SUOMEN SOODAKATTILAYHDISTYS
FINNISH RECOVERY BOILER COMMITTEE

ANDRITZ

60 Years of Development in Kraft Recovery Boiler Technology

Featuring FRBC Highlights

Keijo Salmenoja

Partially retired from Black Liquor

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- Introduction
- Early development (bc FRBC)
- Foundation of FRBC (1964)
- Recent development (ad FRBC)
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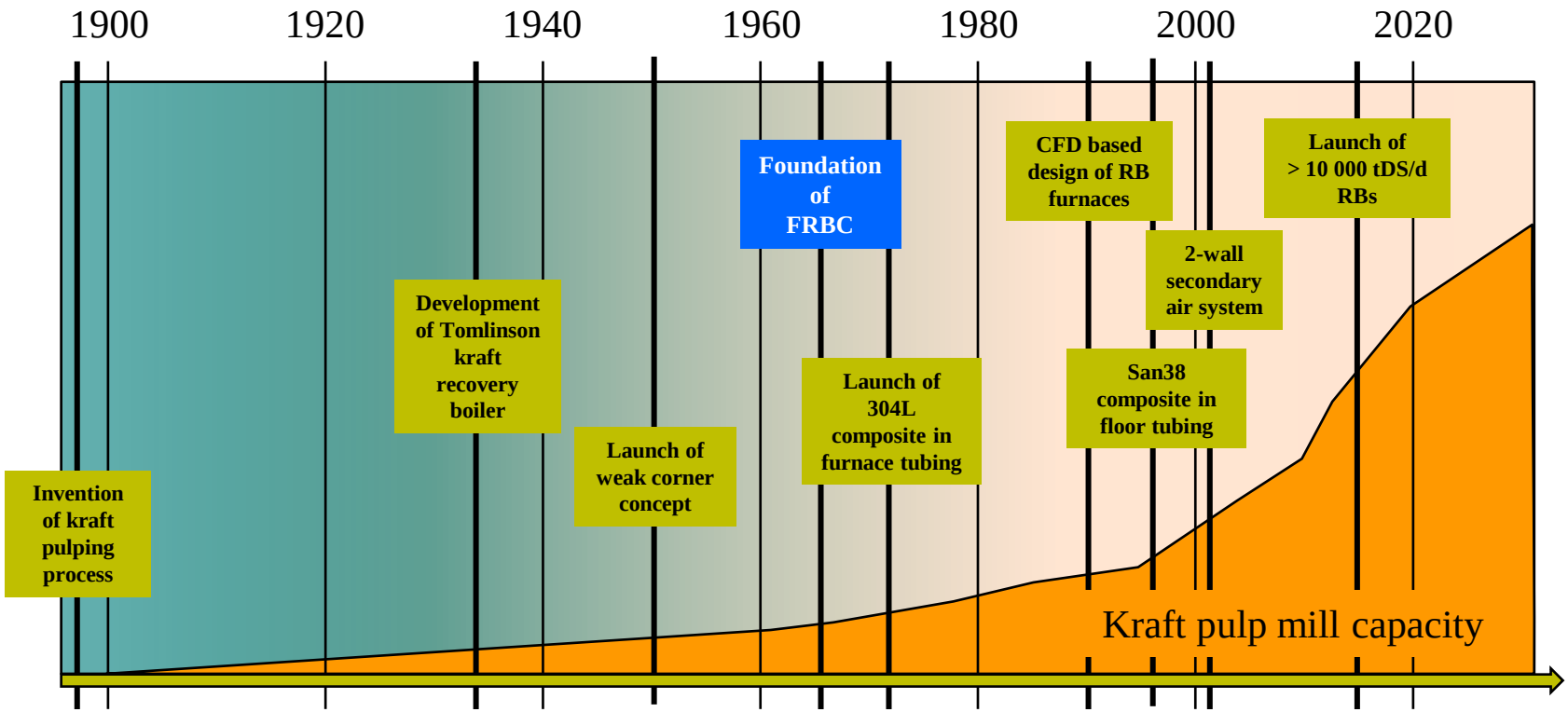
Introduction



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Early Development (bc FRBC)

