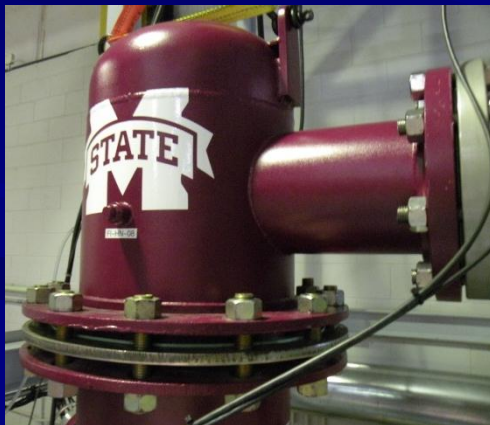
■ Three Sections

- Cap, Middle Section, Base

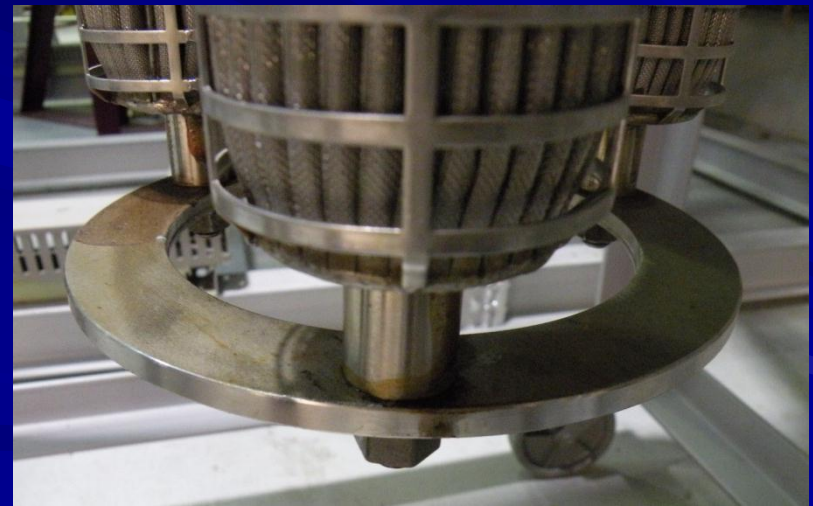
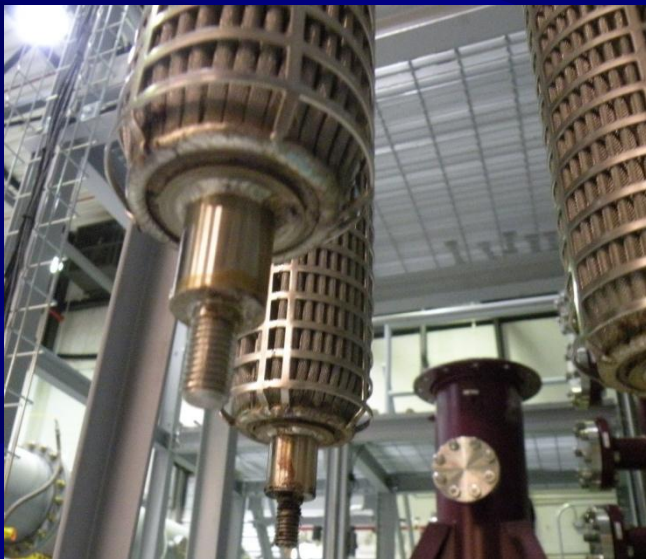
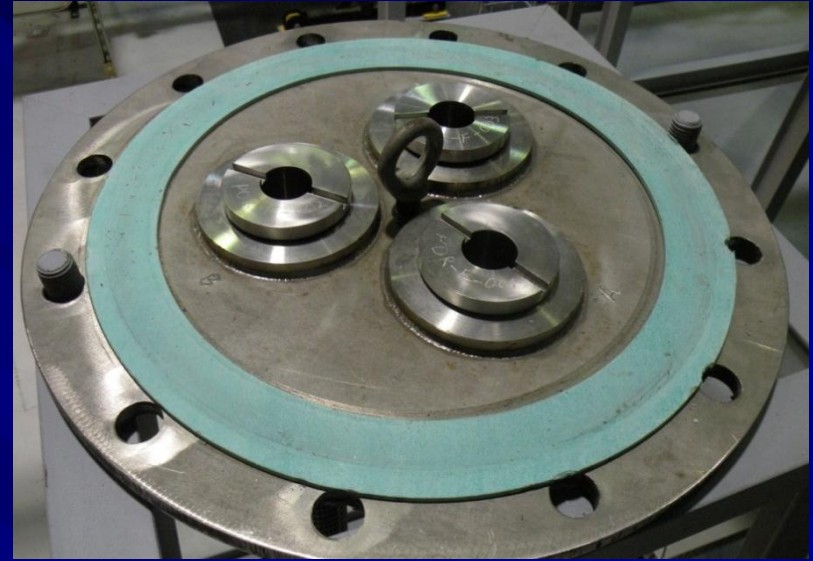
- Air Flow Inlet & Exit

- Ports

- Camera
- Sampling
- Differential Pressure
- Temperature
- Static Pressure



Tubesheet



Piping

■ Upstream Piping

- Aerosol Injection Port
- Aerosol Sampling Port
- Sensors
 - Temperature
 - Relative Humidity
 - Static Pressure

