

## European HRSG Forum (EHF2024) Highlights and Press Release

The tenth annual IAPWS European HRSG Forum was held on the 13<sup>th</sup> – 15<sup>th</sup> May 2024 in Prato, Italy. It was chaired by Barry Dooley of Structural Integrity and Bob Anderson of Competitive Power Resources. EHF2024 attracted 90 participants from 18 countries and included 40 users.

EHF2024 was developed and continues to be supported by the International Association for the Properties of Water and Steam (IAPWS) and is held in association with the Australasian Boiler and HRSG Users Group (ABHUG) and the US HRSG Forum (HF). The EHF2024 event was organized by Mecca Concepts, Australia. The 2024 EHF had 13 sponsors: Dekomte, NEM, John Cockerill, Tuff Tube Transition, Precision Iceblast Corporation, Altrad Babcock, TesTex, Arnold Group, Valve Pro/Conval, Advanced Valve Solutions, Cormetech, Groome Industrial Services and Metroscope.

This year the EHF included 24 presentations. The meeting provided a forum for the presentation of new information and technology related to HRSGs, case studies of plant experiences and solutions, and for open discussion among the plant users, equipment suppliers, and industry consultants. The mix of the different topics (materials, cycle chemistry, operation, valves, tube failures and assessment techniques, inspection and remaining life aspects, and HRSG gas-side cleaning) kept the attendees interested, alert and participating. EHF again provided a unique opportunity for plant users to discuss questions relating to all aspects of HRSG operation with the industry's international experts. These discussions underlined once more the urgent need for the international exchange of information, which is excellently provided by this IAPWS forum.

Highlights from EHF2024 included:

- It was noted a number of times that more flexible operation (faster starts and more cycles) was being experienced and was anticipated to be even more challenging in the future for HRSG reliability, particularly for
  - Creep and fatigue related failures in superheaters and reheaters.
  - Flow-accelerated Corrosion (FAC) and under-deposit corrosion (UDC) related failures in economizers and evaporators.
- Increased renewables capacity and decarbonization continue to be important topics for combined cycle plant users, OEMs and vendors. Whilst not the highest priority for HRSG on-site teams today, the EHF acknowledged growth of these will play a key role in how gas plants will be operated in the years to come. HRSG OEMs, vendors and users need to be prepared for a future with GTs firing H<sub>2</sub> blended fuels as well as Carbon Capture and Storage plants. The HRSG challenges to be considered when firing blends of hydrogen in the gas turbine include: 1) NO<sub>x</sub> emissions, 2) Purging, 3) Duct Burner operation and 4) Hazardous area classification.
- HRSG tube failures (HTF) remain a major concern and the following aspects were discussed:
  - a) The importance and value of determining the “failure mechanism” was reinforced during root cause assessments. Case studies clearly demonstrated the importance of using a metallurgist for these assessments who understands the plant

equipment and processes to avoid incorrect determination of the mechanism. While strong investigative capabilities have historically been readily available (though not always used), the presentation highlighted industry challenges such as workforce turnover, lack of corporate memory and the risks of not understanding the implications of failure for future component reliability.