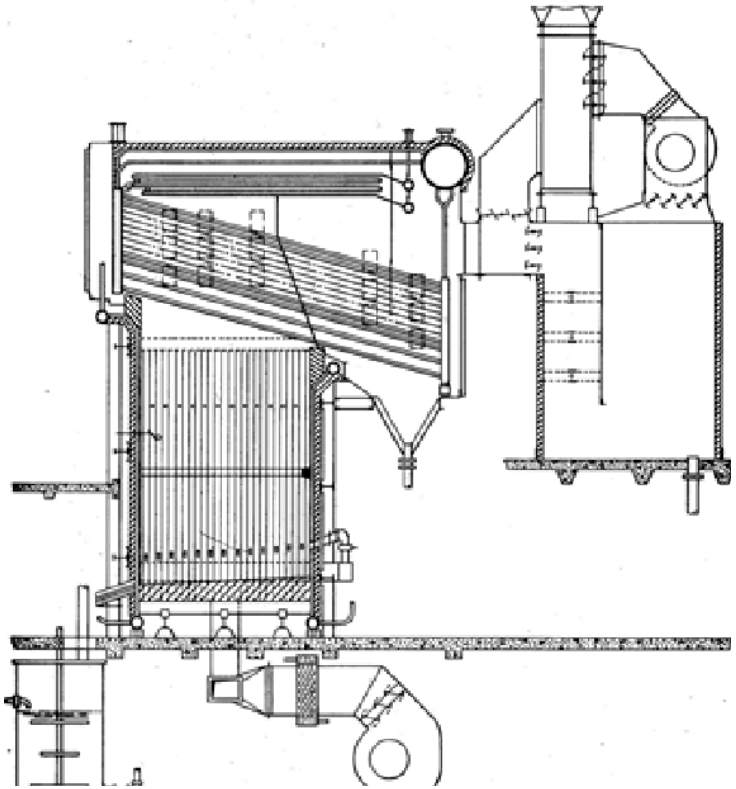
- Kraft pulping evolved from soda pulping, zero sulfidity kraft in Germany in the 1880s
- Typically, batch digesters were used 1920s
  - Capacity of 50-70 m^3
- Black liquor recovery with refractory-lined roasting smelters
  - Heat recovery in an external heat recovery steam generator bank connected by ductwork

Early Development (bc FRBC)

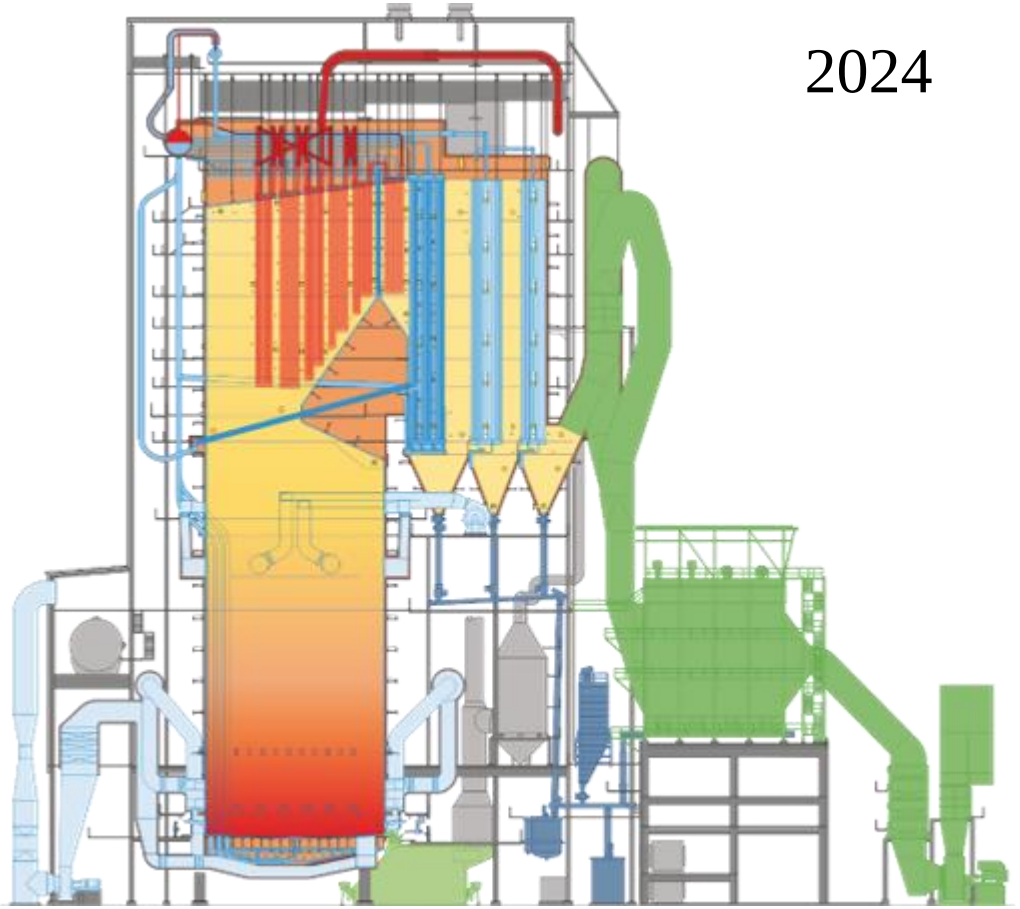
- The launch of the G. H. Tomlinson RB in early 1930s was a milestone in the kraft process
  - Heat recovery steam generator was mounted on top of the smelter reactor to avoid the ducting requirements
  - This minimized the building footprint, making the recovery boiler a dominating feature of the mill skyline