■ Downstream

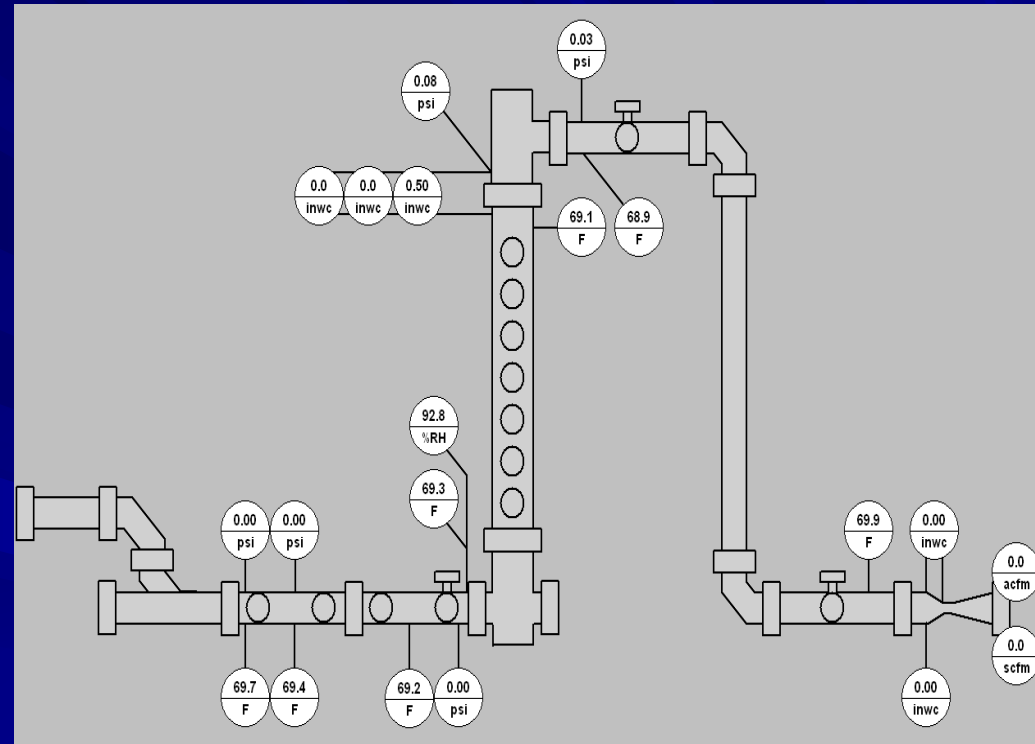
- Aerosol Sampling Ports
- Sensors
 - Temperature
 - Static Pressure
 - Venturi



Sensor Locations

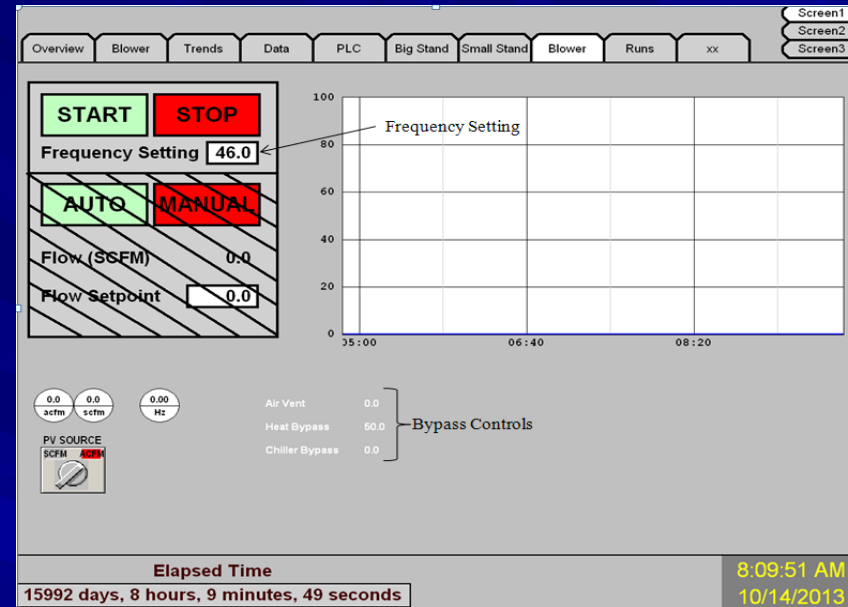
■ Sensors Include

- Static Pressure x 6
 - 0 to 30 PSIG
- Temperature x 6
 - -58° F to 932° F
- Relative Humidity and Temperature
 - 0 to 100%
 - -94° F to 356° F
- Differential Pressure
 - 0 to 2.5 PSIG
 - 0 to 5 PSIG
 - 0 to 15 PSIG



Control System

- Test Stand System Control and Data Acquisition Computer
 - CPU
 - Program Logic Controller (PLC)
 - Wonderware Software for User Interface
- Baldor Variable Frequency Drive (VFD) 20-60 Hz



Air Supply System

- Spencer Vortex Blowers
- Elmo-Rietschle Claw Compressor
- Pneumatic Air Bleed Off Valve
- Primary Flow Signal Venturi



