

Selection and Installation of a Full-Flow Condensate Filtration System

at

Wyodak Plant

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Wyodak Plant

- Gillette, Wyoming
- 365 MWe
- 1,800 psi Throttle Pressure
- 1978 Commercial Operation
- Fuel: Pulverized Powder River Basin Coal



ACC replaced in Spring 2011

After 33 years of service, air-cooled condenser was replaced from December 2010 thru April 2011. High turbine back-pressure due to severe in-leakage provided adequate justification for replacement. (18,000+ MW-hr lost in 2010 due to high ambient temperatures).



Conditions before and after ACC replacement

– Before Replacement

- ▶ Air in-leakage pegs the meter (> 30 scfm)
- ▶ Always running with both air ejectors in service.
- ▶ Condensate pump discharge dissolved oxygen often > 200 ppb, almost always > 100 ppb

– After Replacement

- ▶ Air in-leakage @ 9 scfm with one ejector in service
 - (Note: steam duct from LP turbine to the ACC **was not** replaced with the ACC. Several expansion joints on the line supplying the ACC are likely leaking)
- ▶ Condensate pump discharge dissolved oxygen most always less than 100 ppb and often less than 40 ppb – still a major concern!

Decision made to add full-flow filtration

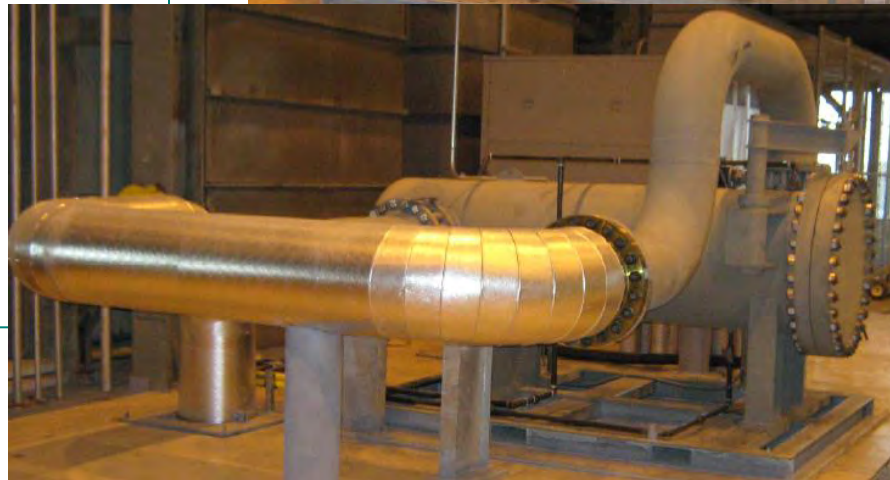
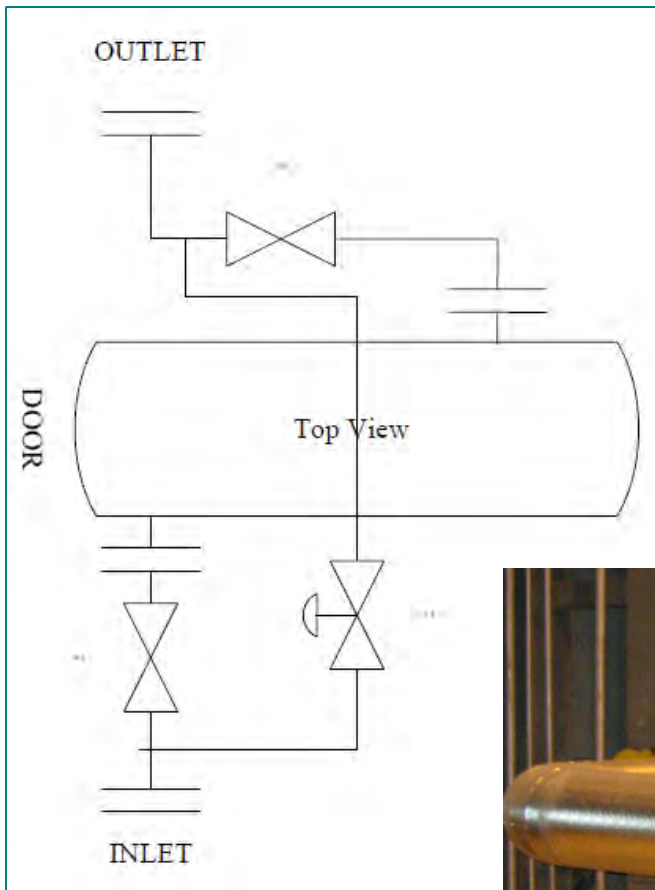
- Following the ACC meeting in Pueblo last year, plant personnel discussed start-up of the new ACC.
- Realized that we needed either a temporary filter for start-up or a permanent installation.
- Plant has a history of doing millipore ‘patch’ tests and full boiler flushes during each start-up.
- Boiler chemical cleans have been done on every outage and 7-10,000 pounds of iron oxide (as Fe_3O_4) removed each clean.
- Ample justification given for purchasing filter.