Introduction

1934

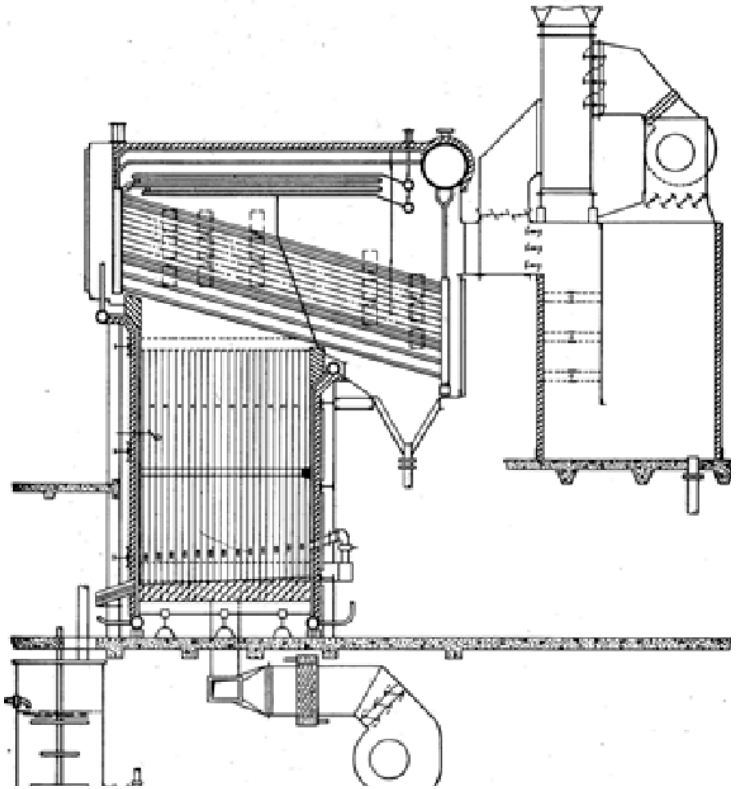


2024



Introduction

1934



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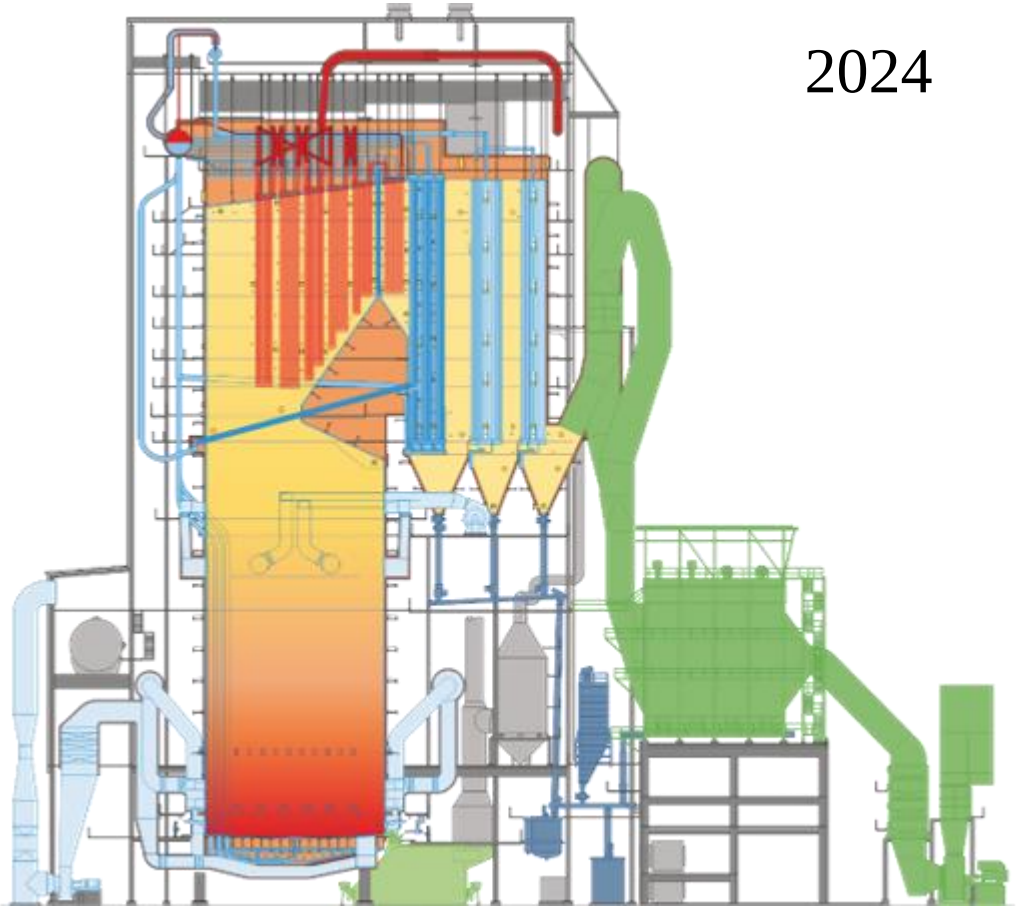