Chiller and Heat Exchangers

■ Water Chiller

- Capacity 51,900 BTU/hr



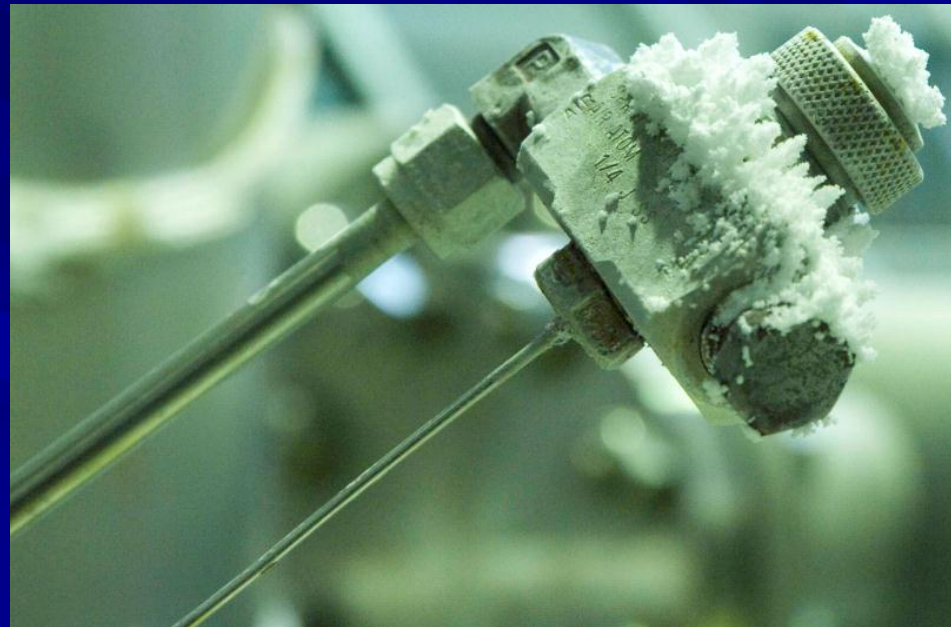
■ Heat Exchangers

- Air to Air Reheat Heat Exchanger
- Air to Chilled Fluid Heat Exchanger



Aerosol Generation

- Large Scale Aerosol Generator
 - Potassium Chloride (KCl)



Aerosol Measurement

Instrument	#/cc (min)	#/cc (max)	Particle Size Distribution (μm)
Scanning Mobility Particle Sizer (SMPS) <ul style="list-style-type: none"> • TSI Model 3080 Electrostatic Classifier • 95 cm Custom Differential Mobility Analyzer (DMA) • TSI Model 3775 Condensation Particle Counter (CPC) 	2	1×10^8	0.008 - 1
