
IDEA2021
Powering the Future: District Energy/CHP/Microgrids
Sept. 27-29 | Austin Convention Center | Austin, Texas

ENVIRONMENTAL FOOTPRINT BENEFITS FROM BOILER WATER TREATMENT IMPROVEMENTS

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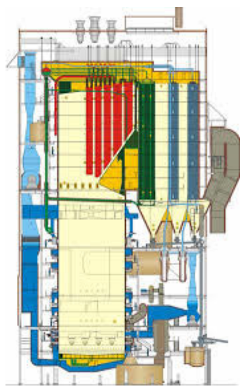
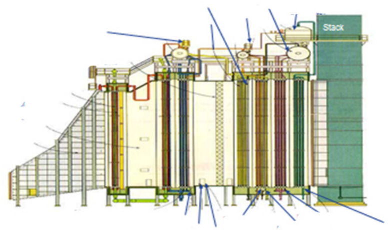
AGENDA

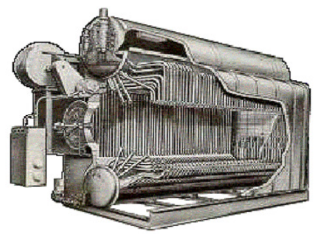
- Purpose of boiler water treatment
- Plains Midstream Gas Plant Case Study
  - Overview of boiler system and design limitations
  - Environmental footprint boiler impact
  - Environmental and Economic benefits of boiler treatment optimization