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Foundation of FRBC

- Boiler pressures > 64 bar lead to several failures in RB waterwall tubes in Finland
  - New phenomenon
  - Rapid furnace side corrosion of carbon steel wall tubes
- Average shutdown time ca. 46 days
- Cost to change the tubes ca. 500 000 FIM (~1 M€) per boiler

Foundation of FRBC

- A national research project, involving all boiler suppliers and pulp producers was initiated in 1964 in Finland to find the reason for rapid wall tube corrosion
- First cooperation meeting was held at Kaukas mill on ***November 11, 1964***
  - Initiate a study to solve wall tube corrosion and to create measures to mitigate the corrosion

Foundation of FRBC

- A jointly sponsored 3-year *Recovery Boiler Corrosion Study* was started in 1965
- Formal cooperation between Finnish Recovery Boiler users and manufacturers was started
- Another study to develop a *Recovery Boiler Control Model* was launched as a separate project in 1970

Foundation of FRBC

- Six different committees were nominated:
  - *Statistical*, *Furnace*, *Durability*, *Water Circulation*, and *Corrosion Outside Furnace*
- Furnace conditions were studied with gas composition, deposit, and temperature analyses
- A computer model was developed to process the measurement data

Foundation of FRBC

- Final report was published in 1968:
  - Corrosion due to sulfidation by H_2S and COS
  - Main contributor to corrosion rate was boiler pressure (wall tube metal temperature)
  - Highest corrosion rates in reducing areas, less corrosion in upper parts of the furnace
  - Recommendation how to protect furnace wall tubes against sulfidation corrosion

Foundation of FRBC

R = reduction zone, **P** = combustion zone, **J** = OFA zone, **Y** = upper zone

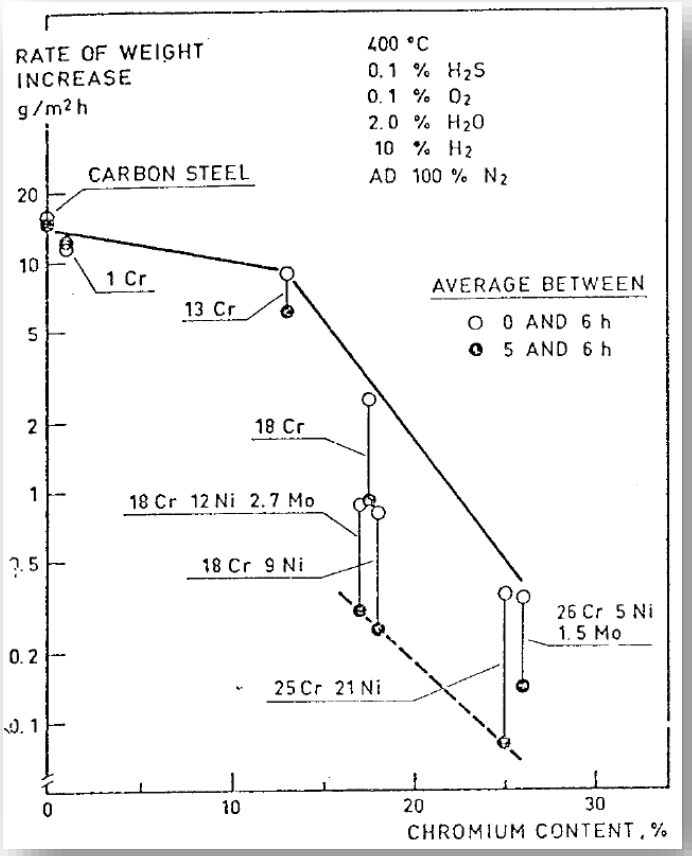
Recommendation for new tubes*	R	P	J	Y
Carbon steel tubing:				
2 mm corrosion alowance	2	3	3	4
Al flame spray coating	0	0	2	2
Cr-Al flame spray coating	0	1	2	3
Cr-Fe flame spray coating	1	1	2	3
Cr-Fe weld overlay	4	4	4	NN
Cr steel tubes, membrane wall	4	4	4	NN
Composite tubes	4	4	4	NN
Dense studded tubes	3	3	3	NN