Scanning Mobility Particle Sizer (SMPS) <ul style="list-style-type: none"> • TSI Model 3080 Electrostatic Classifier • TSI Model 3081 Differential Mobility Analyzer (DMA) • TSI Model 3772 Condensation Particle Counter (CPC) 	2	1×10^8	0.008 – 0.6
TSI Model 3321 APS (with TSI Model 3302A Diluter)	1	1×10^3 (1×10^5)	0.3 – 20
TSI Model 3340 LAS	<0.02	1.8×10^3	0.09 – 7.5

Pressure Reducer

- **Elevated Differential Pressure**
 - Loading Test
 - Instrument
- **Pressure Reducer is Necessary for > 1 PSIG**

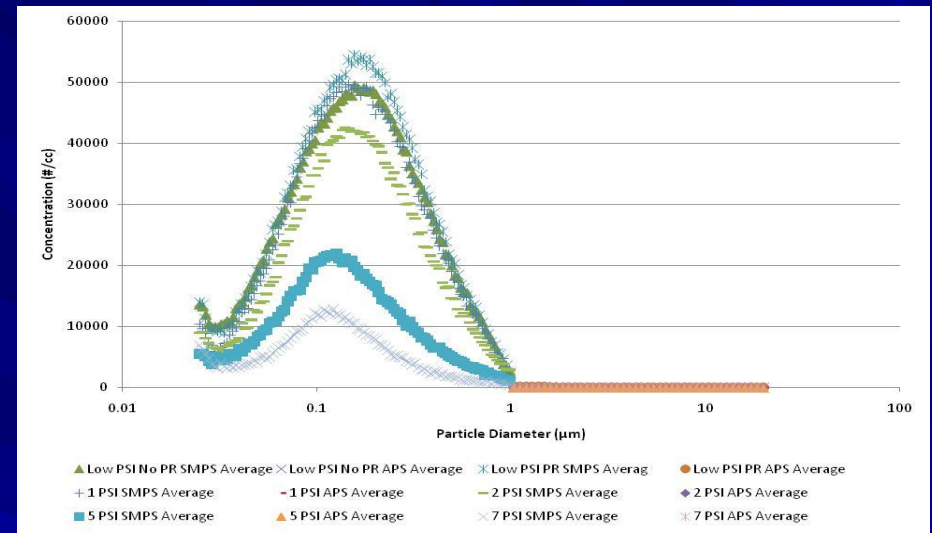
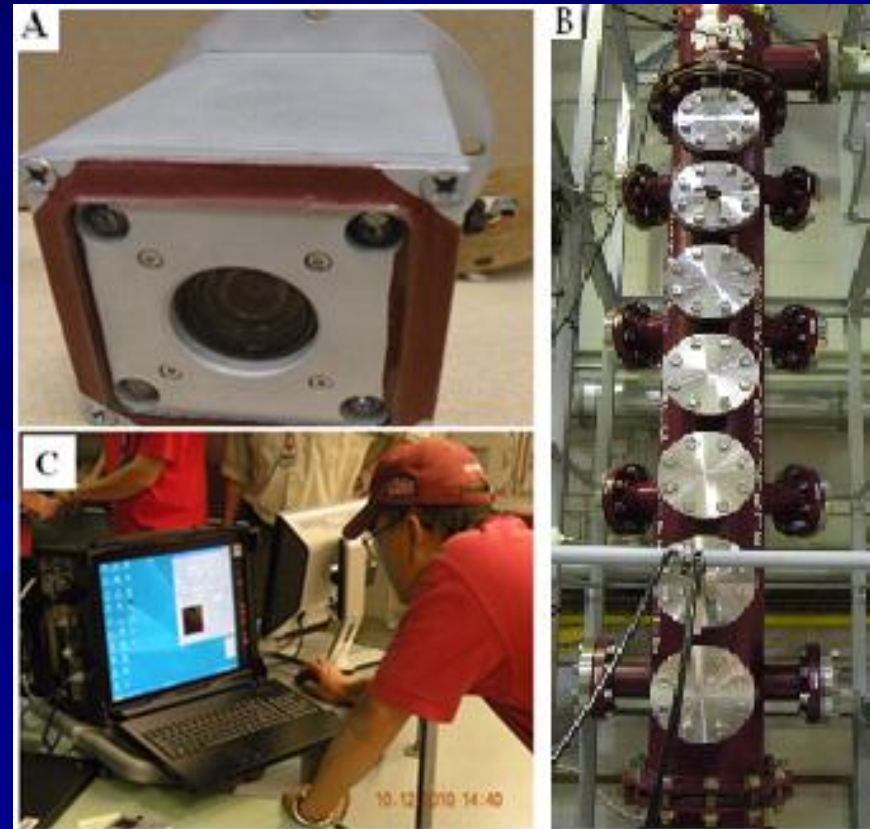


