# Selection and Installation of a Full-Flow Condensate Filtration System

at

Wyodak Plant

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*and Pat Caton – AEC PowerFlow*

*3rd Air-Cooled Condenser User Group Meeting*
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# Wyodak Plant

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



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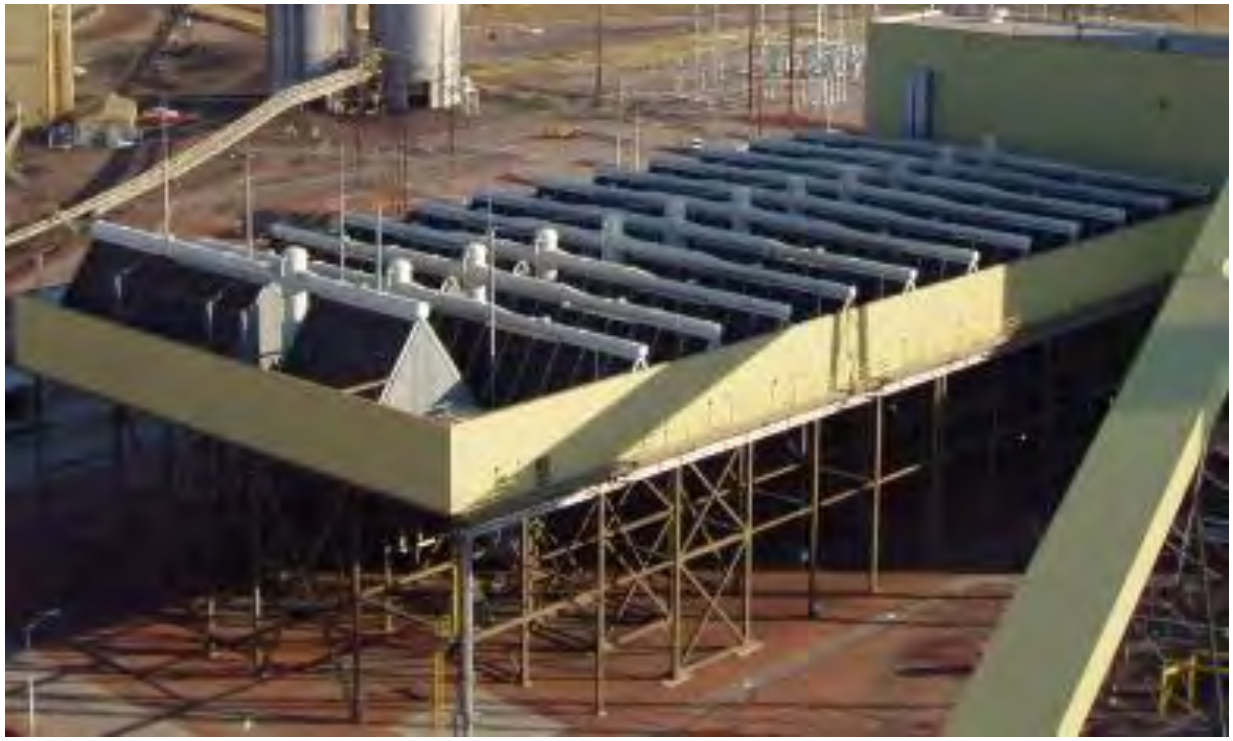
# ACC replaced in Spring 2011

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).





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# 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!

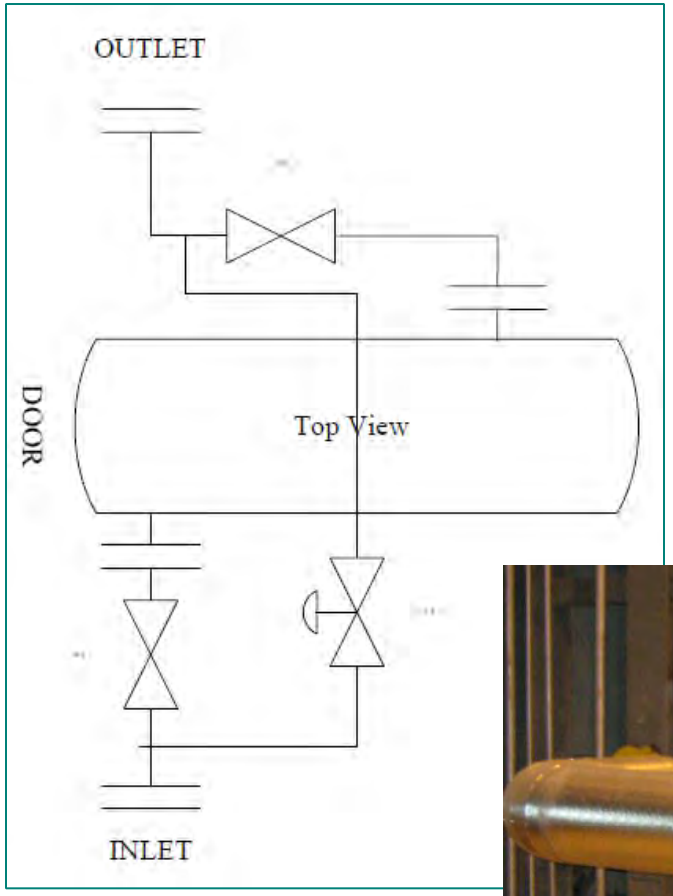
# Decision made to add full-flow filtration