***1970**

0 = No protection, **1** = 0-1 years, **2** = 1-3 years, **3** = 3-6 years, **4** = over 6 years

Foundation of FRBC

- The role of Cr was established in sulfidation reactions
  - Cr content > 13%
- Development and launch of composite tubing in Sweden,
- First tested in Finland



Platan, M. And Virtanen, P., Industrial Cooperation on Recovery Boiler Plant Problems in Finland, Paperi ja Puu, No 9 (1972).

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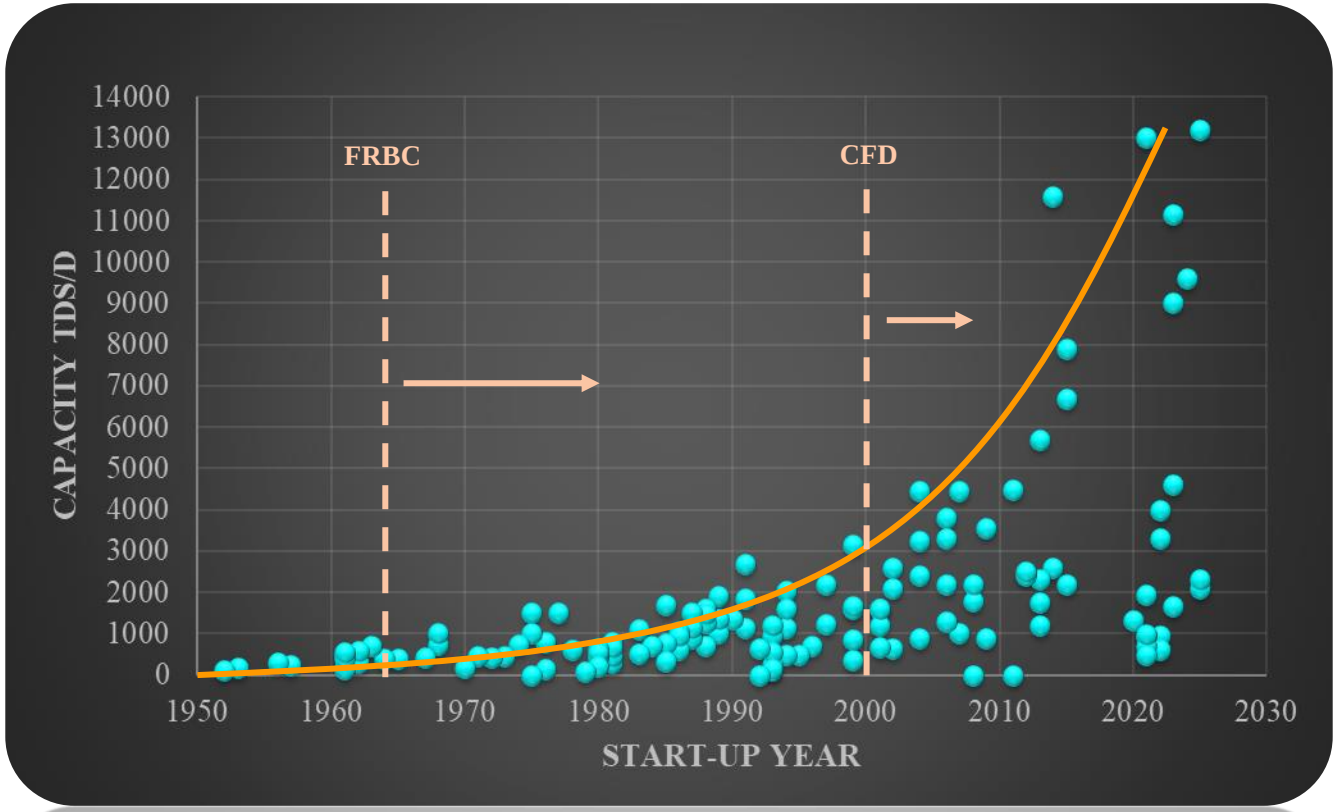