Filter Selection

- Experience at Currant Creek plant (Mona, UT)
 - ▶ 178 string-wound Cuno filters
 - ▶ In service for 1 year with no real increase in pressure drop. This suggests significant bypassing with string-wound filter.
 - ▶ Filters always in service
 - ▶ 1,000 ppm chromium on filtrate analysis
 - ▶ Normal air in-leakage at 30 acfm



Pall High Flow Filter Chosen



Pall High Flow Filter System – Design Conditions

- Vessel design code: ASME VIII DIV 1 “U” STAMP
- Flow rate: 5,500 gpm
- Operating pressure: 450 psig
- Filtration: Beta X(c) = 5,000
- Calculated clean element pressure drop: 0.608 psig
- Calculated vessel pressure drop: < 5 psig
- Bypass automatically opens at a pressure drop of 50 psig
- Installed downstream of condensate pump and upstream of 5th point feedwater heater (1st LP heater)

Theory of Operation

- Condensate filtration package consists of 1 vessel with 19 pleated filter elements, isolation valves, by-pass piping w/isolation valve, drain valves, DP transmitter and NEMA 4 control panel. All components are mounted on a structural steel frame.
- Vessel inlet and outlet port isolation valves are butterfly valves with a manual handwheel / gearbox operator. These valves are used for positive isolation of the vessel from the condensate system when element changeout is required.
- Isolation valve in the by-pass loop is also a butterfly valve with a pneumatic actuated, spring return operator. The operator uses a solenoid valve for pilot control of the main actuator piston. The solenoid valve receives an output signal from a PLC in the control panel, based on an input signal from the differential pressure transmitter.
- The by-pass loop is included to provide uninterrupted flow when elements need to be changed. By-pass loop can handle full system flow. No operator intervention is required to move into the by-pass mode. At Wyodak, the switchover to bypass mode happens at 50 psid across the filter. Local alarming is available to alert operations of the need to change filters.

Operating Results

Micron Size	Time at New Installation	Time Exhasuted	Running Days
20	1331 4/8/11	1600 5/4/11	17
20	1500 5/5/11	1900 5/11/11	6
40	1200 5/12/11	1800 6/16/11	19
20	1200 6/17/11	0500 7/18/11	30
20	1600 7/19/11	0330 8/4/11	14
20	1650 8/5/11	1100 8/22/11	15
20	1500 8/23/11	0625 9/8/11	16
20	1400 9/8/11	TBD	

Filters are generally quite dirty at 25 psi and are changed within a few days of this delta P. Bypass opens at 50 psi.