- b) FAC was again identified as the most important and largest tube failure mechanism worldwide and was discussed with clarification of the effect of pH in addressing two-phase FAC and oxidizing power in preventing single-phase. The HRSG repair companies indicated that addressing FAC was their most often repair.
- c) UDC was highlighted and related to the transport and deposition of corrosion products. Alleviation relates directly to the removal of HP Evaporator tubes and their analysis to avoid heavy deposits as compared to the IAPWS Deposition Map. As a result, chemical cleaning of internal HP evaporator tubes is also gaining momentum.
- d) Pressure part failure in superheaters and reheaters relating to condensate, drains and attemperators continue as at past EHF.
- e) Advanced inspection methods including robotic waterside inspection of HRSG evaporator and economizer tubes for wall loss were illustrated with much improved access to tubes from upper headers. Discussion focused on developing the ability to robotically measure HP evaporator internal tube deposit density.
- f) Innovative repair methods including the use of tube sleeves can provide lower cost options that will keep HRSGs and plants running in the short-to-midterm. An interesting use of friction welding for dissimilar metal welds in HRSG tubes was discussed.
- International updates on HRSG cycle chemistry included:
  - a) The latest chemistry influenced reliability statistics, referred to as Repeat Cycle Chemistry Situations (RCCS), continue to show an overall improvement. But the international data base indicates that 86% of plants have ineffective corrosion products monitoring programs, 80% have reduced cycle chemistry instrumentation when compared to the international standard, 78% don't monitor drum carryover and about 73% are not challenging the status quo.
  - b) These statistics related well with the main problem areas in HRSGs including feedwater corrosion products, FAC and UDC, and to the provision of chemistry guidance.
  - c) A new IAPWS procedure for monitoring corrosion products in fast start and flexibly operated plants can quickly indicate to the operator whether the chemistry control during operation is optimum and whether the shutdown procedures are providing protection.
  - d) An update on the application of Film Forming Substances (FFS) (both amine (FFA) and non-amine (FFP) based) was provided. Overall, the applications illustrate reduced corrosion product transport and general protection in water-touched circuits, but

questionable film formation in steam circuits. The participants were provided with the key pre-application procedures required to provide optimum results and prevent problems of under-deposit corrosion and "gunk" formation. Examples of increased HP evaporator deposits and UDC when using FFS were provided.

e) Information on the latest IAPWS cycle chemistry Technical Guidance Documents for combined cycle/HRSG plants was provided.

- International updates on thermal transients included:  
The latest thermal transient influenced reliability statistics continue to show only moderate overall improvement with most problems continuing to be associated with attemperators. The international data base indicates that only 9% of plants have an organized tube failure prevention policy, 21% routinely inspect attemperator hardware, 83% experience leaking attemperator spray water of which 95% use block valve/control valve sequencing logic that encourages leaking, 40% experience attemperator overspray conditions, 31% allow operators to manually control attemperators, and 22%/43% effectively drain the HPSH/RH during startup.
- This year EHF included a number of presentations related to valves, bypass valves, and attemperators/desuperheaters with the key highlights being:  
A tutorial on feedwater control valve design and application, discussion on increase in flexible operations (start/stop, low load, etc) impacts HP bypass pressure control valve and desuperheater performance, how advances in predictive methods to evaluate attemperator performance have improved the cost and duration of problem troubleshooting as compared to trial and error, and how recently developed twin-nozzle radial spray assemblies have resulted in improved spray water evaporation in shorter steam pipe straight lengths.
- The latest developments and case studies on two of the fireside cleaning processes (Ice Blasting and Kinetic Shockwave) remain hot HRSG topics. For HRSGs with badly fouled finned tubes, cleaning remains one of the fastest ROI for the combined cycle plant from improved heat rate/efficiency. Discussion covered the efficacy of the processes, the meaning of "deep" cleaning and the possibility of any effect on internal oxides and deposits.
- New areas of using electric heating were introduced including a) steam turbine casings for pre-warming and maintaining warm start conditions, and b) for maintaining the HRSG HP drum at positive pressure during wet layup to reduce thermal fatigue damage associated with cold startup and enhance layup corrosion protection. Electrical heating of HP downcomer systems demonstrated the ability to maintain residual temperature and pressure in the HP evaporator following unit shutdown, with the potential to reduce the duration and fuel burn associated with the subsequent startup.
- The rehabilitation of an HRSG following the collapse of the stack provided an interesting case study, focusing on challenges related to access, scoping of the HRSG impact damage, preservation of the damaged water/steam systems, repair/replacement strategy and hydraulic waivers.



- The latest information on penetration seals was presented with case studies.
- A mini workshop was conducted on the cause of the many failures of branch tees in the combined cycle fleet, on which tees should be inspected, how to rank the risks and provide corrective actions.
- A conference dinner, generously hosted by Dekomte, was held for the first time at EHF in the Conservatorio San Niccolo in central Prato. This enabled all delegates and sponsors to enjoy each other's company over a wonderful dinner in a beautiful setting.

The eleventh EHF conference (EHF2024) will be held 13<sup>th</sup> – 15<sup>th</sup> May 2025 in Prato, Italy.

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