- 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



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# 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
- Calcualated 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 5$^{th}$ point feedwater heater (1$^{st}$ LP heater)



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# 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 availble 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



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# Visual Results

40 & 20 micron elements

40 micron outer surface

20 micron outer surface



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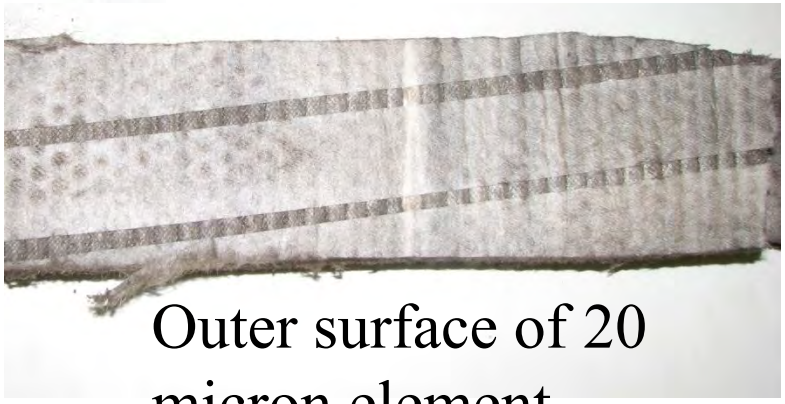
# More pictures

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



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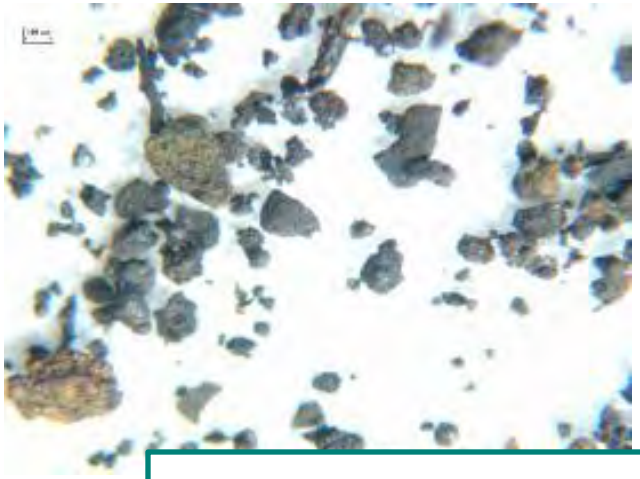
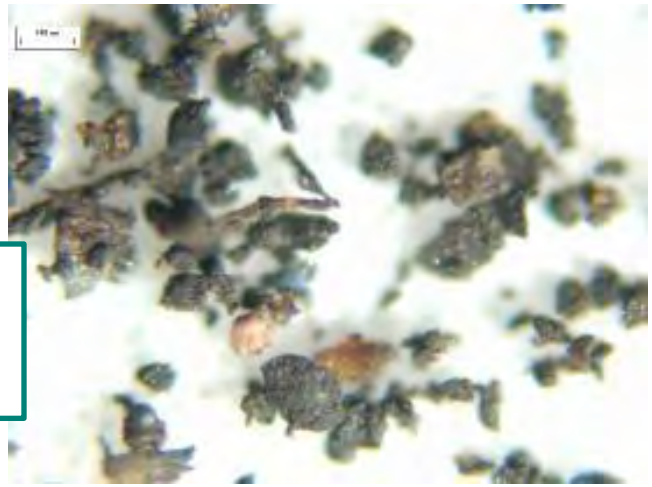
20 micron element cut from above

Magnetite debris from filter (magnetic)



