Combined Cycle Users Group: Trends in Power Plant Chemistry, Water, and Wastewater

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Emerging Trends

- Steam Cycle Chemistry
- Cooling Water Treatment
- Makeup Water and Demineralization Systems
- Wastewater Treatment
Steam Cycle Chemistry

- Drum Internal Chemistry
  - Do you really need phosphate?
  - Drum blowdown control

- Condensate and Feedwater Chemistry
  - Amines – to use or not to use?
  - Sample panel maintenance contracts
  - Rapid cycling impacts
Drum Internal Chemistry: Phosphate Treatment

- Only purpose of phosphate feed is to control drum pH
- Drum pH only lowers if contaminants present
- May be able to stop phosphate feed if
  - No history of condenser tube leaks
  - No history of demin upsets
  - Air-cooled plant
  - Plant has condensate polishers
- Requires careful historical analysis
- Drum pH will drop like a rock if contamination occurs without phosphate
Drum Internal Chemistry: Blowdown Control

- Required blowdown depends on
  - Drum iron concentration
  - Corrosive ion (chloride/sulfate) concentration
- Monitor iron
  - Directly (suspended iron test)
  - Indirectly (particle or turbidity analyzer)
- Monitor corrosive ion concentration indirectly (cation conductivity)
- Adjust blowdown to keep both iron and cation conductivity within limits
Condensate and Feedwater: Amines

- Consensus in flux
- Ammonia poor choice for control of 2-phase FAC
- Also results in lower initial condensation pH ($IC_{PH}$)
- Amine blends improve protection, but increase cation conductivity
  - Amine decomposition products usually don’t increase corrosion
  - Do increase CC, which could mask CC from more corrosive anions
- Should amines be used?
  - Depends on severity of 2-phase FAC and turbine corrosion
  - Plant-specific judgment call, but may provide benefit
Condensate and Feedwater: SAP Maintenance Contracts

- Maintenance a pain for many plants
- SAP should be first line of defense – detect problems
- Why use a contractor?
  - Takes them much less time
  - pH/Cond analyzers should be offset weekly by plant, but maintenance contract for other analyzers may provide benefit
  - Costs may actually lower (more efficient)
  - Alternative is non-functional panel and increased wet test frequency (more risk)
Condensate and Feedwater: Rapid Cycling

- No way around it – it hurts
- Equipment ages more rapidly
- All-volatile treatment eases chemistry burden
- Add iron traps (especially for ACCs)
- Keep pH high in target range
- Must have rock-solid corrosion product transport monitoring program
Cooling Water Treatment

- Chemistry Automation
- Chlorine Dioxide
- Recycled Water Transitions
Cooling Water Treatment: Chemistry Automation Technologies

• Vendors
  - Nalco – “3D TRASAR”
    • Most mature technology
    • High reliability
    • Complete process automation and chemistries
  - GE – “TrueSense” and “GenGard”
    • Advertise “halogen resistant” chemistries
    • Adequate reliability
    • Partial automation (can add 3rd party controllers)
  - Ashland – “OnGuard”
    • Not as many features, but some unique ones
    • Generally reliable
  - ChemTreat – “ChemTreat Solutions”
    • 3rd party equipment
    • Can be reliable, but nothing proprietary
  - Others – 3rd party controllers common
• Cyber security concerns
• May offer things power doesn’t need
  – Remote monitoring and control
  – Remote alarm notification
  – Heat exchanger performance monitoring
Cooling Water Treatment: Chlorine Dioxide

- Included as oxidizing biocide for many new plants
- More efficient than bleach - does not react
  - to form trihalomethanes (THMs)
  - with ammonia-nitrogen
  - with most treatment chemicals (corrosion and scale inhibitors)
- Effective
  - over a wide pH range
  - in high ammonia waters (recycled)
- Raw materials (HCl, Sodium Chlorite) hazardous
- Extremely volatile and gasses off
  - Usually generated in batches, must use immediately (same day)
  - Pay attention to vent location
  - Consider submerged/on-demand generators
Cooling Water Treatment: Recycled Water Transitions

- Use usually focuses on cooling systems, but purveyors encourage other uses (demineralized water production, for example)
- Many users transitioned to without careful preplanning and suffered as a consequence. Can successfully replace other sources, but risks must be clearly understood and mitigated where possible.
Cooling Water Treatment: Recycled Water Transitions

- Increasing drivers to use recycled water
- Not a simple project – requires engineered systems and approach
- Typical limiting constituents (chloride, ammonia, phosphate) may impact feasibility
- No guaranteed water quality (wide variation possible)
  - Obtain long-term trend data
  - Analyze carefully
  - Leave room for future capacity
Cooling Water Treatment: Recycled Water Transitions

Create and follow a project plan:

1 – 5: DEVELOPMENT AND INVESTIGATION

1. GATHER WATER QUALITY DATA FROM PRIMARY WATER SOURCE AND FROM ALTERNATIVE WATER SOURCE.
2. IDENTIFY POTENTIAL CONSTITUENTS OF CONCERN FOR COOLING TOWER AND FOR ENVIRONMENTAL DISCHARGE.
3. CALCULATE WB, DB, %RH AT ANNUAL AVG AND SUMMER PEAK TEMP. COLLECT MONTHLY PAN EVAPORATION AND RAINFALL.
4. PERFORM/REVIEWS HEAT BALANCE TO DETERMINE COOLING TOWER EVAPORATION RATES AT SUMMER PEAK AND ANNUAL AVG CONDITIONS.
5. IDENTIFY REGULATORY CHEMISTRY LIMITS AND LIQUID VOLUME DISCHARGE LIMITS (e.g., ZLDS).

