Kogan Creek Power Plant's Air Cooled Condenser

Update For ACC User Group
September 2011

Contents

- Kogan Creek Power Station and its Air Cooled Condenser
- Design Chemistry
- Issues
- Actions
- Ongoing Performance
- Consequences

Kogan Creek Power Station

Kogan Creek Power Station :

- 750MW single unit coal fired power plant
- Supercritical Benson type boiler
- Direct Air Cooled
- Commissioning completed in December 2007
- Located near Chinchilla, Queensland, Australia

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Kogan Creek Power Station

Air Cooled Condenser

- GEA Alex (Aluminium Exchanger design
- Single tube row
- Carbon steel tubes with aluminised exterior
- Aluminium cooling fins
- 48 off 9m diameter fans (200kW motors)
- Steam Flow: 413.8kg/s full load, 457.2kg/s Overload

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Pre–Service Inspection

Design Chemistry

- Oxygenated Treatment (80ppb)
- pH 8.0 – 8.5
- Ammonium Hydroxide to control pH
- Hydrogen cycle mixed bed condensate polishing
- Condensate filtration
- Concerns were held that the design chemistry was not suitable for the unit, alternate chemistry program proposed but not implemented (lack of ACC specific chemistry guidelines at the time to support concerns)

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Early Operation

- Iron monitoring results on the unit confirmed earlier concerns with the design chemistry (suspicion of 2 phase FAC in the ACC)
- High levels of Iron identified in the condensate system
- Condensate filtration system under-performing, periodic elevated feedwater Iron levels (corrosion product transport)
- Risk of damage to the boiler from corrosion product transport now confirmed

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Early Inspection

- An early inspection in May 2008 (~4000hrs of operation) was undertaken
- Severe corrosion identified from LP Turbine exhausts through steam ducting and ACC inlets.
- 2 Phase FAC identified as the cause of the corrosion
- Suspicions about the design chemistry confirmed
- Concerns about downstream impacts (boiler, turbine) ongoing

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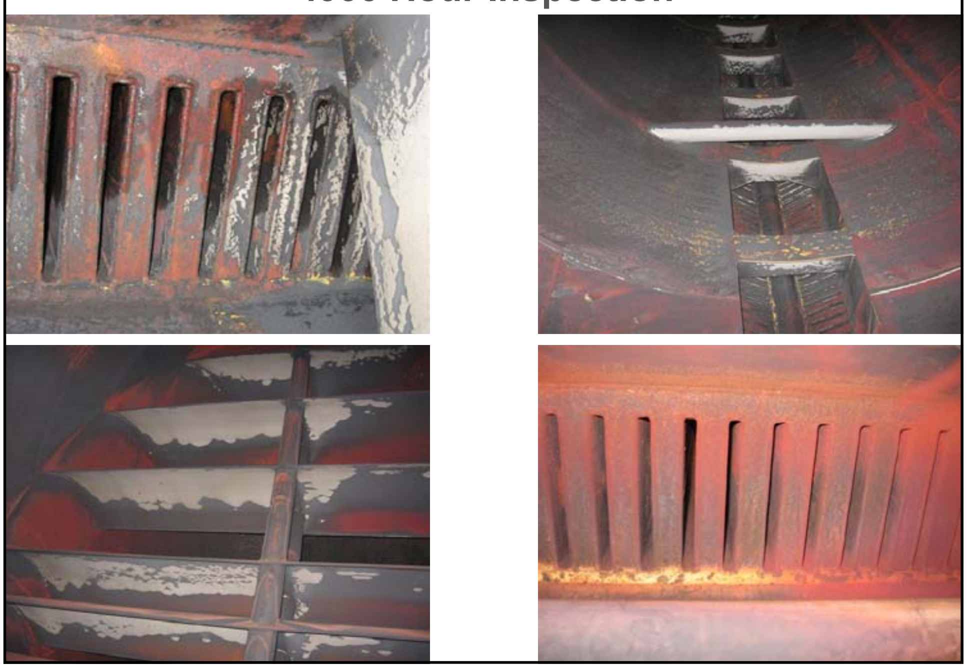
4000 Hour Inspection