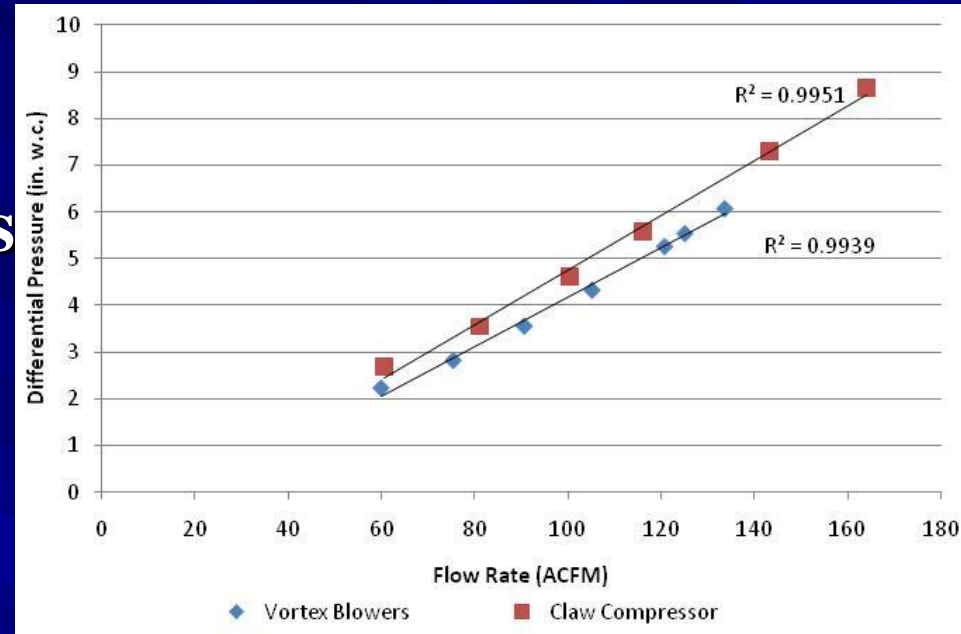
Image Collection

- Camera System
 - Digital Camera
 - Lighting
 - Access Ports

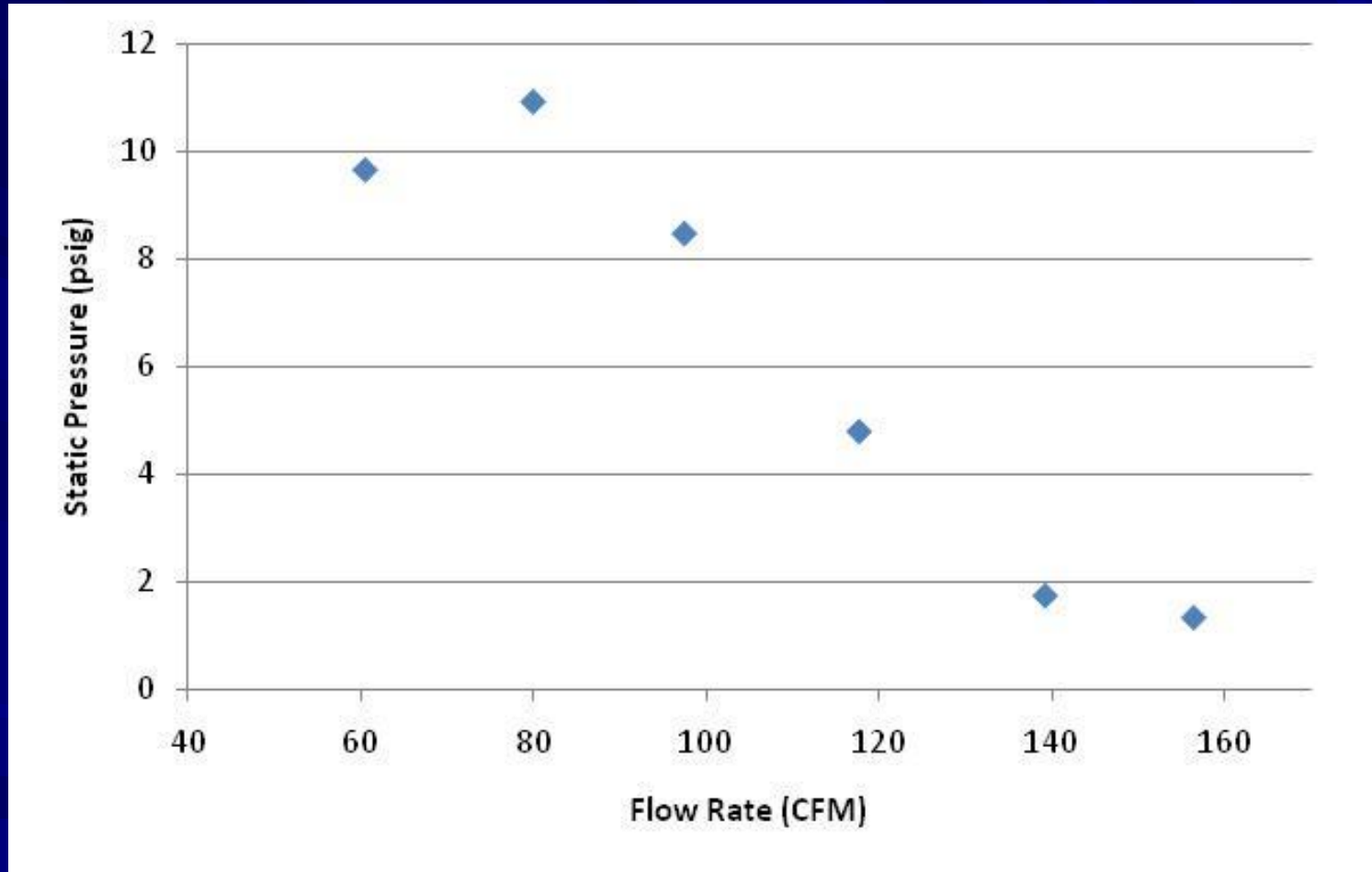


Air Supply System

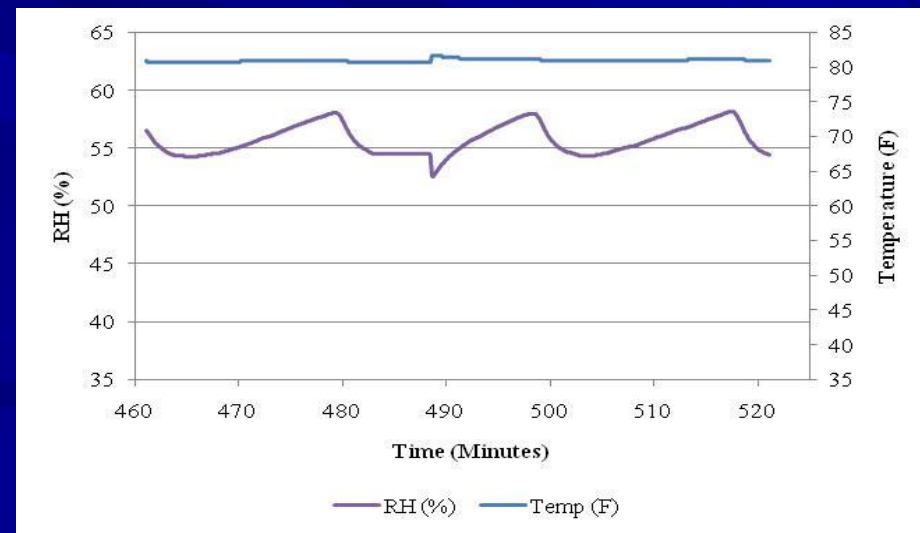