6 – 9: INITIAL MODELING

6. USE COMPUTER MODELS TO OPTIMIZE PRE-TREATMENT DESIGN CONSISTENT WITH COOLING TOWER MANUFACTURER CHEMISTRY LIMITS.
7. USE COMPUTER MODELS TO OPTIMIZE POST-TREATMENT DESIGN CONSISTENT WITH SITE DISCHARGE EFFLUENT CHEMISTRY LIMITS.
8. CREATE WATER BALANCE USING SELECTED WATER TREATMENT COMPONENTS BASED ON PRIMARY WATER SOURCE.
9. PERFORM INITIAL COST ESTIMATE FOR WATER TREATMENT SYSTEM WITH PRIMARY SOURCE OF WATER.
10. USE COMPUTER MODELS TO OPTIMIZE PRE- AND POST-TREATMENT SYSTEMS USING ALTERNATIVE SOURCE WATER AND DISCHARGE LIMITS.

10 – 14: ALTERNATIVE MODELING AND OPTIMIZATION

11. CREATE WATER BALANCE USING WATER TREATMENT COMPONENTS BASED ON ALTERNATIVE WATER SOURCE.
12. PERFORM INITIAL COST ESTIMATE FOR WATER TREATMENT SYSTEM WITH ALTERNATIVE SOURCE WATER.
13. IF REQUIRED, PERFORM SIMILAR CALCULATIONS FOR SYSTEM USING AIR-COOLED CONDENSER.
14. COMPARE ALL ALTERNATIVES FOR CAPITAL COSTS AND O&M COSTS.
15. REVIEW WITH ENVIRONMENTAL GROUP TO DETERMINE HAZARDOUS WASTE CHARACTERISTICS.

16 – 17: PERMITTING AND PILOT TESTING

16. REVIEW (REWRITE) DISCHARGE PERMIT. ENSURE WASTE IS WITHIN DISCHARGE LIMITS, OR MODIFY SITE DESIGN AND DISPOSAL OPTIONS.
17. PERFORM PILOT TESTING OR STUDIES, IF NEEDED.
18. WRITE / REVIEW APPLICATION FOR CERTIFICATION, IF NEEDED.
19. FINAL DESIGN, FINAL HEAT AND WATER BALANCE, FINAL PERMITS, FINAL DESIGN DRAWINGS.
20. DEVELOP EQUIPMENT SPECS, ISSUE RFP, EVALUATE PROPOSALS, SELECT VENDOR(S).

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Makeup Water and Demineralization Systems

- Vendor Issues
- EDI vs. Mixed Bed Demin
Makeup Water and Demin Systems: Vendor Issues

- Losing knowledge (retirements and .com lure)
- Moving away from custom systems
  - You get what they offer
  - May not be what you want or need
  - Engineering burden shifts to Buyer (conceptual and detailed)
- Major design issues on recent projects
  - Various suppliers
  - Substantial retrofits/reengineering required
  - Can’t assume systems will work
  - “Caveat Emptor”
Makeup Water and Demin Systems: EDI vs. Mixed Bed

- Recent EDI designs very reliable (as good as mixed beds)
- Avoid on-site and off-site mixed beds
- Modest cost
- Modular (easy to replace)
- Go-to design now (RO/EDI)
- Consider retrofits to replace onsite units
Wastewater Treatment

- Reclamation Options
- Deep-well Injection
Wastewater Treatment: Reclamation Options

- Cost proportional to % reclaimed
- MUST have clear understanding of discharge impacts
  - Any reclamation increases TDS of remaining waste
- Complex reclamation systems usually operational nightmares

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<th>Reclamation Option</th>
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<th>2</th>
<th>3</th>
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<tr>
<td>Description</td>
<td>Simple Wastewater Reclamation</td>
<td>50% Wastewater Reclamation</td>
<td>75% Wastewater Reclamation</td>
<td>99% WW Reclamation (Simple System)</td>
<td>99% WW Reclamation (Complex System)</td>
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<td>Total Cost ($ per gpm of fresh water saved or gpm of wastewater reduction)</td>
<td>$0</td>
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Wastewater Treatment: Deep-well Injection

- Used to be a good potential alternative
- Increasing scrutiny and regulation
  - Seismic concerns
  - Fresh water safety concerns
  - Identified with hydraulic fracturing
  - Permitting getting more complex
- May still be a fit, but requires extremely detailed analysis
Questions?

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What a good iron monitoring program can prevent