Actions

- Increase in feedwater/condensate pH to reduce 2 phase FAC in the ACC – initially to 9.5 and then to 9.8
- Operate condensate polishers in ammonium form to allow practical operation at elevated pH
- Replace condensate filter elements with a more suitable design
- Allow operation of condensate polishers at elevated temperature (above 62.5C) until condensate filters are replaced

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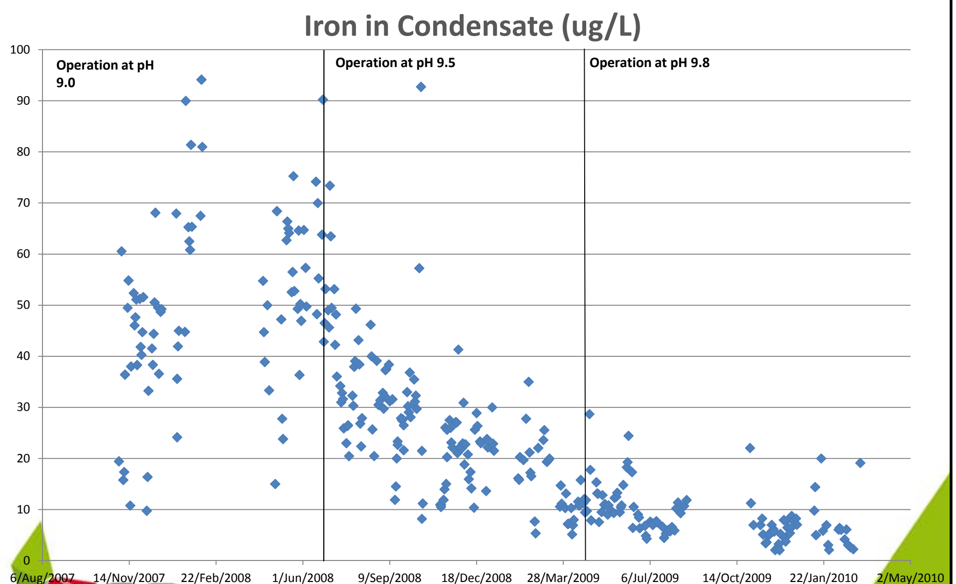