Purpose of boiler water treatment

- Steam generation to support production/operation

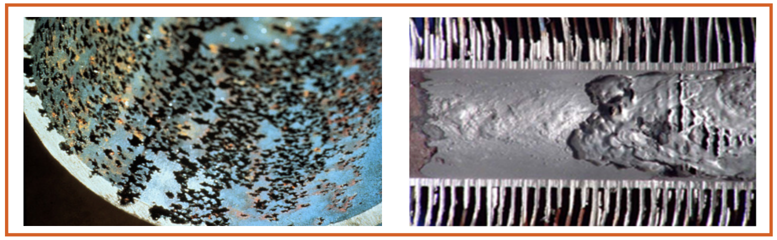


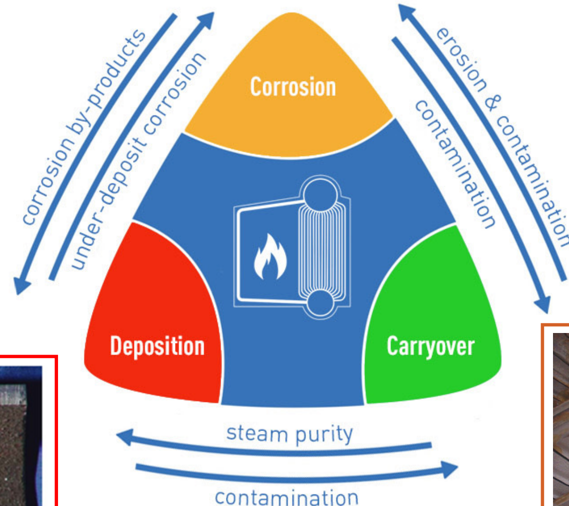


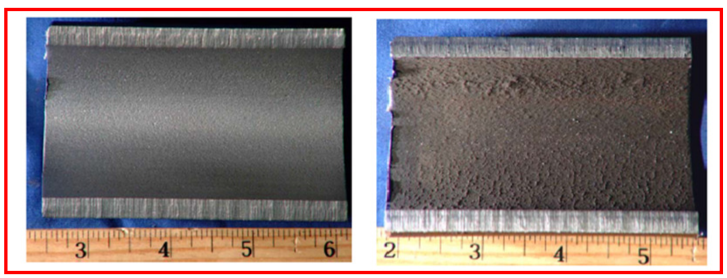


Purpose of boiler water treatment

- Asset protection:
  - Reliability







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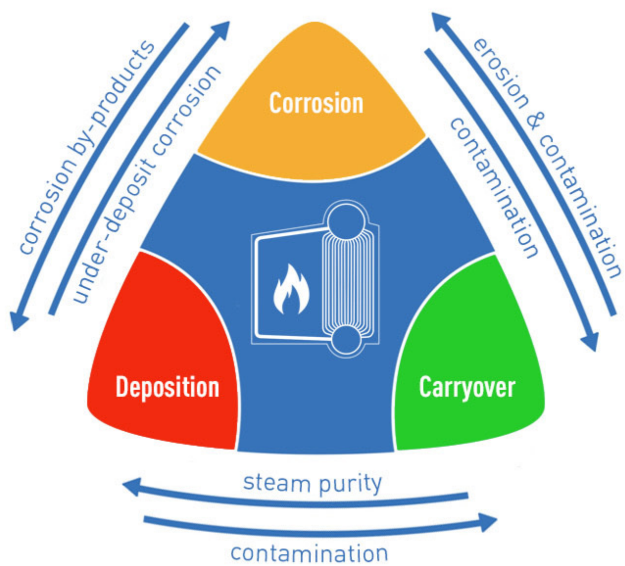
Purpose of boiler water treatment

INFRASTRUCTURE PROTECTION



INDUSTRY GUIDELINES

TABLE 1 — SUGGESTED WATER CHEMISTRY LIMITS
INDUSTRIAL WATERTUBE, HIGH DUTY, PRIMARY FUEL FIRED, DRUM TYPE

Makeup water percentage: Up to 100% of feedwater
Conditions: Includes superheater, turbine drives, or process restriction on steam purity
Saturated steam purity target: See tabulated values below.

Drum Operating Pressure (1)(11)	psig 0-300 (MPa) (0-2.07)	301-450 (2.08-3.10)	451-600 (3.11-4.14)
Feedwater(7)			
Dissolved oxygen ppm (mg/l) O_2-measured before chemical oxygen scavenger addition (8)	<0.007	<0.007	<0.007
Total iron ppm (mg/l) Fe	≤0.1	≤0.05	≤0.03
Total copper ppm (mg/l) Cu	≤0.05	≤0.025	≤0.02
Total Hardness ppm	≤0.3	≤0.3	≤0.2
pH @ 25°C	8.3-10.0	8.3-10.0	8.3-10.0
Chemicals for preboiler system protection	NS	NS	NS
Nonvolatile TOC ppm (mg/l) C (6)	<1	<1	<0.5
Oily matter ppm (mg/l)	<1	<1	<0.5
Boiler Water			
silica ppm (mg/l) SiO_2	≤150	≤90	≤40
Total alkalinity ppm (mg/l)*	<700(3)	<600(3)	<500(3)
Free OH alkalinity ppm (mg/l)* (2)	NS	NS	NS
Specific conductance (12) µmhos/cm (µS/cm) 25°C without neutralization	5400-1100(5)	4600-900(5)	3800-800(5)
Total Dissoloved Solids in Steam (9)			
TDS (maximum) ppm (mg/l)	1.0-0.2	1.0-0.2	1.0-0.2

