3A.3 Power Systems Development Facility: High Temperature, High Pressure Filter System Operations in a Combustion Gas

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Abstract

The Power Systems Development Facility* (PSDF) is an engineering scale demonstration of two advanced coal-fired power systems and several High-Temperature, High-Pressure gas filtration systems. The PSDF was designed at sufficient scale so that advanced power systems and components could be tested in an integrated fashion to provide confidence and data for commercial scale-up. This paper provides an operations summary of a Westinghouse Particulate Control Device (PCD) filtering combustion gas from a M.W. Kellogg Transport reactor located at the PSDF.

The Transport reactor is an advanced circulating fluidized bed reactor designed to operate as either a combustor or a gasifier. Particulate cleanup is achieved by using one of two PCDs, located downstream of the Transport reactor. As of April 1998, the Transport reactor has operated on coal as a combustor for over 2600 hours. Operationally, the PCD has worked well, with few mechanical problems. To date filter elements from 3M, Blasch, Coors, Dupont, IF&P,

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McDermott, Pall, Schumacher and Specific Surface have been tested up to 1400 °F. Silicon carbide filter elements have been exposed for over 2300 hours on coal with no steady-state failures.

The Southern Research Institute's *in-situ* sampling systems on the PCD inlet and outlet have operated successfully. Isokinetic samples using a batch sampler, a cascade impactor, and a cyclone manifold have provided valuable data to support the operation of the transport reactor and the PCD. Southern Research Institute has also supported the PSDF by conducting filter element materials testing.

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Presentation Outline

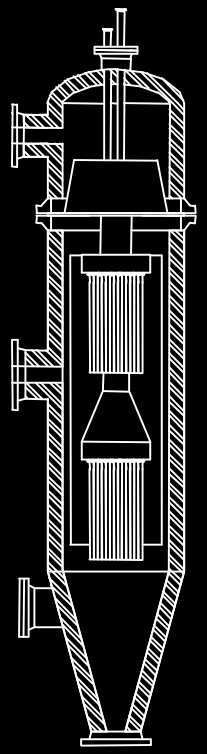
- Description of Westinghouse Advanced Particle Filter (APF)
- Combustion operations with the Westinghouse APF
- Filter element testing
- Current and future activities

Will be updated

M.W. Kellogg Transport Reactor

- Can be operated in either combustion or gasification mode
- Over 3000 hours on coal in combustion mode since start-up in August 1996
- Operated to date on two types of coals and sorbents

Westinghouse Advanced Particle Filter



- 91 candle filter elements on two plenums
- Top and bottom plenums are back-pulsed separately
- Tangential inlet
- Cylindrical shroud

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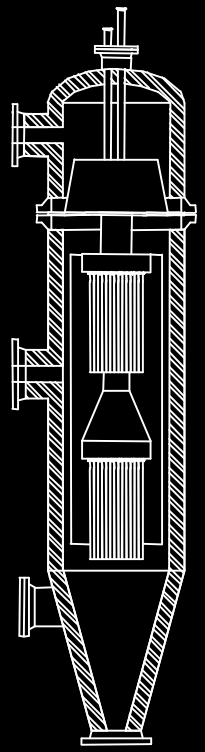
Typical Operating Conditions



- Temperature 1375°F
- Pressure 200 psig
- Face velocity 5 ft/min
- Baseline DP 75 inwg
- DP rise 30 inwg
- Pulse pressure 450 psig
- Pulse duration 0.2 sec
- Pulse frequency 40 minutes
- Inlet loading 10,000 ppmw
- Particle MMD 20 micron