Note 1: Unit didn't start up until 4/18/11

Note 2: Unit came down for chemical clean 6/9/11

Visual Results



40 & 20 micron elements



40 micron outer surface



20 micron outer surface

More pictures

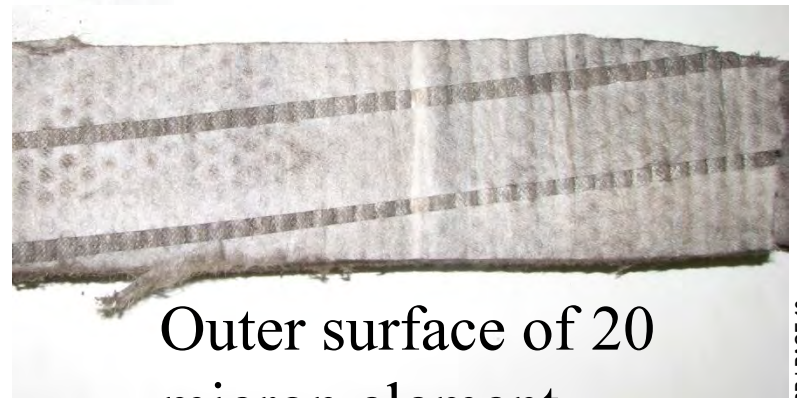


Media pack showing uniform loading

Over 420#s of magnetite removed in first 2 months of operation.



Media Pack with Support Layer Removed



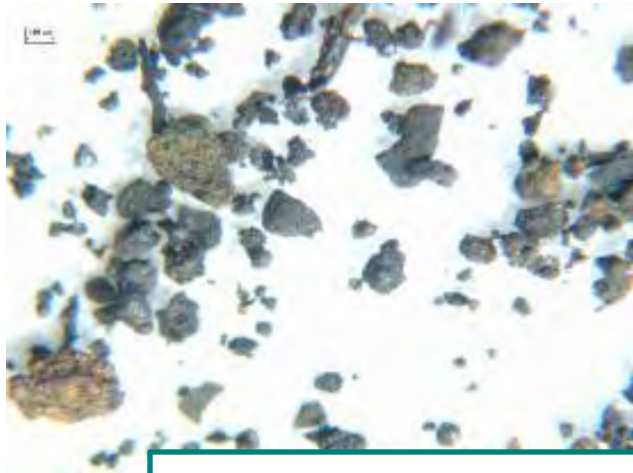
Outer surface of 20 micron element



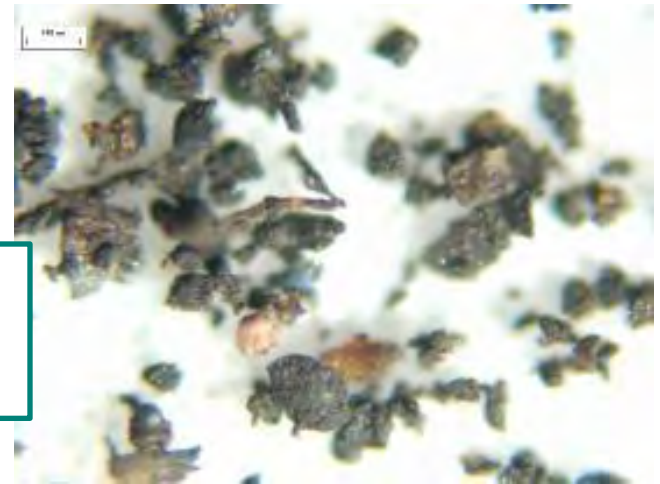
20 micron element cut from above



Magnetite debris from filter (magnetic)