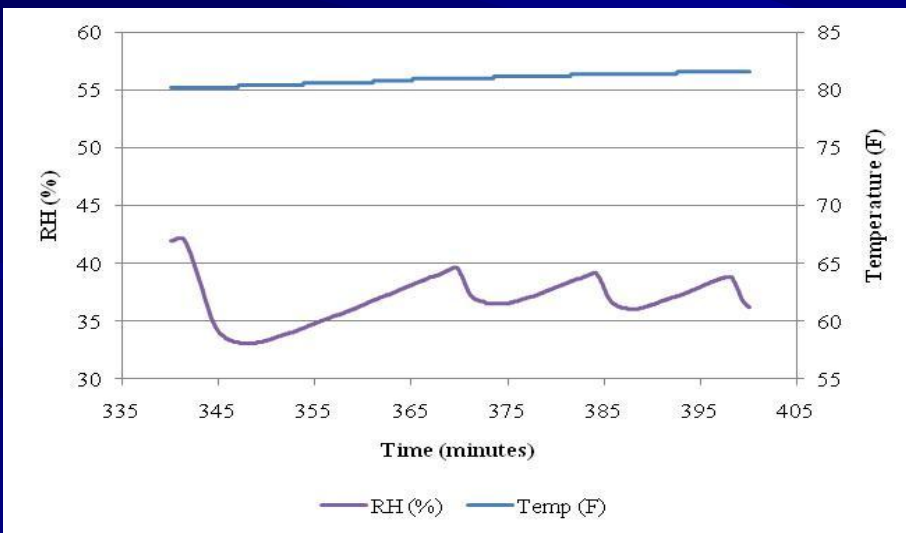
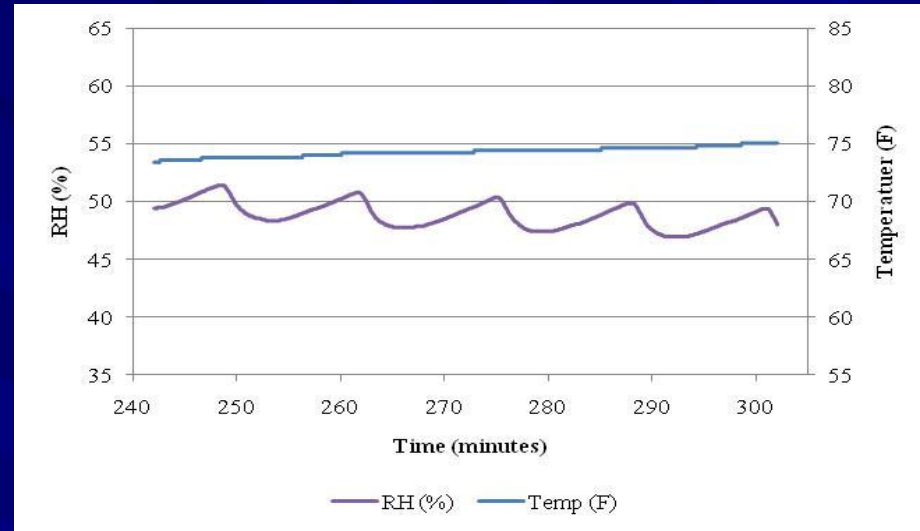
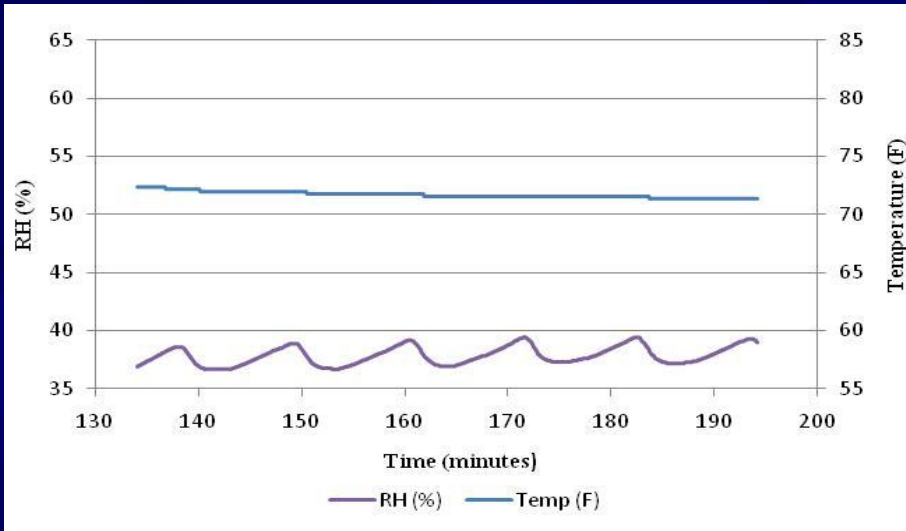
- Two Systems Characterized
 - Spencer Vortex Blowers in Series
 - 133 ACFM Maximum
 - Elmo-Rietschle Claw Compressor
 - 160 ACFM Maximum



