Finnish Recovery Boiler Committee’s Influence on Recovery Boiler Safety and Technology

60th Anniversary International Recovery Boiler Conference

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SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

Background

Reasons for improved technology and safety in recovery boilers

- Role of associations globally
- Studies and published reports
  - Corrosion
  - Emissions
- Safety improvements
  - Guidelines
  - Automation
  - Experience and design development
- New features

BLRBAC = Black Liquor Recovery Boiler Association
FRBC = Finnish Recovery Boiler Committee
SHK = Sodahuskommittén

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History timeline of recovery boiler safety and technology

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First decades of recovery boilers

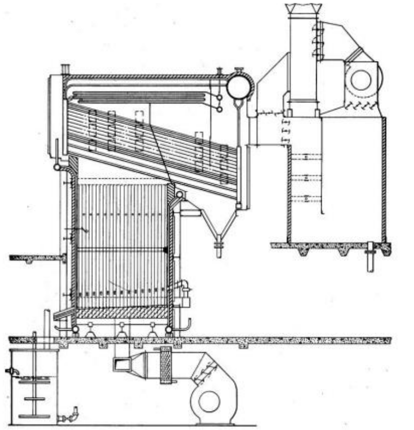
1934

First recovery boiler with water cooled furnace at Domtar (Windsor pulp mill)

1937

First recovery boiler in Finland built at Oulu mill by B&W

32 bar and 420°C



1959

First higher parameter boiler at Imatra mill by CE

64 bar and 480°C

1930 **1935** **1940** **1960**

Era before Finnish Recovery Boiler committee
Co-operation between mills

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History timeline of recovery boiler safety and technology

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Improvement of boiler efficiency, high steam parameters, higher heat flux in furnace

1962

BLRBAC founded by insurance companies

1965

Last fatal explosion occurred at Äänekoski

1967

Rapid drain down to 8” system added in BLRBAC

Availability

Safety

1960 **1965** **1970**

Corrosion occurred in furnace started organized study work in collaboration of all recovery boiler users in Finland in Nov 1964.

1962

Negotiations in Ekono due to rapid corrosion in recovery boilers

1964

“Soodakattilajaos” (RB Committee) in TLK

1965-67

Common study for furnace corrosion, Study committee was nominated

1967

Experience sharing days for Superintendents in Oulu

1969

General, Reliability, Superheater Committees founded

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1972

304L composite in recovery boiler furnaces to avoid sulfide corrosion

1979

Valmet introduced first DCS system

Automation

1970 **1975** **1980**

Emission studies during 1970

Damage reporting started in FRBC

1970

Report for BL firing methods, continuous DS measurement

1971

Dynamic control system studied and utilized in Kaukopää

1973

Revised Recovery Boiler Instruction

1974

NOx, SO2 & H2S measurements at Finnish mills

1978

Recommendation for the Protection of Recovery Boilers

1978

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Improvement of boiler efficiency, high steam parameters, higher heat flux in furnace

1982

Climate Legislation

Diluted odor gases incineration started

1986

High dry solids firing with Super concentrator → Minimized SO_x

1987

First single drum recovery boiler

1989

Dissolving tank vent gases incineration in Sunila SK10

Environment

1980 **1985** **1990**

Black liquor properties, spraying behavior, high dry solids and steam economy were main topics for studies in 1980-90

Black Liquor Committee founded

Environmental Committee founded

Study to handle and incinerate vent gases in RB

Recovery Boiler Days established in Helsinki

1980 **1984** **1985** **1988**

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1991

First RB Optimizer developed and implemented in Kemi

1993

CNCG burning started in Metsä Botnia (Kemi)

1996

Sanicro 38 composite tubes in RB furnaces

1990 **1995** **2000**

High dry solids firing spraying, droplet mechanism and evaporation fouling studied further