Debris at 50x



Debris at 100x

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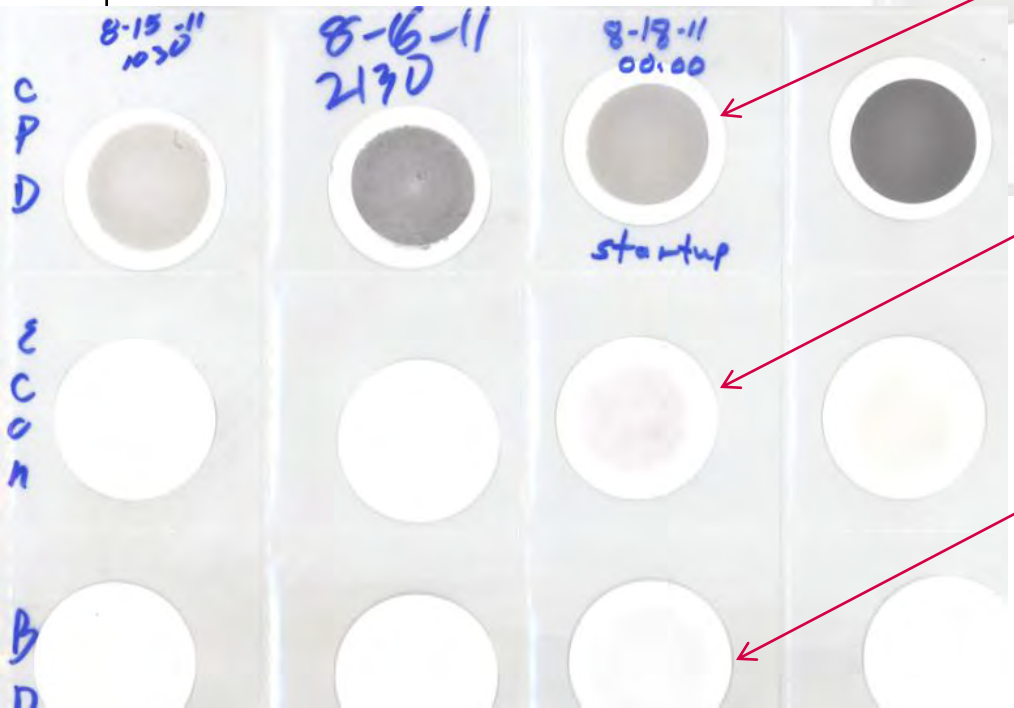
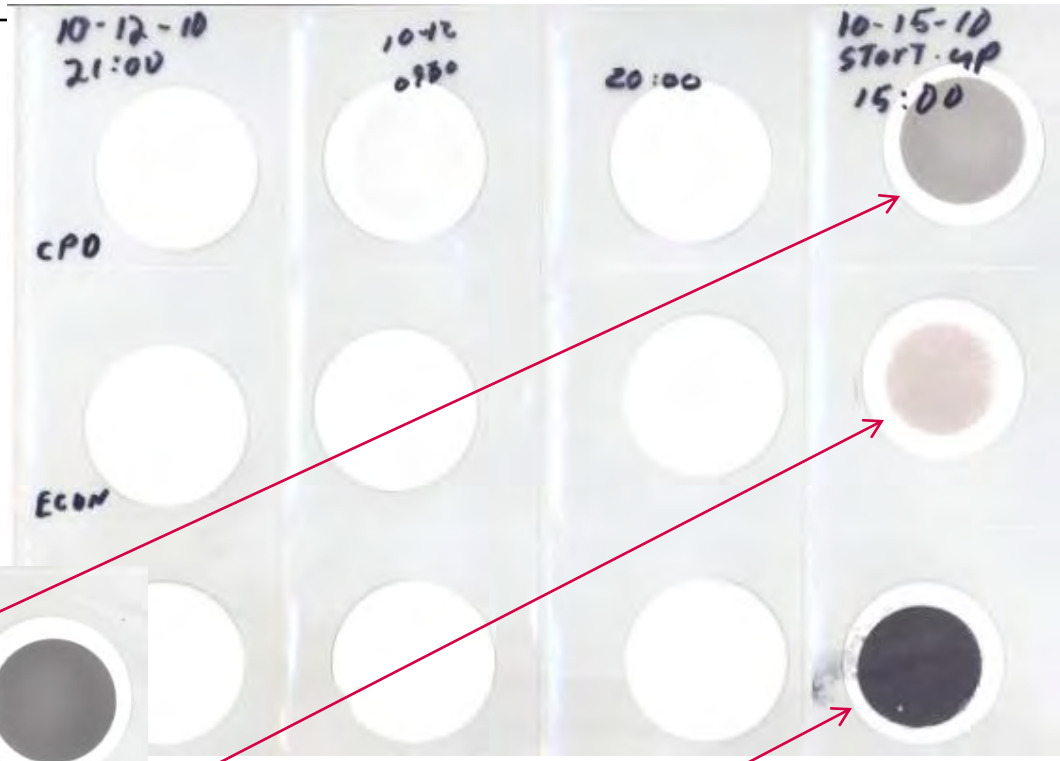
# Iron millipore samples before & after filter

- 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.



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# 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 10µ or 6µ filter; however, the cost of element replacement suggests using 20µ elements.

# Questions???

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



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