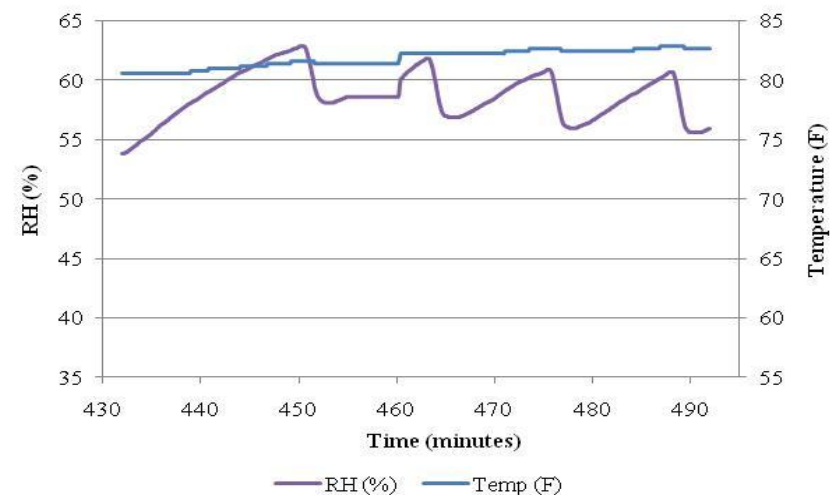
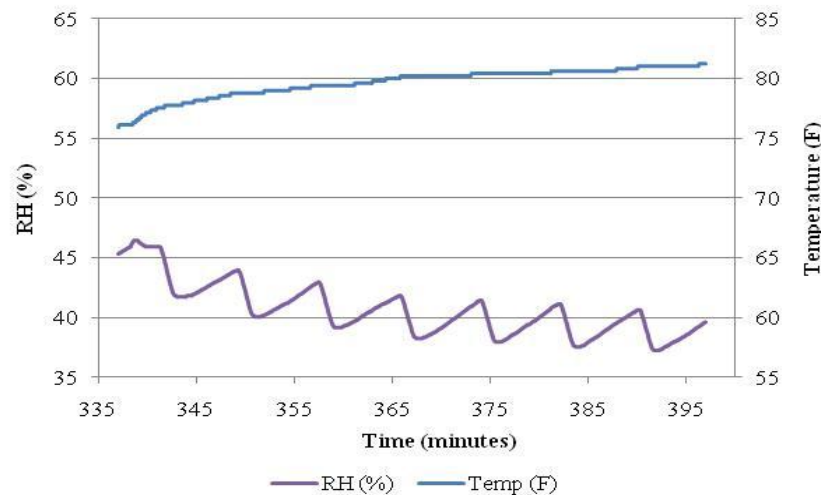
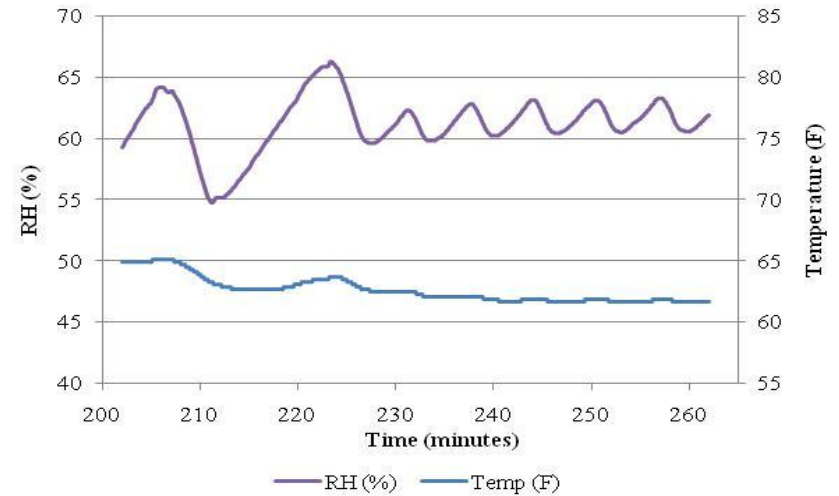
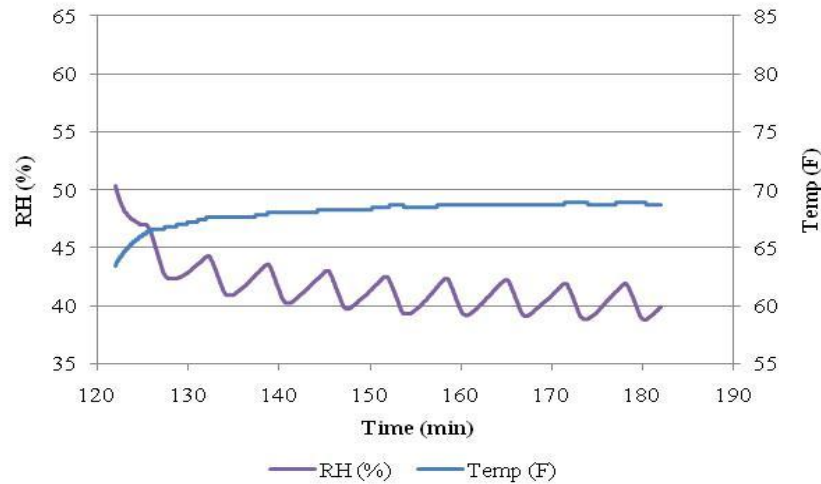
Claw Compressor Performance Curve



Temperature and Relative Humidity for 50 CFM



Temperature and Relative Humidity for 160 CFM



Preliminary Metal Media Filter Element Testing

■ Filter Elements Tested

- Porvair Filtration
- Sintered Fiber
- Pleated Media
- 3 ¼ Feet Length
- 3 inch Diameter