1991

NCG collection systems in Finnish pulp mills by Ekono

1992

Report of air emissions, reduction and control

1993

Study for nitrogen reactions in black liquor firing by ÅA

Recommendation for compound tube inspection in furnace floor

1996

Automation Committee founded

1998

Report for new materials of recovery boilers (SOMA)

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History timeline of recovery boiler safety and technology

Improvement of boiler efficiency, high steam parameters, higher heat flux in furnace

2002

Corrosion and fouling problems occurred

First AshLeach to Brazil

2008

First high efficient recovery boiler in Finland with AshLeach

First smelt spout robot installed in Kymi

Reliability

2000 **2005** **2010**

Boiler leak detection and instructions published

2001

Report for high temperature hydrogen attack and boiler water norms

Recommended procedure for incineration of NCG

2002

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Towards to safe working environment

Recommended procedure for incineration of non-condensible gases published in 2002

- Recommendations published ~10 years after CNCG firing started
- Revised once per decade (2005, 2013, 2021)
    - Firing condition updates for diluted and concentrated NCGs, methanol and turpentine
    - Guidelines for NCG burner and support firing
    - NCG collection overview in 2021
        - Sources, safety consideration, back-up incineration location, bottling procedure
    - Added examples of accidents and damages
- Increased understanding of safety perspective and purpose of LEL and UEL in NCG handling

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2003 Safety instrumentation and SIS guidelines

2005

2010

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Recommended procedure for incineration of NCG

Study and report of NOx emissions in recovery boilers published

2001

2002

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Impact to safety instrumentation improvements

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Safety instrumentation and rapid drain system was a key improvement to prevent fatal accidents

- Instructions for implementation of safety instrumentation due to variations in implementations
- A guide and checklist to provide the proper tools for promoting safety and long-term availability
- Definition of proper documentation
- Definition of safety interlockings
  - Boiler interlockings
  - Purging conditions
  - Firing conditions
  - ESP

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Report for high temperature hydrogen attack and boiler water norms

Recommended procedure for incineration of NCG

Study and report of NOx emissions in recovery boilers published

2006

PPE recom-mendation for operators published

2009

Fast carryover measurement ("Minuutti-sondi") project published

Safety recommend-dation for recovery boilers

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History timeline of recovery boiler safety and technology

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Towards magnum size boilers and autonomous operation

Development of recovery boiler capacity and electricity generation to a new era

Minimized environmental footprint

Digitalization, Industrial Internet, Analyzers, Advanced process control, Autonomous mills, Data to cloud

2019

First ClO_2 NOx scrubber in recovery boilers

2023

Newest high power recovery Boiler started up in MF Kemi

104 bar and 505°C

Capacity

2010

2015

2020

FRBC publishes guidelines and recommendations for water chemistry standards

2011

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Guidelines and recommendations for water chemistry standards

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Proper water chemistry monitoring a key for long lifetime of pressure part tubing

Höyry, ammoniakki/orgaaninen amiini - fosfaattikemia ei kuparimateriaaleja		Optimoitu vesikemia (O)	Toimintaraja 1 (TR 1)	
			ammoniakki	ammoniakki ja orgaaninen amiini
pH		9,3 - 9,6	9,3 - 9,6	
Kationivaihdettu johtokyky (1	mS/m	≤ 0,02	0,03	0,05
SiO_2	µg/kg	≤ 5	10	
Na	µg/kg	≤ 5	10	
Cl	µg/kg	< 3	3	
SO_4	µg/kg	< 3	3	
TOC (2	µg/kg	< 100 (3	100 (4	500 (4
Fe (kokonais)	µg/kg	≤ 5	10	

(1 Käytettäessä orgaanisia amiineja hyväksytään korkeampi kationivaihdettu johtokyky jos sen aiheuttaa hiilidioksidi, CO_2

(2 Orgaanisen aineen kokonaispitoisuus muuttuu amiiniannostelun mukaan. Lisäveden ja lauhdevuodon aiheuttama TOC raja on ≤ 200 µg/kg.

alkaloinnista pH 9,6 on tehty ETA:lla.