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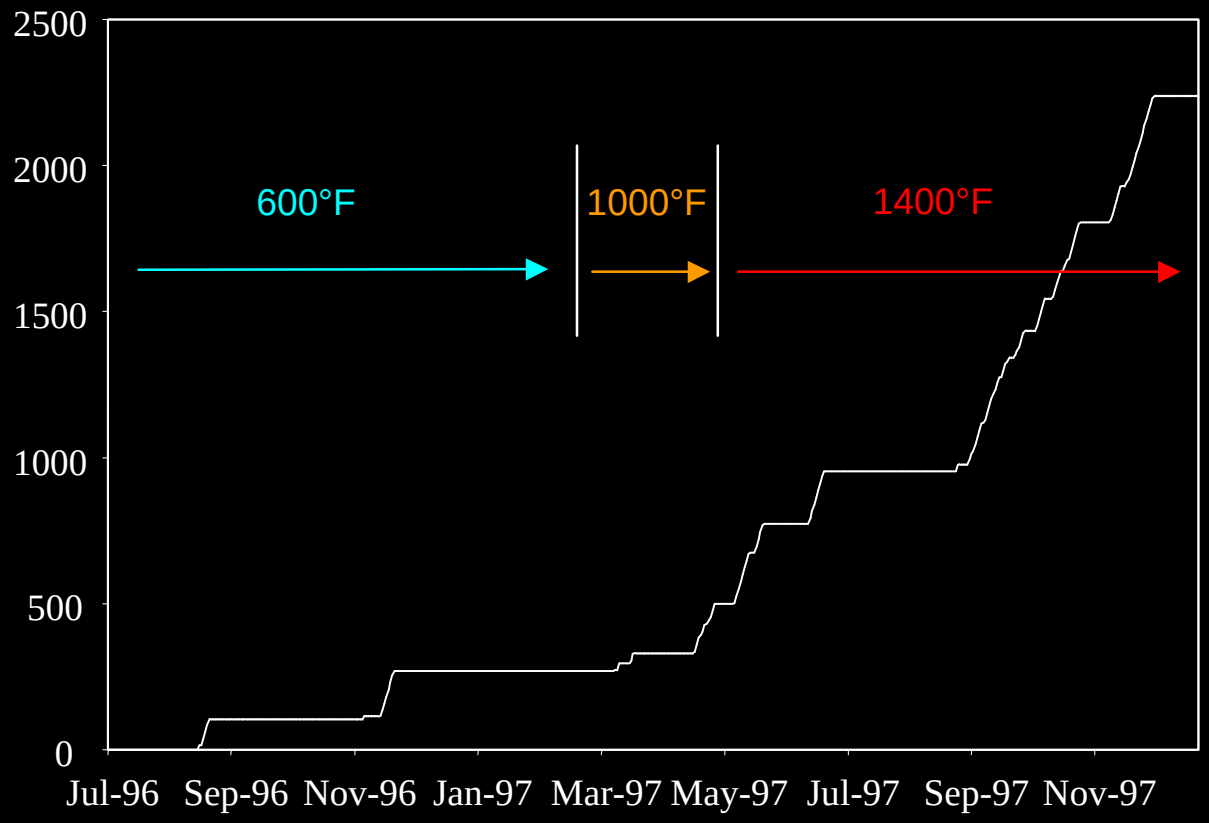
Cumulative Hours on Coal Since Start-up



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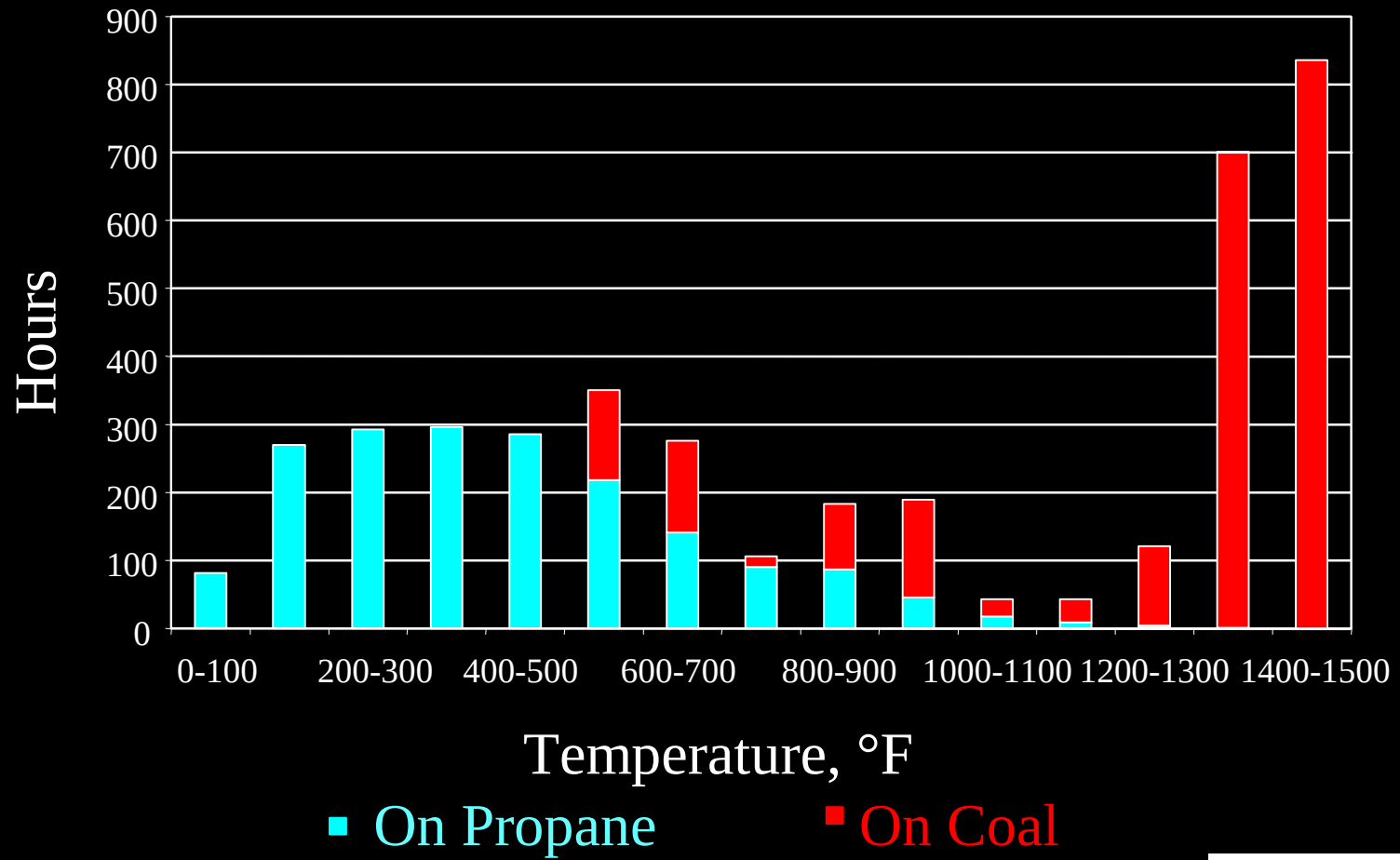
Temperature vs. Hours Since Start-up