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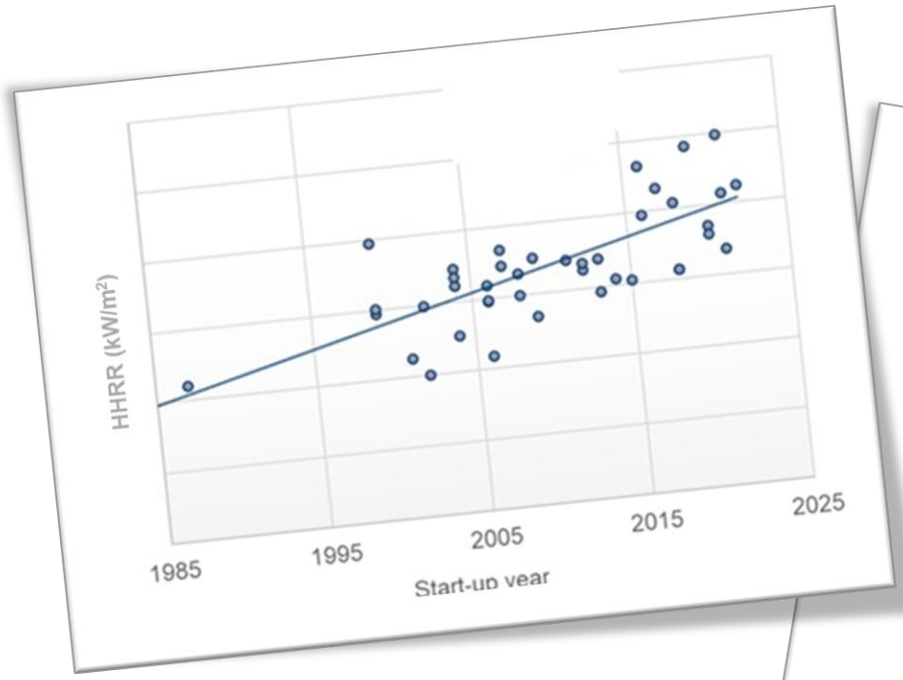