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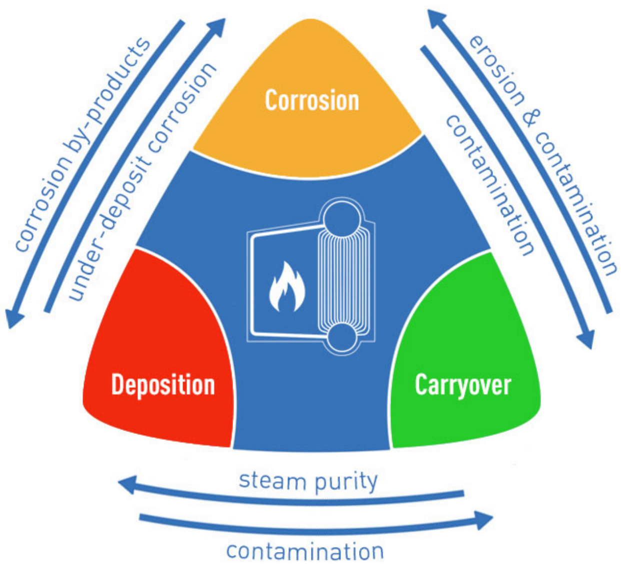
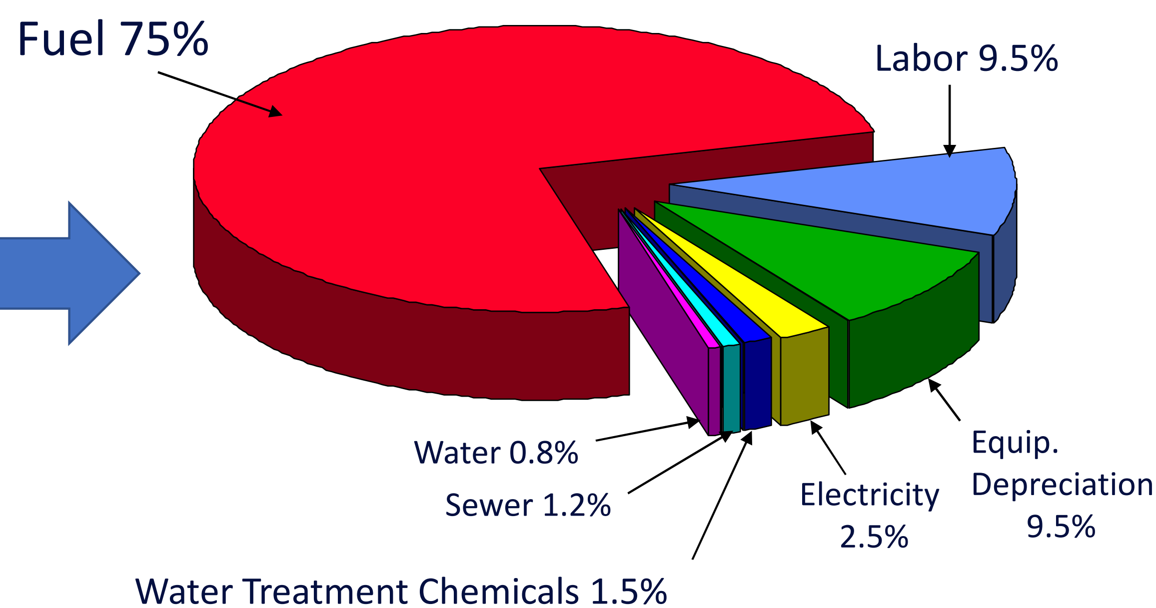


COST OF OPERATION & ENVIRONMENTAL FOOTPRINT