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General Observations

- No ash bridging has been observed since start-up in 8/96
- Mechanically the filter unit is in good condition

update

Filter Elements Tested

Manufacturer	Type	Material	Hours on Coal
3M	Oxide	Composite	283+
	Type 203	Composite	1251
Blasch		Alumina/mullite	54
Coors	P-100A-1	Alumina/mullite	810
Dupont	PRD66C	Composite	283+
IF&P	REECER	Recrystallized SiC	283+
McDermott		Composite	283+
Pall	326	SiC	2150+
	442T	SiC	2150+
	FeAl	Iron Aluminide	283+
Schumacher	F40	SiC	616
	TF20	SiC	822+
	T10-20	SiC	1522+
Specific Surface	CC-4001	Cordierite	54

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Filter Element Losses

- Commissioning
- Thermal transients

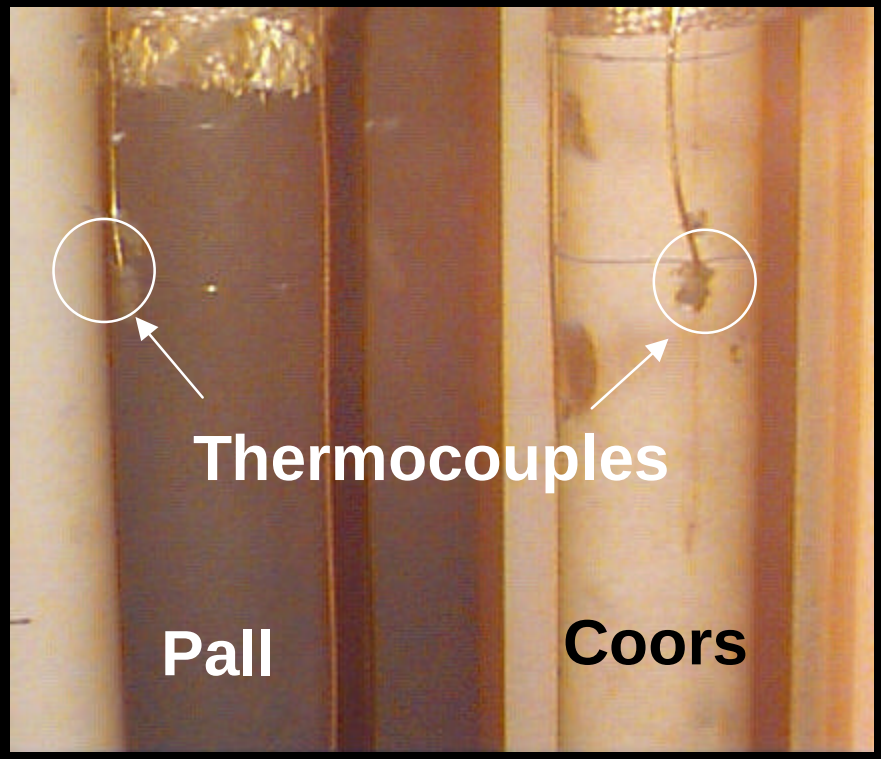
Commissioning

- SiC filter elements broken due to
  - –Transport reactor particulate carry-over problems
  - –inexperience in measuring filter vessel ash level
  - –inadvertent coal feed
- No SiC filter elements broken since commissioning