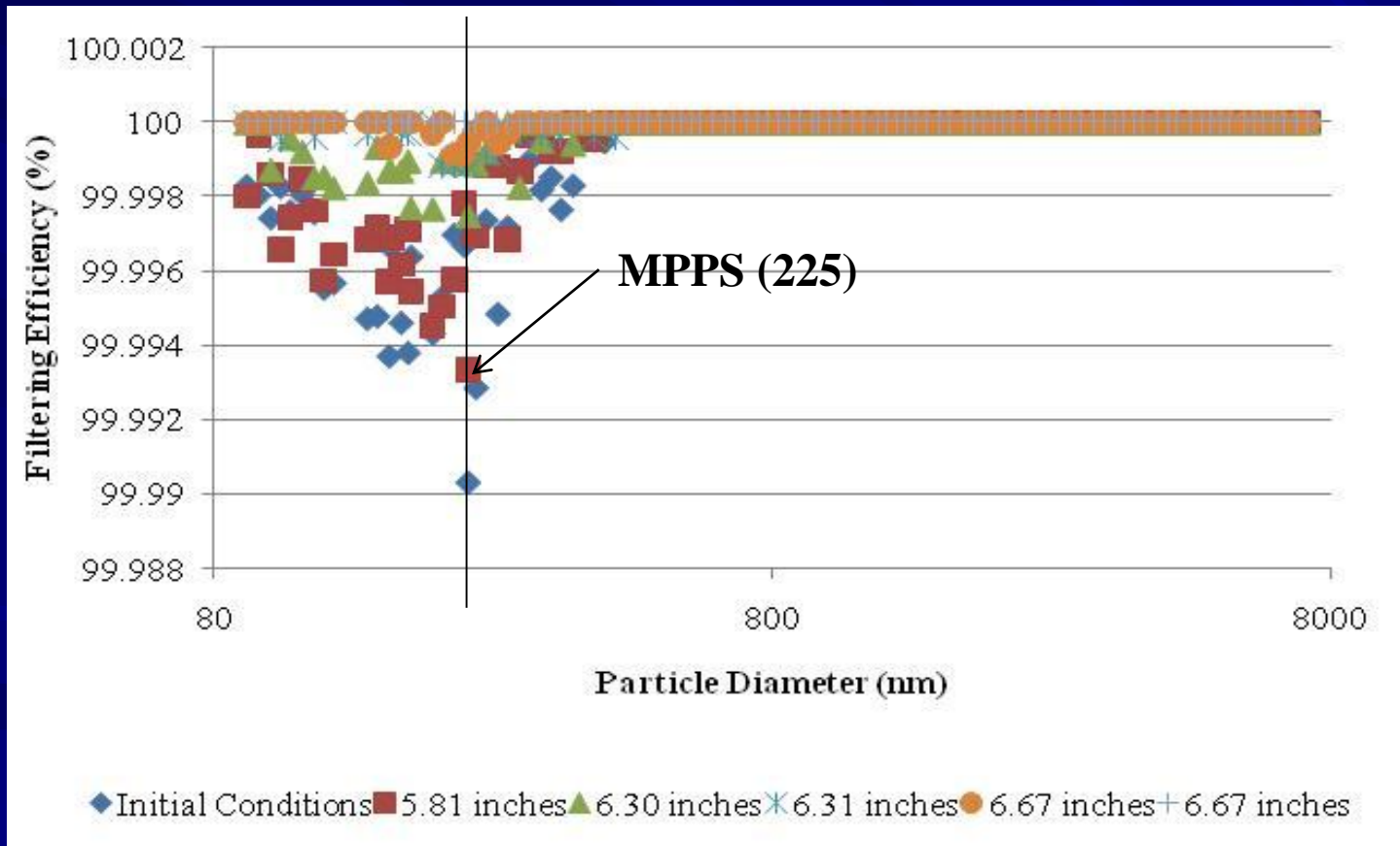
■ Testing

- 120 CFM
- 5 ½ Hours
- Potassium Chloride (KCl)



Preliminary Metal Media Efficiency Curve & MPPS

- Efficiency vs Particle Diameter
- Efficiency Increases with Loading



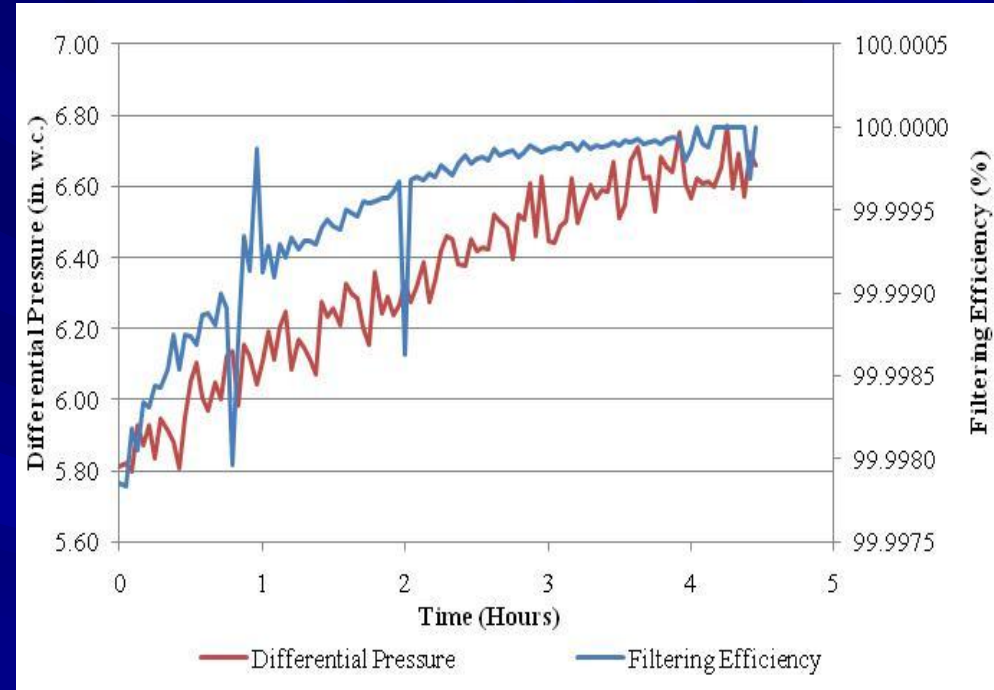
Preliminary Metal Media Total Filtering Efficiency

■ Total FE vs Time

- Increases with Loading

■ Differential Pressure vs Time

- Increases with Loading



Recommendations

- **Upstream HEPA Filters**
- **Aerosol Generation**
 - **Aerosol Injection Against Elevated Pressure.**
 - **Temperature and Moisture Reduction**
- **High Temperature Section**
- **High Pressure Test Stand**
- **Back Pulse Capability**

Acknowledgements

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Questions?