Plains Midstream Case Study
Empress, AB

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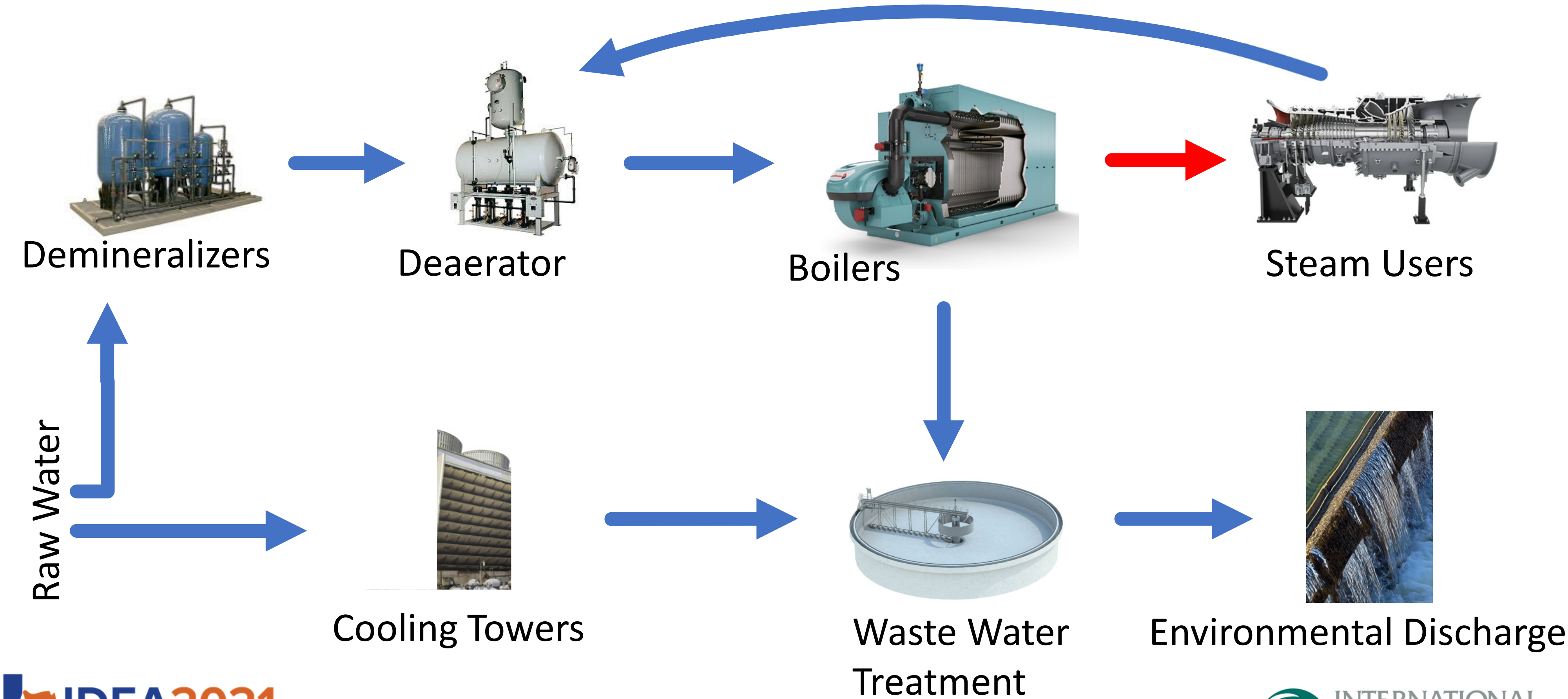
Overview of Plains Midstream boiler system