Thermal Transients

- Oxide-based monolithic filter elements broken due to local combustion on surface of elements during transition to coal
- System temperature prior to coal feed raised to ensure complete combustion in reactor

Instrumented Filter Elements



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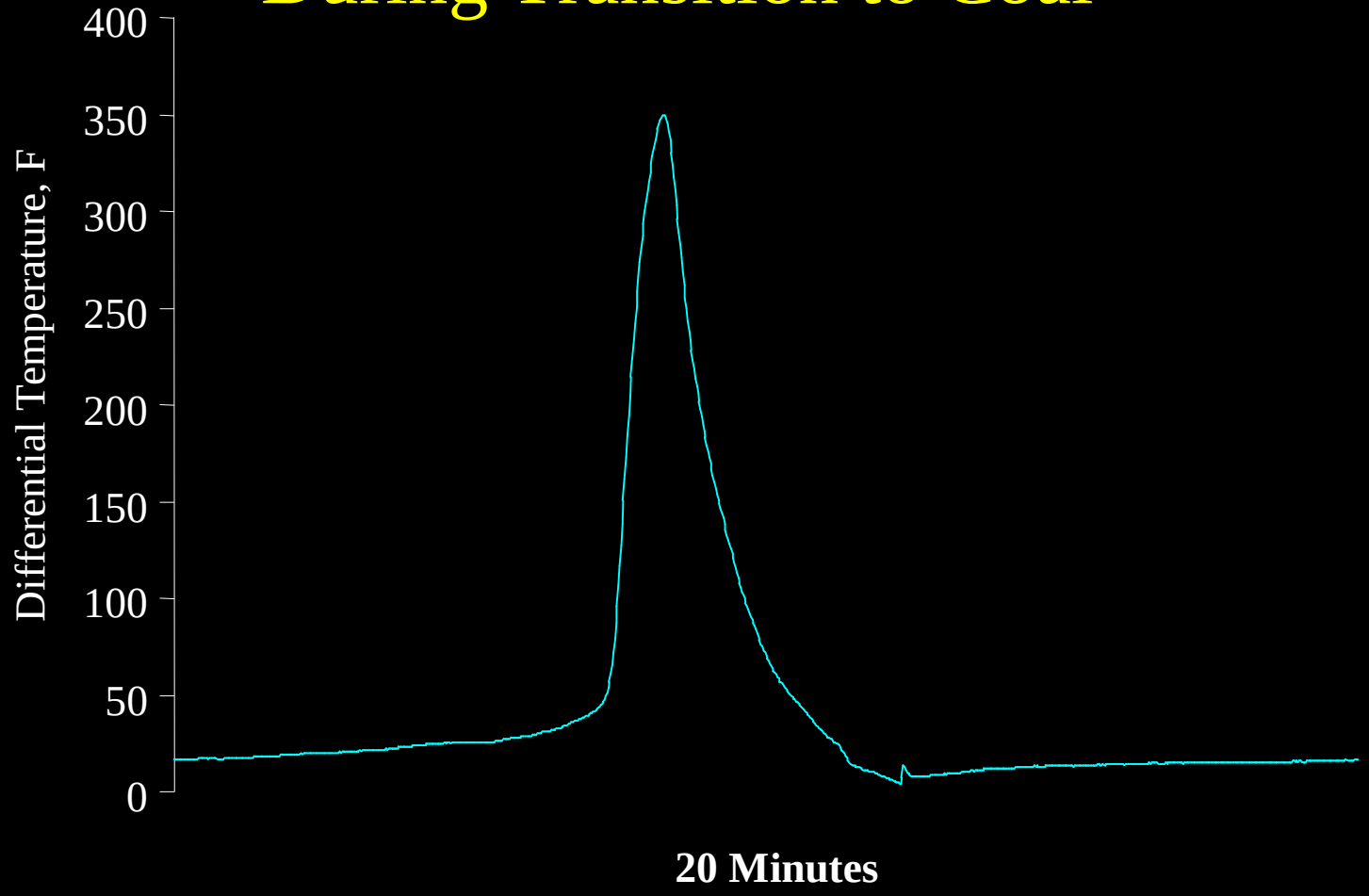
Thermal Gradient Across Filter Element During Transition to Coal