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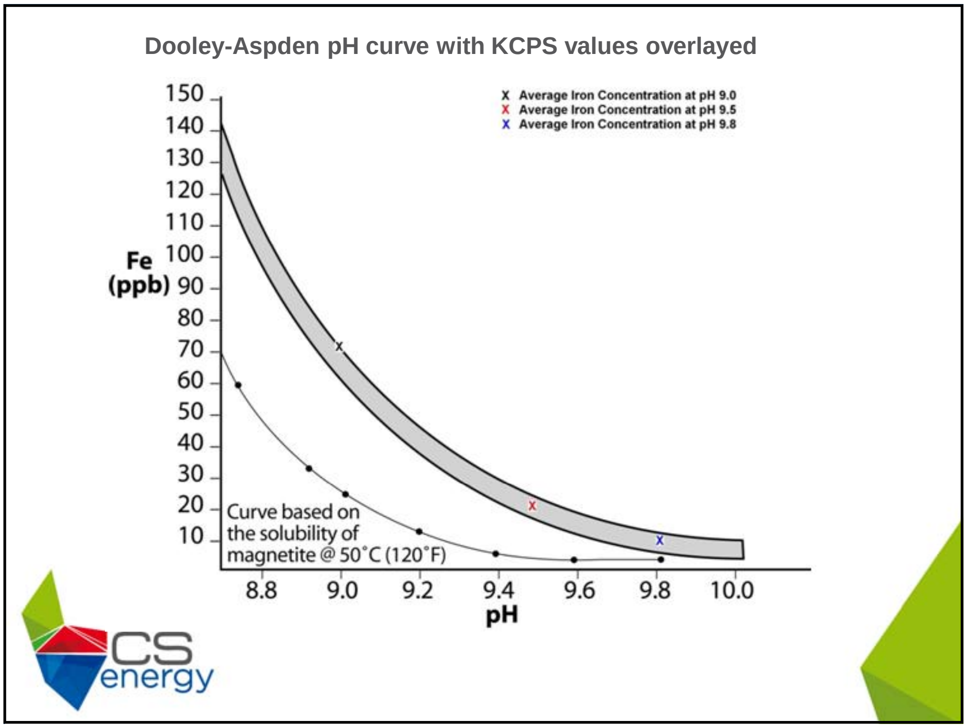
Dooley-Aspden pH curve with KCPS values overlayed
X Average Iron Concentration at pH 9.0
X Average Iron Concentration at pH 9.5
X Average Iron Concentration at pH 9.8
Fe (ppb)
150
140
130
120
110
100
90
80
70
60
50
40
30
20
10
Curve based on the solubility of magnetite @ 50˚C (120˚F)
8.8
9.0
9.2
9.4
9.6
9.8
10.0
pH
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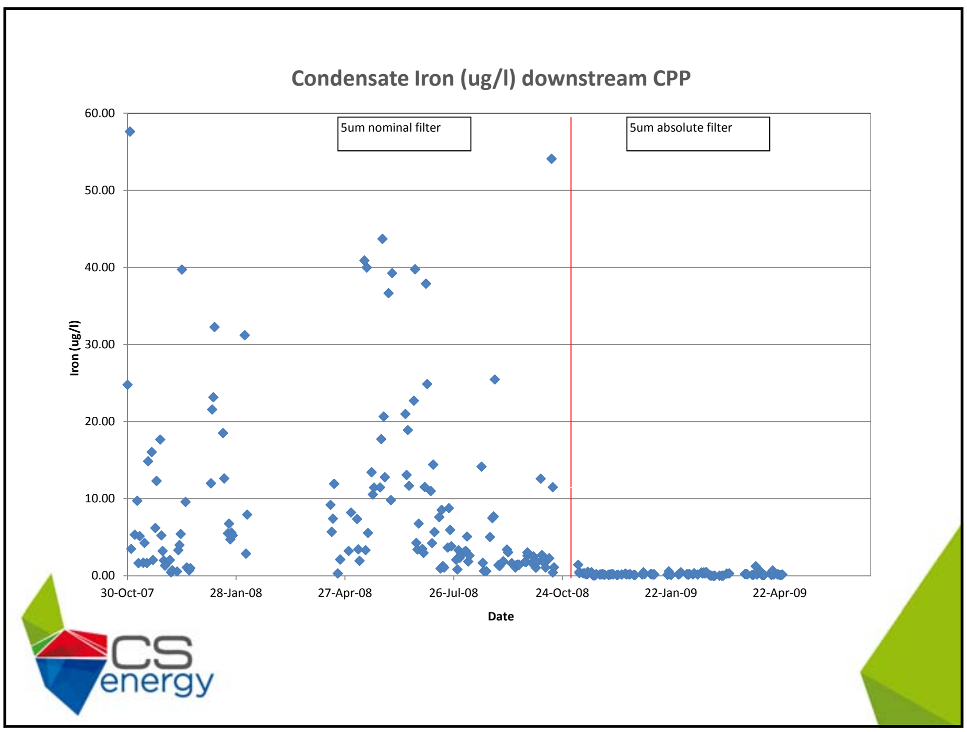
Condensate Iron (ug/l) downstream CPP
5um nominal filter
5um absolute filter
Iron (ug/l)
60.00
50.00
40.00
30.00
20.00
10.00
0.00
30-Oct-07
28-Jan-08
27-Apr-08
26-Jul-08
24-Oct-08
22-Jan-09
22-Apr-09
Date
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Results