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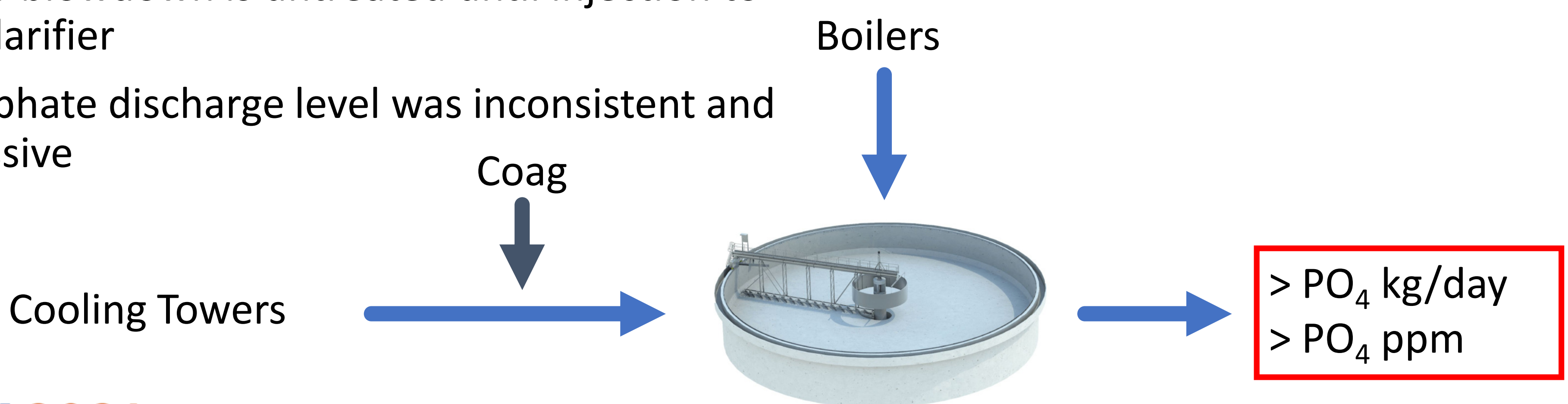
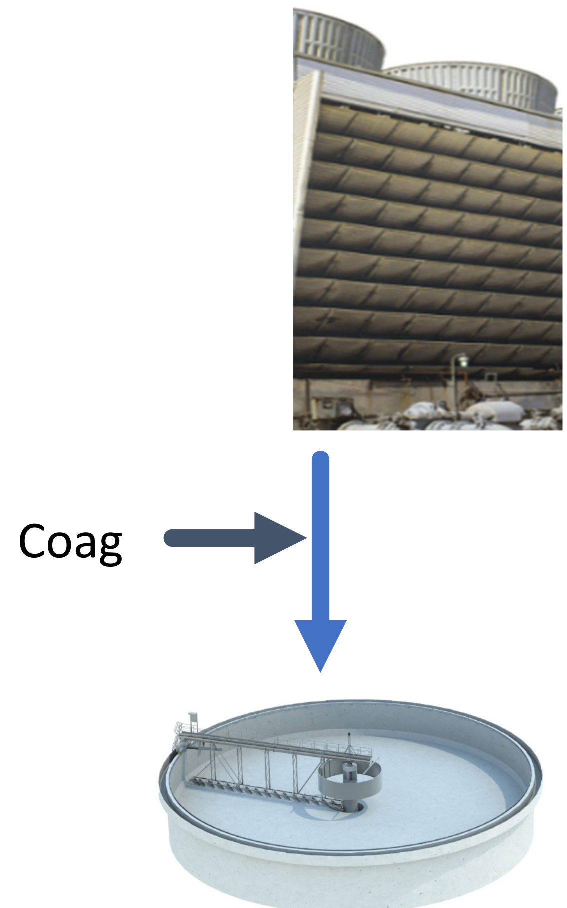
Waste Water Treatment