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Monolithic SiC Filter Element Growth Measurements

- The length of 24 monolithic SiC elements measured before and after exposure
- No growth detected after 1000 hours of exposure at 1400°F

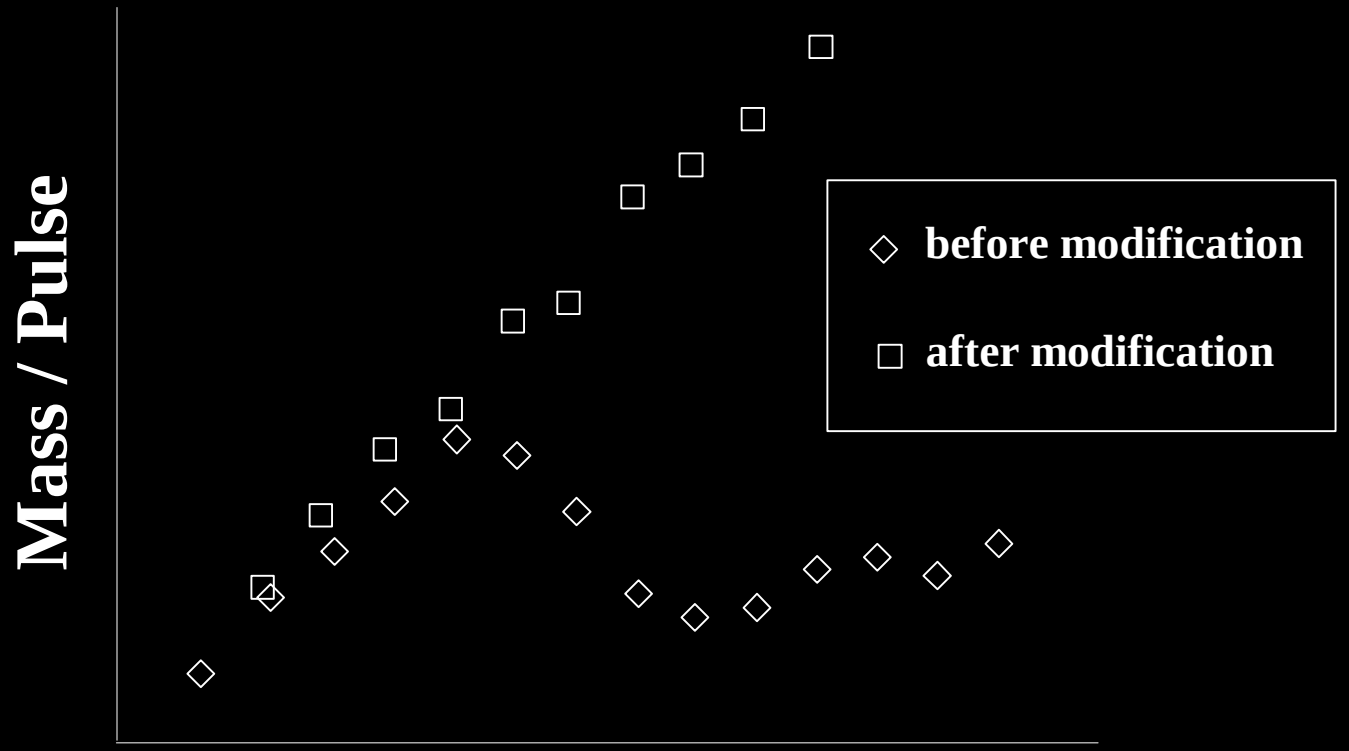
Monolithic Filter Element Strength Testing

- Coors P-100A-1 filter elements tested by SRI
- Ultimate strength of filter elements measured using a hydrostatic O-ring test
- SiC filter element testing ongoing
- Non-destructive testing with Roger Chen of WVU ongoing

Operational Developments

- Outlet loadings have been consistently demonstrated below 1 ppm
- Ash level in the solids outlet cone of the filter vessel has been reliably monitored using thermocouples
- Pulse valve performance has been characterized and improved

Back-pulse Valve Testing Results



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Current and Future Testing

- Characterize the effects of the back-pulse on the filter system
- Evaluate the effects of higher face velocity
- Evaluate the thermal loads on filter elements
- Characterize the differences in filter cakes generated with different coals and sorbents
- Assess the long-term durability of filter elements