- Increasing the pH of the feedwater/condensate led to a significant reduction in corrosion in the ACC.
- Several months needed to observe the full benefit of increasing the pH
- Replacement of the condensate filter elements resulted in an immediate and drastic improvement in corrosion product transport
- Operation of deep mixed bed, ammonium form condensate polishers at high temperatures (up to 70C) is possible, performance is reduced however

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August 2011 Outage (3 ½ Years since commissioning)

Observations

- Corrosion damage in the ACC very severe after just 4000hrs of operation (pH ~9.0).
- Increasing pH takes months to realise full benefits
- Corrosion damage still evident in ACC after >2 years operation at pH ~9.8, appearance continuing to improve over time.
- Application of oxygenated water to tube inlets appears to protect from FAC experienced in ACC at the tube inlets, but not further down the tube (Unit make-up water sprayed into ACC inlet header)

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Consequences

- Prior to the replacement of condensate filter elements in 2008, a significant amount of Iron entered the boiler through the feedwater
- Concerns were held with respect to deposits forming in the boiler
- Concerns also about the potential for Iron deposits on the turbine
- Sampling indicated very low levels of Iron in steam, confirming concerns about boiler deposits

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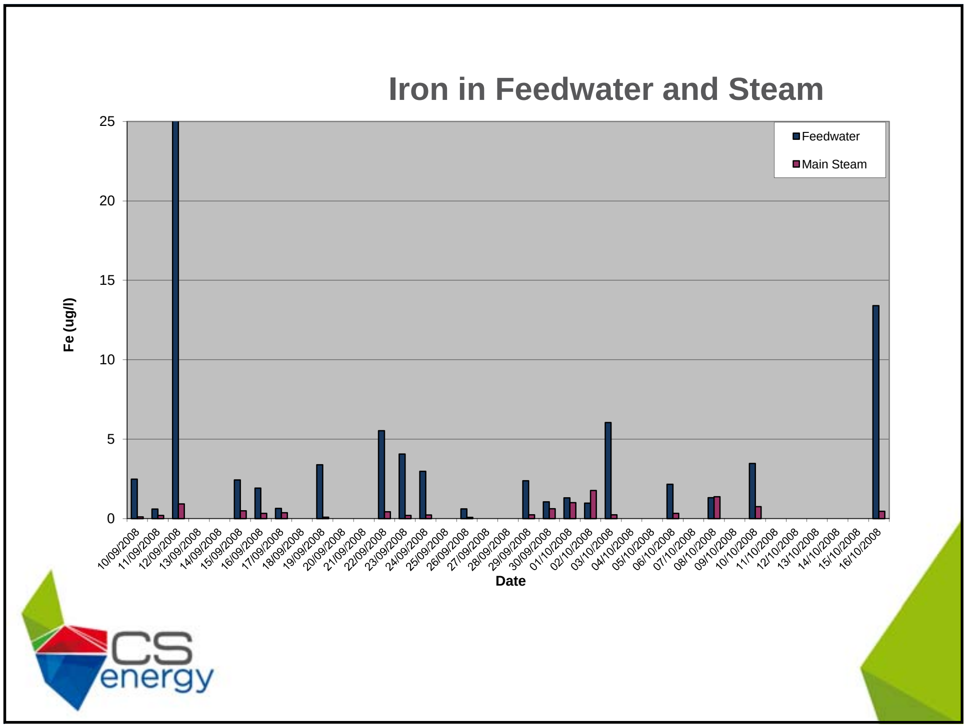
Iron in Feedwater and Steam
Feedwater
Main Steam
Fe (ug/l)
0
5
10
15
20
25
Date
10/09/2008
11/09/2008
12/09/2008
13/09/2008
14/09/2008
15/09/2008
16/09/2008
17/09/2008
18/09/2008
19/09/2008
20/09/2008
21/09/2008
22/09/2008
23/09/2008
24/09/2008
25/09/2008
26/09/2008
27/09/2008
28/09/2008
29/09/2008
30/09/2008
01/10/2008
02/10/2008
03/10/2008
04/10/2008
05/10/2008
06/10/2008
07/10/2008
08/10/2008
09/10/2008
10/10/2008
11/10/2008
12/10/2008
13/10/2008
14/10/2008
15/10/2008
16/10/2008
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Boiler Tube Deposits