- Waste Water from Cooling Tower and Boiler blowdowns
- Limited treatment space and reaction time
- Coagulant injected to the Cooling Tower blowdown
- Boiler blowdown is untreated until injection to the clarifier
- Phosphate discharge level was inconsistent and excessive



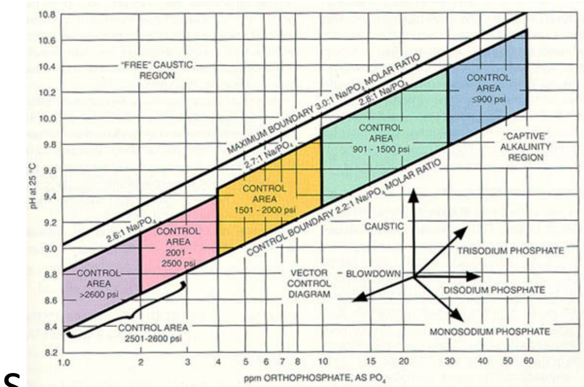
Cooling Towers

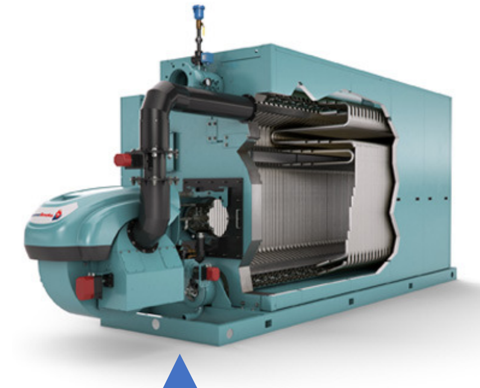
- Phosphate is a common corrosion inhibitor for open recirculating cooling systems
- Levels of 5-15 ppm PO_4 are typical depending on pH and hardness levels
- Non-phosphate Cooling Tower chemistries have been newly introduced by SUEZ and others to address phosphate discharge regulations, but was not available at that time.
- Coagulant treatment was optimized for Cooling Tower phosphate removal, so it was not the main source of phosphate "leakage".



Boiler Treatment

- 1 MMkg/day of steam @ 400 psig
- 15-25 ppm PO_4 in the boiler water
- Coordinated pH/PO_4 treatment was applied due to demineralized feedwater
- Below 900 psig, Coordinated pH/PO4 is not warranted due to lower localized heat flux. Phosphate then neither acts as a pH stabilizer nor a precipitation aid
- Conversion to patented all-polymer terpolymer solubilizing technology
- From daily batch making and manual blowdown to automated neat chemical treatment