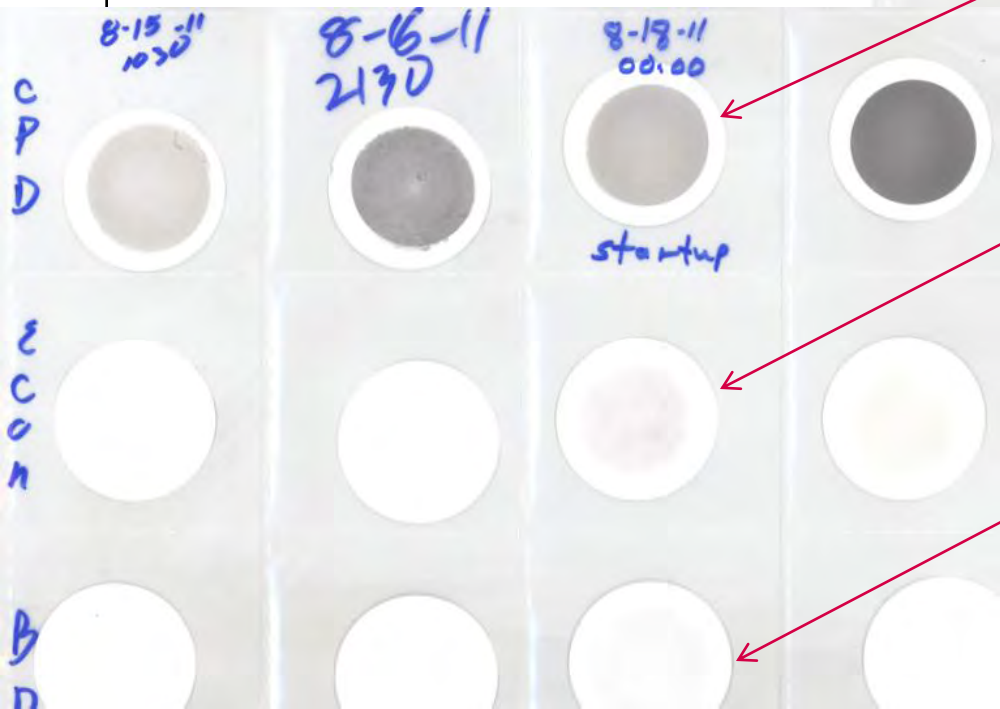
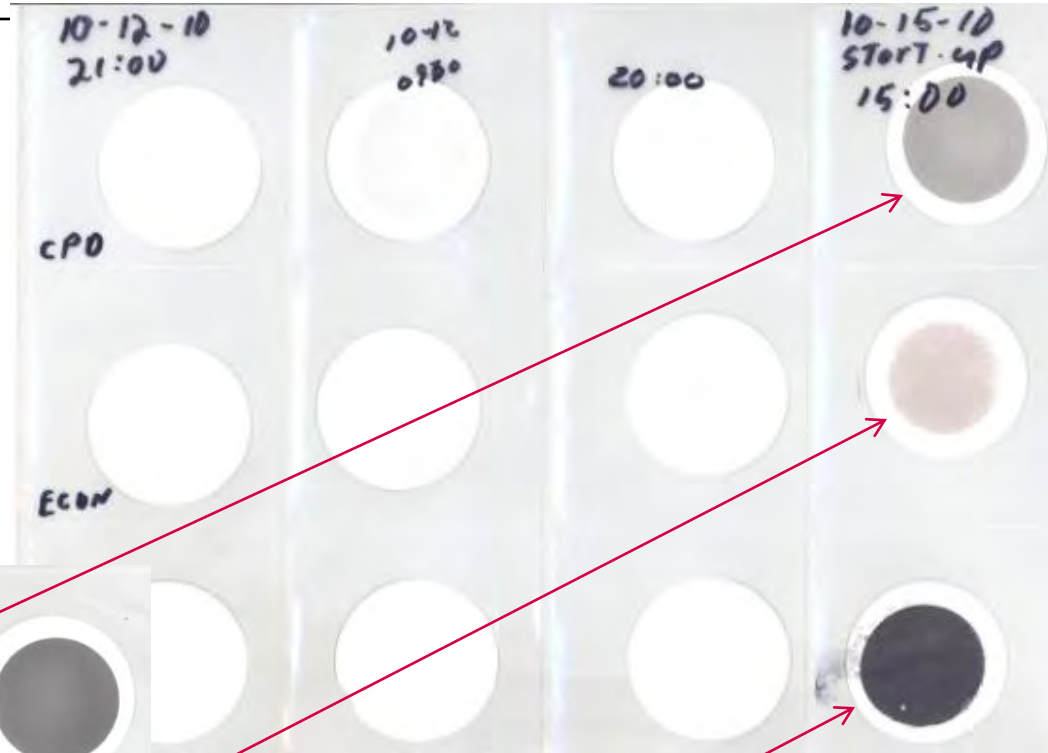
Debris at 50x



Debris at
100x

Iron millipore samples before & after filter

- During start-up, high levels of iron seen in both economizer and continuous blowdown samples before installation of filter.



Significantly lower levels after filter is installed.

Conclusions

- Filter installation has been very effective at removing suspended iron.
- Additional testing is recommended to quantify current iron transport.
- Better removal is available with 10 μ or 6 μ filter; however, the cost of element replacement suggests using 20 μ elements.

Questions???

- Thank You for any advice / input and for your attention!