Tube Location	Inner Layer (μm) (Indigenous oxide)	Outer Layer (μm) (Deposited Material)
Spiral Waterwall FL23800 FS	2.5	7.5
Spiral Waterwall FL23800 NFS	3.7	7.2
Spiral Waterwall FL30300 FS	2.0	11.8
Spiral Waterwall FL30300 NFS	8.2	24.7
FL38700 FS	33.8	86.3
FL38700 NFS	2.8	65.6
FL42000 FS	2.5	22.9
FL42000 NFS	4.2	25.8

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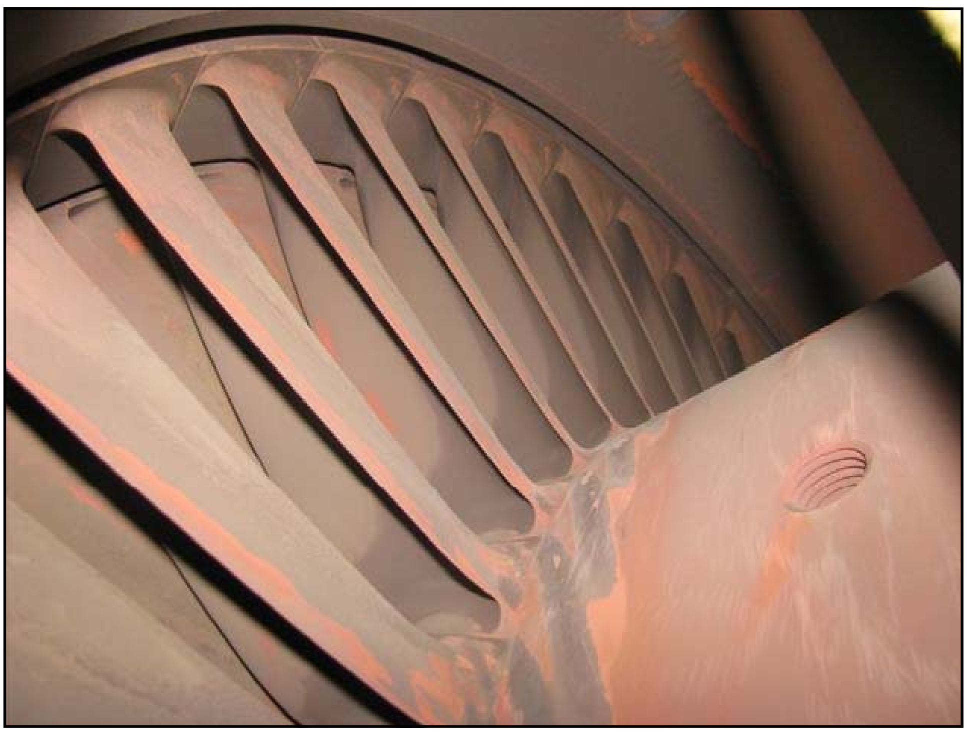

Consequences

- Significant boiler tube deposition identified during the plants 8000hr outage (October 2008)
- Boiler chemical clean conducted to remove deposits (August 2009)
- Significant deposits of Iron confirmed on late and final stages of the HP turbine (August 2011)
- Significant Iron deposits not found at IP and LP turbine inlets or exhausts (August 2011)

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What have we learned?

- When specifying new units with ACCs take chemistry requirements into account – ACC requirements may be different from those specified by the boiler manufacturer
- Corrosion of ACCs can be detrimental to more than just the ACC – boilers and turbines may also be at risk
- As with many things, addressing the issues before they become problems is a lot cheaper (and more effective)
- Corrosion and corrosion product transport must be addressed
- ACC Chemistry guidelines now available

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