International Association for the Properties of Water and Steam

Perspective on Cycle Chemistry In Fossil and Combined Cycle Plants

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Continuing Cycle Chemistry Damage in Fossil and Combined Cycle / HRSG Plants

50% (70%) of all fossil (combined cycle / HRSG) damage

- Chemistry influenced Tube Failure (BTF / HTF) damage / failure mechanisms
  - Flow-accelerated Corrosion (FAC)
  - Under-deposit Corrosion (UDC) (HD, APC and CG)
  - Corrosion Fatigue & Stress Corrosion Cracking (TG and IG)
  - Pitting
- Corrosion Product Transport
  - Deposition in Waterwalls, HP Evaporators and Steam Turbines
  - Importance of an ACC in the Cycle
- Steam Turbine Damage / Failure
  - PTZ (Pitting, SCC and CF cracking)
  - Deposition in HP / IP / LP

Does this Failure / Damage Occur Because

- They are failure / damage mechanisms?
- Design of Fossil / HRSG Plant ?
- Design of Steam Turbine?
- Design of the Feedwater System?

Or because of

- Plant Staff not Addressing the Basics of Cycle Chemistry
- Not installing a Fundamental Level of Instruments
- Not using the International Standards for Cycle Chemistry
- Not Using Total Iron as an Indicator
- Not having an Integrated Management Program in Place to Prevent Repeat Cycle Chemistry Situations

Identifying Repeat Cycle Chemistry Situations

- Recent analyses from over 200 power plant/failures/damage situations worldwide over last 15 years revealed that some of the key basics of Power Plant Cycle Chemistry are not as ruggedly addressed as perhaps they should be, and
- All cycle chemistry-influenced failure and damage can always be related back to multiples of 10 repeat cycle chemistry situations in fossil plants
- Most powerful tool at plant level to identify whether there are cycle chemistry problems which will result in future failure / damage.
- and at International level to identify where guidance is needed

Dooley, Shields and Shulder, PPChem. 2008 10(10), pp 564-574

Plant Assessments using Repeat Situations Analysis

* 84 Fossil Plants

BTF Mechanism and Root Cause Assessments
FAC Assessments. ACC Assessments
Cycle Chemistry Assessments and Conversions to OT and PT
PTZ Blade and Disk Failure/Damage Assessments
Copper Deposition on HP Turbine and in Superheater
Development of Shutdown/layup and Preservation Procedures

* 45 HRSG/Combined Cycle Plants
(14 HRSG manufacturers)

HRSG Assessment (Cycle chemistry, FAC and Thermal Transients)
Cycle Chemistry Assessments and Optimization
HRSG FAC Assessments. ACC Assessments
HRSG Tube Failures
Development of Shutdown/layup and Preservation Procedures

Based on 129 Plant Assessments 2008 - 2013

Repeat Situations in Cycle Chemistry Control

In a total of 45 HRSG/Combined Cycle Plants

*	Corrosion products	45
*	HP evaporator deposition	26
*	Chemical cleaning	3
*	Contaminant ingress	6
*	Drum carryover	43
*	Air in-leakage	4
*	Shutdown protection	28 (& 45*)
*	On-line alarmed instrumentation	45
*	Not challenging the status quo	35
*	No Action Plans	N/A

* Use of DHA on ST

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Repeat Situations in Cycle Chemistry Control

In a total of 84 Fossil Plants

*	Corrosion products	77
*	Boiler waterwall deposition	34
*	Chemical cleaning	10
*	Contaminant ingress	17
*	Drum carryover	67
*	Air in-leakage	39
*	Shutdown protection	67 (& 79*)
*	On-line alarmed instrumentation	71
*	Not challenging the status quo	66
*	No Action Plans	N/A

* Use of DHA on ST

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Categories within Repeat Situations

* Corrosion Products

Not Known - Too high – Above local guideline values
Inadequate extent and not sufficient locations
Techniques used – Incorrect detection limit – Soluble only

* Drum carryover

Not conducted since commissioning
Even on units with PTZ problems
Not aware of simple process (IAPWS)
Saturated steam samples not working
Samples often not isokinetic; some have ASME nozzles

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Categories within Repeat Situations

* **Instrumentation**

Low % compared to International Standard (IAPWS)
CACE (cation conductivity) and Conductivity on MU line most often missing together with Steam Monitoring
Not alarmed. Many shared and not switched
Plant relies on grab samples to control plant (1-2 times per day)
Too many out of service, not maintained or calibrated

Plant	Range of %	Average
CC/HRSG	0 - 88% (0 @ 100%) (7 over 80%)	58%
Fossil	0-100% (5 @100%) (25 over 80%)	65%

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Categories within Repeat Situations

* **Air in-leakage**

Not Known - Too high – Oxygen above local CPD guideline values
"Local" guidelines often too high
Operators not monitoring
No comprehensive AIL program

* **Challenging the Status Quo**

Same chemistry since commissioning
Questioning of proprietary chemical additions
Continue to use reducing agents in combined cycle/HRSGs and all-ferrous fossil plants
Using incorrect or outdated guidelines
Incorrect addition point for chemicals (most often reducing agent)

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Categories within Repeat Situations

* **Shutdown Protection**

No equipment for providing SD protection
Equipment present but not used or inoperable/not maintained
Poor/no operator procedures
Only partial protection applied (boiler/HSRG vs feedwater)
No DHA for the steam turbine except on the newest plants

* **Contaminant Ingress**

No assessment of risk
Inadequate instrumentation and alarms (especially for seawater)
Operators allow excedances of all Level Alarms
No comprehensive procedures
Chemists compromise limits to plant ability (make high readings acceptable)

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In Conclusion in 2013

- Many of the uncertainties identified in the 1980s and 1990s have been addressed
- and there is much closer (not complete) international agreement on fossil/HRSG chemistry guidance
- But failure and damage is still occurring due to some incompatibilities and plants allowing repeat situations to continue
- We need to get all manufacturers worldwide to use the international standard to avoid incompatible equipment designs and early operation problems
- Since 2008 this has been the IAPWS Technical Guidance Documents