(3 Saa sisältää asetaattia ja formiaattia yhteensä ≤ 15 µg/kg

(4 Saa sisältää asetaattia ja formiaattia yhteensä ≤ 30 µg/kg

"-" Kyseistä arvoa ei voida antaa.

- Collected all water chemistry standards and given recommendations for different pressure class published in 2011
- Mitigated corrosion problems in boiler tubes and steam turbines
- Prevent hydrogen attack risks when pH is controlled to requested level
- Major role in improving safety when keeping pressure parts in desired condition

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2010

2015

2020

FRBC publishes guidelines and recommendations for water chemistry standards

Electrical safety systems in recovery boilers; evacuation, fire alarms and fire fighting, ATEX etc.

Testing procedure for Safety Integrated Systems in recovery boilers

2011

Low temperature corrosion study by ÅA

2014

Recommendation for smelt spouts

Safety audit of NCG system

2018

Cyber security principles in RB automation systems

2022

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Digitalization creates opportunities but also new risks

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Cyber security principles in recovery boiler's automation systems

- Cyber security acts a major role to keep information safe when digitalization is utilized, and visions are more towards autonomous operation
  - No confidential information to "wrong hands"
  - No cyber attacks to mill's operation systems (viruses, overloading of the system)
- The information package of cyber security management by FRBC and Insta
  - "Handbook" of cyber security
  - Recommendation for risk management
  - Examples of possible risks and risk evaluation templates

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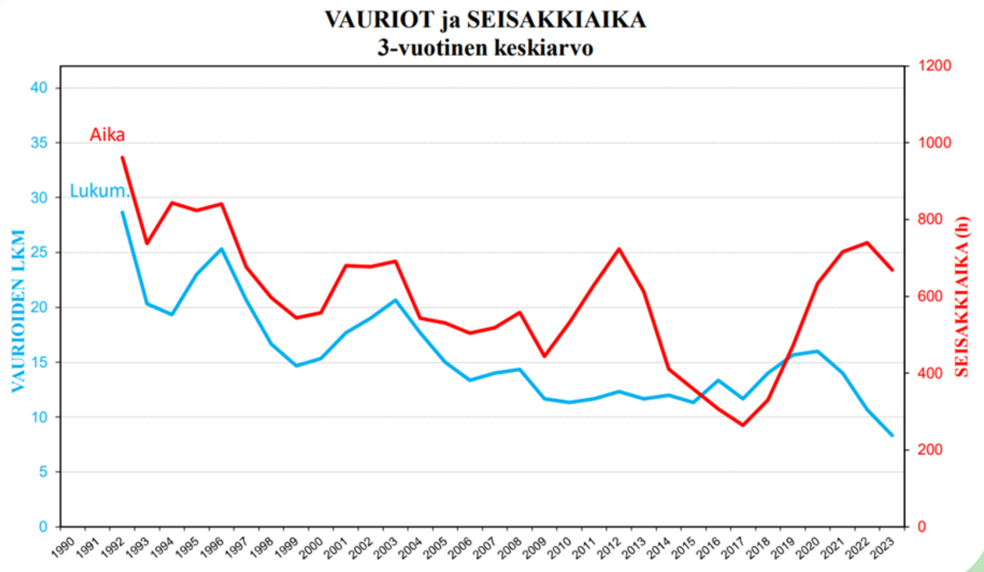
Summary

“Everybody has right to come back home safe and healthy”

- FRBC major role especially in safety improvements, emissions and water chemistry
- From corrective actions (damage control) to preventive actions and new time challenges → Annual/periodical inspections and data sharing
- Indicator of improved safety is decreased sequence of accidents and pressure part damages due to
  - Improved understanding of metallurgy
  - SIS and early leak detection
  - Understanding the role of water chemistry
  - Understanding of NCG handling and firing
  - Improved safety by new features



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FORWARD