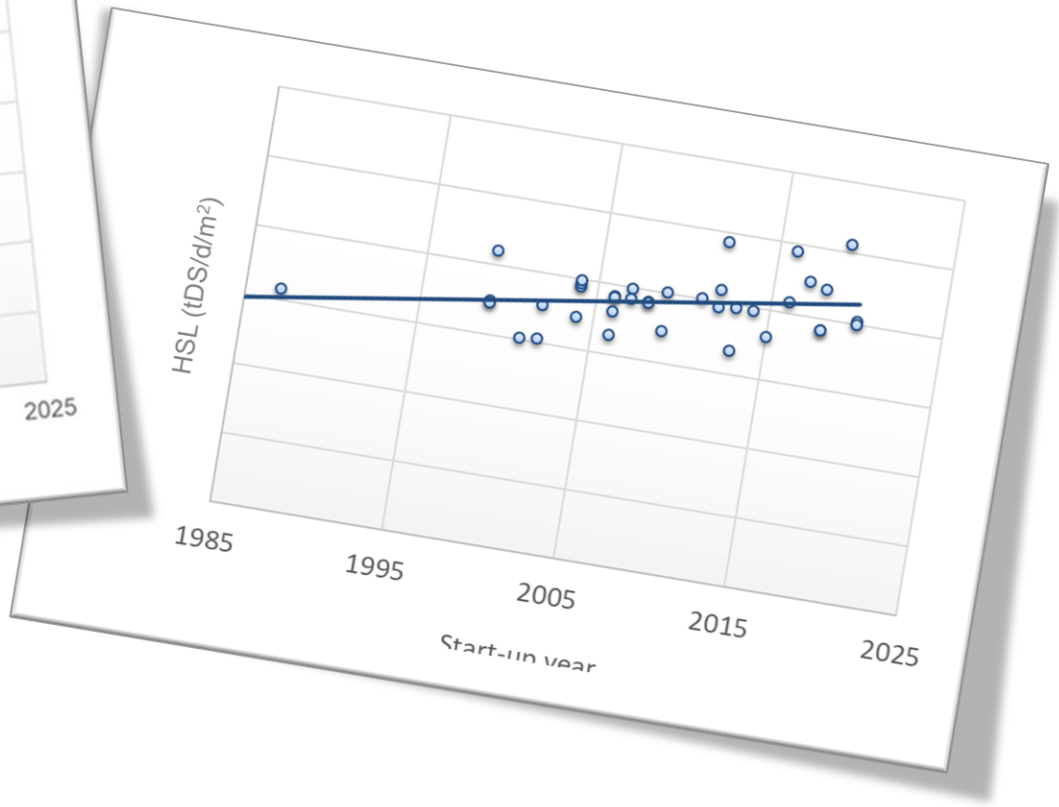

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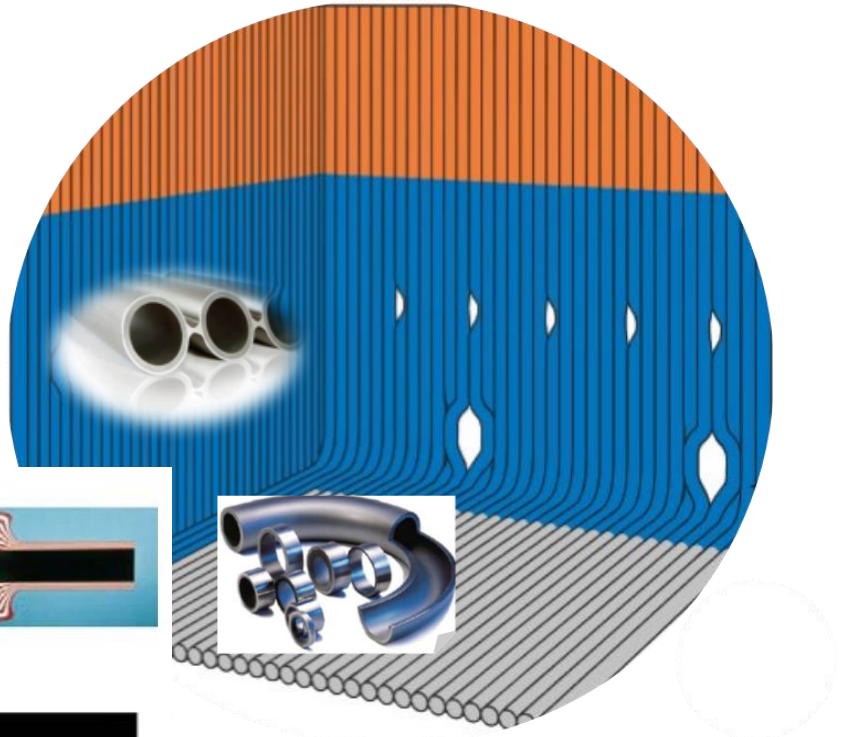
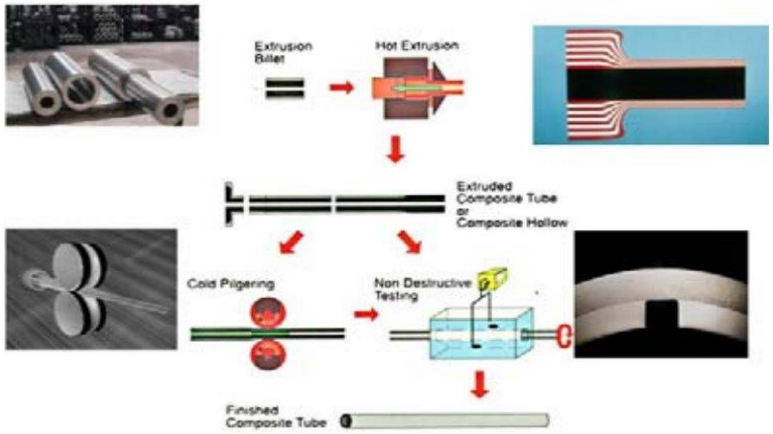
FRBC highlights I

- First RB with 304L composite furnace started up in 1972 in Sweden





FRBC highlights II

- SOMA, New Materials in Recovery Boilers *1998-2001*
- SOTU II, Future Recovery Boiler - Constraints to Increase Power-to-Steam Ratio *2003-2006*
- SKYREC, Increasing Recovery Boiler Steam Generation to a New Level
- *2008-2011*