from

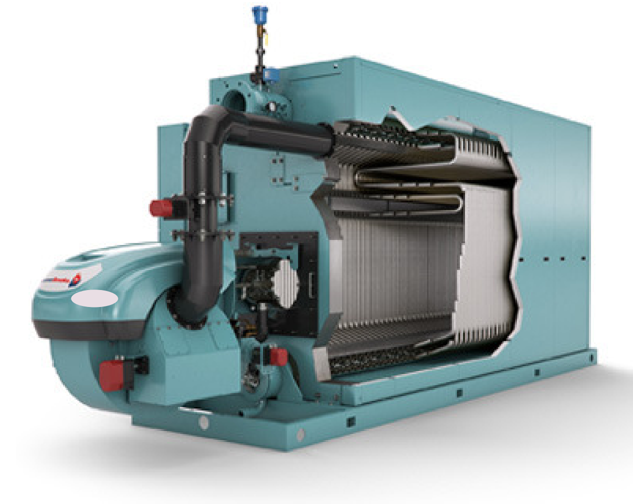
Phosphate batch

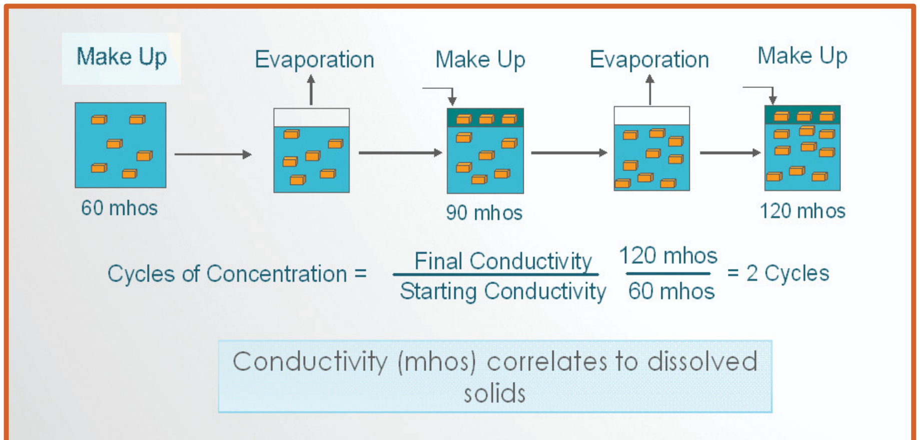
to

Neat Terpolymer

Boiler Treatment

- Erratic treatment and blowdown made for an average of 43 Cycles of Concentration
- Operational Boiler Water Chemistry guidelines on demineralized water would easily allow 65-75 Cycles





<u>The impact of increased Cycles of Concentration:</u>

1) **%Blowdown = 1 / CoC**

= 1 / 43 = 2.3% BD

= 1 / 75 = 1.3% BD

⇩45%

2) **Blowdown = BFW – Steam**

3) $E_{STEAM} = E_{MU} + E_{COND} + E_{BW}$

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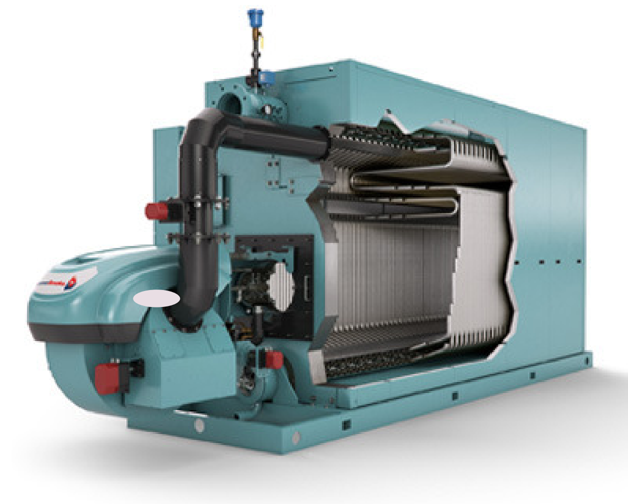
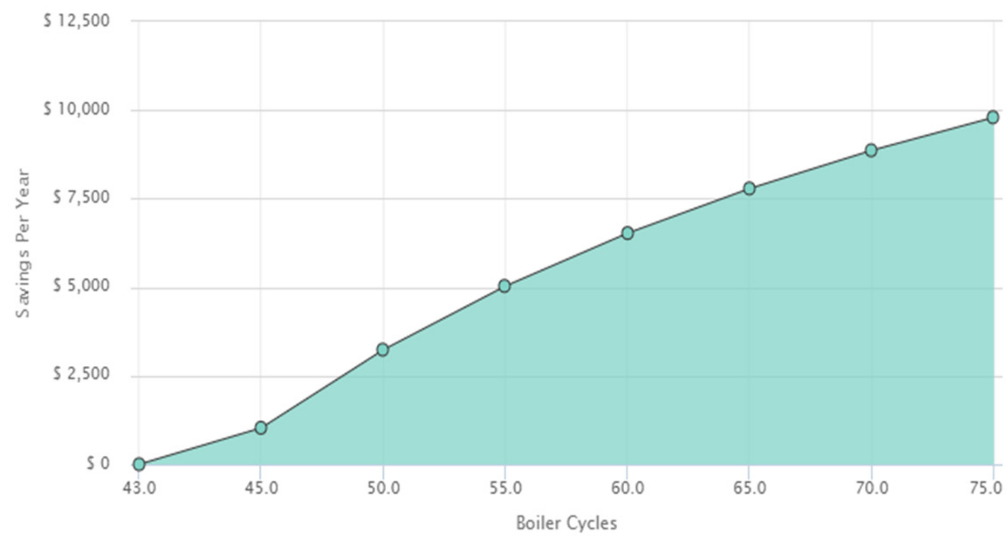
Boiler Treatment

