FINNISH RECOVERY BOILER COMMITTEE'S INFLUENCE ON RECOVERY BOILER SAFETY AND TECHNOLOGY

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ABSTRACT

The story of recovery boilers in Finland started three years after first built recovery boiler at Domtar (Windsor pulp mill), when Babcock & Wilcox installed a brand new recovery boiler at Oulu mill in 1937. In 1950s, after building a few new kraft mills and recovery boilers in Finland, co-operation and communication between all parties including mills and technology suppliers started to be more organized and active in the end of 1960s. This was a foundation or even so-called starting point for fruitful and successful collaboration to improve recovery boiler safety, technology and environmental impact in Finnish pulp mills.

Associations could be seen as one of the significant reasons why recovery boiler technology has developed, and why recovery boilers are currently certainly safe places to work. *BLRBAC* has published several comprehensive safety and operational guidelines in North and South America which have created a basis for global standards in boiler controls and operation. In Scandinavia, *Finnish Recovery Boiler Committee (Soodakattilayhdistys)* and *The Swedish Norwegian Recovery Boiler Committee (Sodahuskommittén)* have also made studies to develop inspection instructions, improve technologies to mitigate environmental emissions and published guidelines for e.g. odorous gas firing or water chemistry quality. This has increased lifetime of recovery boilers and significantly prevented accidents in the pulp industry.

Finnish Recovery Boiler Committee is divided in a few subcommittees to concentrate on present topics for each subjects; General, Reliability and Superheater Committee were founded in 1969, Operation Committee 1970, Black Liquor Committee 1980, Environmental Committee 1984 and Automation Committee 1996. This has made possible to coordinate studies for interesting topics over the years to improve boiler design, operation and safety.

FRBC's biggest achievements in safety improvement are guidelines for 1) odor gas handling and incineration, 2) safety related instrumentation and 3) instructions for proven inspection methods. This is a solid foundation for safe and modern recovery boilers with comprehensive and integrated automation with new safety features for operator safety.

Milestones of *FRBC*'s major influence on safety and technology are identified as following

1. Foundation for co-operation was built in *Teollisuuden Lämpötekninen Kerho* in 1964. Primary function was to collect all recovery boiler users and manufactures to promote safety, economic and environmentally friendly operation.
2. Experience sharing days for superintendents (Konemestaripäivät) established in 1967 to promote new technologies and share experience and damage reports to all parties. Open communication and co-operation between Finnish pulp mills were accelerated.
3. Damage reporting started in collaboration with Finnish pulp mills in 1970. First leakage was reported in 19th of January in 1970 that happened in UPM Kaukas in the end of 1969. This practice is still in use in *FRBC* and damages are discussed annually in the event of Experience sharing days for superintendents.
4. Corrosion problems occurred in boiler furnace in many mills due to increased boiler pressure. All Finnish pulp mills were involved in research which was utilized to investigate the root cause. Conclusion was that rapid tube wastage was happened due to sulfidation corrosion by reduced gaseous sulfur compounds and the way to prevent occurred corrosion was to use High Chromium steels. 304L composite were installed in recovery boiler furnace in 1972.
5. Incineration of diluted and especially dissolving tank vent gases were studied in 1985 and first test was done in Sunila SK10 in 1989. This procedure improved odor gas handling and was a first step to odorless mills.
6. NCG collection systems in Finnish pulp mills were investigated in 1991 by Ekono, but recommended procedure for incineration of non-condensible gases was published in 2002, about 10 years after first CNCG incineration in recovery boilers. Guideline contains firing conditions for all malodor gases and recent addition is wide overview of NCG collection. Guidelines have been updated three times and latest revision was published in 2021.
7. *FRBC* has also published several recommendations and one of the most important have been recommendation for compound tube inspections in furnace floor in 1993. New materials in recovery boilers (SOMA project) were researched and finally published in 1998, two years after first installation of Sanicro 38.
8. Because SO_2 emissions were anymore minor part in air pollutants due to high dry solids firing start-up in late 1990s, focus moved to research and mitigate NO_x emissions. Based on deep study of NO_x emissions and Nitrogen reactions in recovery boilers, mills were able to reduce NO_x emissions by air staging. Further reduction is also possible by new scrubber technology and first ClO_2 de-NOx scrubber was delivered in China in 2019.
9. Safety instrumented system guideline was published in 2000s, because it was seen necessary to have instruction for implementation due to variations in implementations in different mills. Safety instrumentation guidelines was published first time in 2003 and it contained e.g. definition of safety interlockings and proper implementation documentation. Guideline was revised recently in 2021.

10. Instructions for water chemistry and boiler leak detection published in the beginning of 2000. Controlling of water chemistry and understanding correct quality requirements improved lifetime of boiler operation due to proper water treatment.
11. Improvement of boiler availability and cleanability was major topic in the end of 2000. *FRBC* studied several related topics to support availability improvement by coordinating research of spraying behavior of high dry solids black liquor, better materials for higher steam parameters and fast carryover measurement guidelines. “Minuuttisondi”-project was published in 2009 to measure and prevent liquor carryover. Related to occurred superheater corrosion, AshLeach system was installed in worldwide in 2002 and first system in Finland was started in 2008 to control potassium and chlorine composition in recirculated ash.
12. The 2010 is known a century when pulp mills’ capacity and electricity generation were rapidly increased to a new level alongside with new trends of digitalization and ambitious environmental targets. Due to rapid involvement of digitalization and future look of autonomous operation, mills need to deal with new challenges of cyber security to keep confidential information protected and prevent cyber-attacks to the mills. *FRBC* published an information handbook together with *Insta* related to cyber security principles and recommendations for risk management in 2022.

To summarize, *Finnish Recovery Boiler Committee* has taken a major role especially in improvement of safety, automation implementation and operation principles. Safety aspects actually have given a direction of all design development. These are so-called preventive safety actions instead of replacements or corrective actions after incidents. In the future, besides of the personal safety, there is also a bigger role by new challenges due to digitalization, because more and more data is collected and used to improve efficiency and promote autonomous operation of the pulp mills. This causes new challenges in safety and forces industry to focus actively also on cyber security to keep confidential information and mill networks protected.

In technology wise, *Finnish Recovery Boiler Committee* could be seen to act as a crucial party to keep all automation and material inspection guidelines up-to-date when digitalization is utilized step-by-step and new materials are foreseen to be utilized due to increased demand of improved efficiency targets. More research is expected also from environmental perspective, because it is foreseen that environmental permits for air pollutants might be stricter in future which gives pressure to the mills to minimize their environmental footprint.