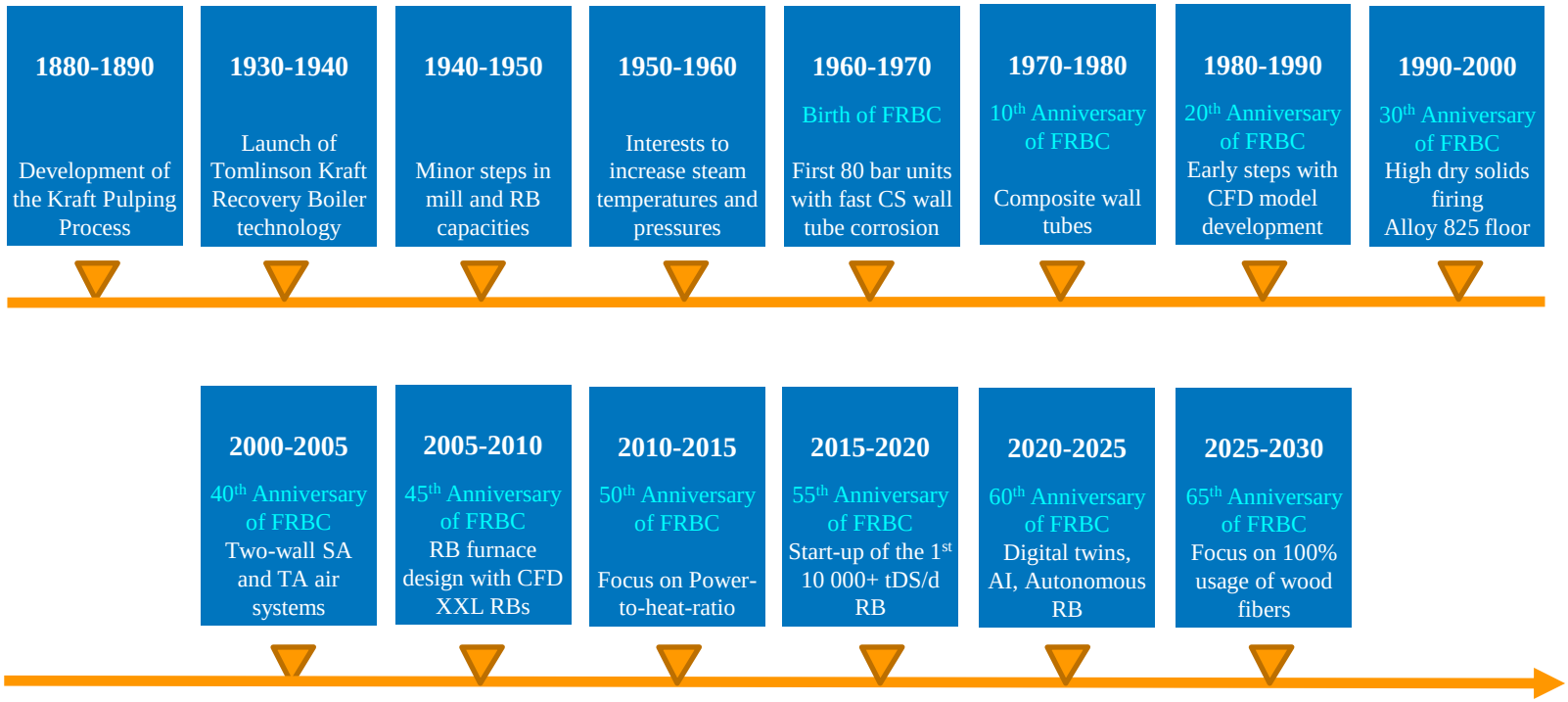
FRBC highlights III

- Composite tubes
- RB materials, material issues
- BL spraying and firing
- NO_x emissions, formation and reduction
- Dust formation
- Utilization of precipitator ash
- Low-temperature corrosion

FRBC highlights IV

- Over 20 recommendations and guidelines published
- More than 60 projects completed
- Co-operation with:
  - AFRY, Åbo Akademi University, Aalto University, LUT, TAU, VTT, JYU, University of Oulu
- Best MSc Thesis award since 2009 (2000 €)

FRBC Highlights V



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- Introduction of composite tubing
- Utilization of CFD (Computational Fluid Dynamics) simulations in RB design
- High dry solids firing
- 2-wall secondary and tertiary air system
- Understanding BL chemistry in combustion
- Pushing the steaming ratio of RBs