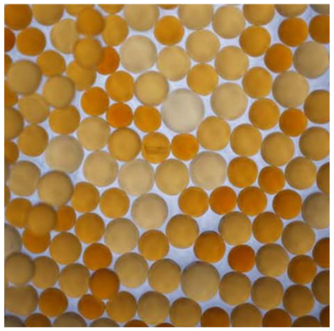
- Improvements in chemical treatment, dosage, monitoring and control, as well as application of operational best practices (blowdown control) generated:
  - Chemical savings
    = $18,980/year
  - Fuel savings
    = $10,000/yr
  - Reduction in fresh water
    ⇩ 1,000,000 USG/year
  - CO_2 emission reduction
    ⇩ 200 Ton CO_2/year





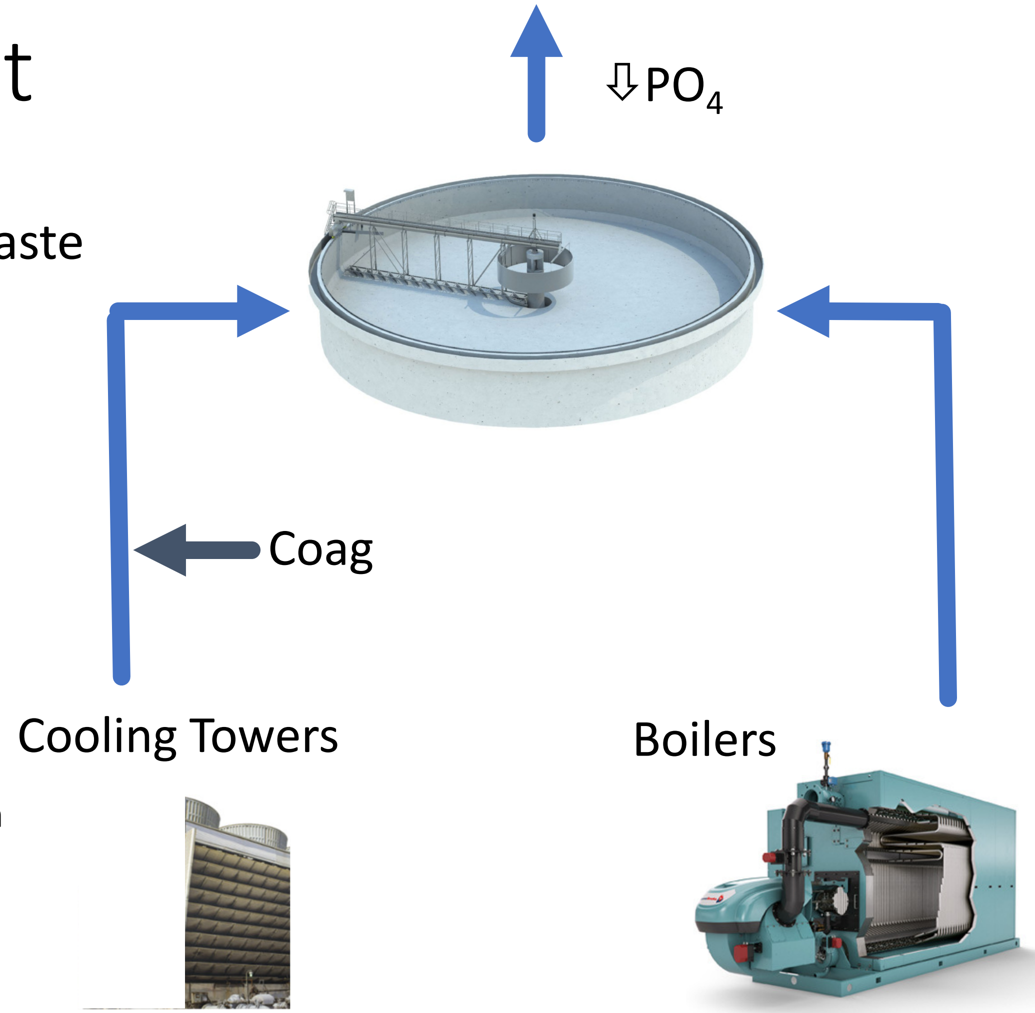
Boiler Pretreatment

- Reductions in fresh water demineralization requirement reduced regenerations frequency on the cation and anion, which translated to:
  - 52 fewer regenerations per year
  - Acid and caustic regenerant savings
    = $11,250/yr
  - Reduction in regeneration water
    ⇩ 100,000 USG/year

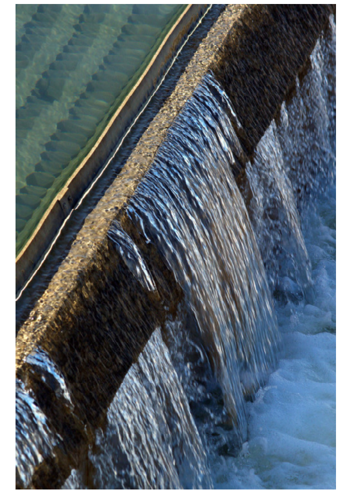


Waste Water Treatment

- Elimination of phosphate-based boiler treatment resulted in reduced load to waste water:
  - Phosphate discharged
    ⇩ 200 kg/yr
    ⇩ 1 ppm as PO_4
  - Savings in coagulant
    = $11,900/year
  - Eliminated the need for waste water system redesign
  - Eliminated the risk of discharge limit violation



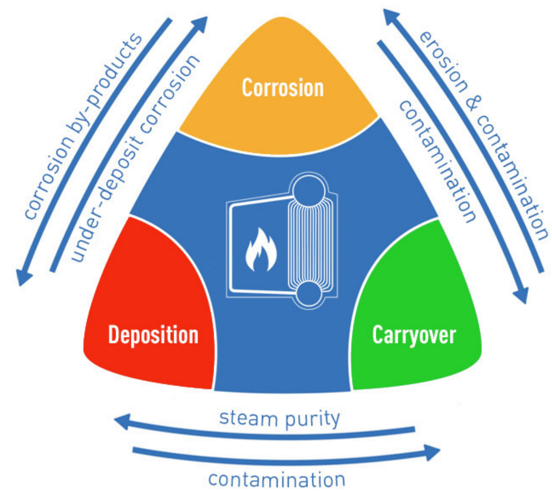
Conclusions – Environmental and Economic Benefits



- **A project to overhaul the boiler treatment to remove stress on the waste water system provided multiple environmental footprint benefits:**
  - Phosphate discharged
    - ⇩ 200 kg/yr
    - ⇩ 1 ppm as PO_4
  - Fresh water usage
    - ⇩ 1,1 MMUSG/yr
  - CO_2 emission reduction
    - ⇩ 200 ton co_2/yr

While providing a safer, more efficient and more reliable operation, at a lower cost:

- **OPERATIONAL SAVINGS**
  $51,850/YEAR



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Thank You!

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PLAINS MIDSTREAM CANADA

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Q&A