Increased flexibility and power-production from biomass through material development and corrosion prediction

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Goal

The overall goal of the project is to increase the efficiency and flexibility/predictability of power generation from biomass.

The scientific goals of the project:

- Determine the applicability and ***limitations of aluminium*** oxide forming materials for improved biomass conversion effect, as well as ***their comparison*** with ***existing materials***.
- Scale up ***lab-probe-fixed installation*** tests - predict impact of e.g. material and temperature on lifetime of key components. Implement ***thermodynamic-kinetic modelling*** of oxidation in complex environments.

Strategy

INCREASED POWER PRODUCTION FROM BIOMASS

Alumina forming materials – biomass environment

INCREASED FLEXIBILITY – BIOMASS POWER PRODUCTION

Scale up lab-probe-fixed installation – biomass environment

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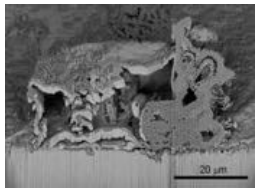
Research strategy – a two pronged approach

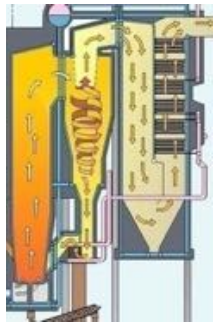
Fundamental research

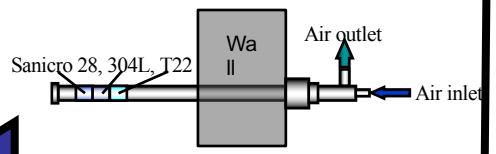
Corrosion mechanisms



Laboratory studies

Fundamental understanding of the corrosion process in boilers





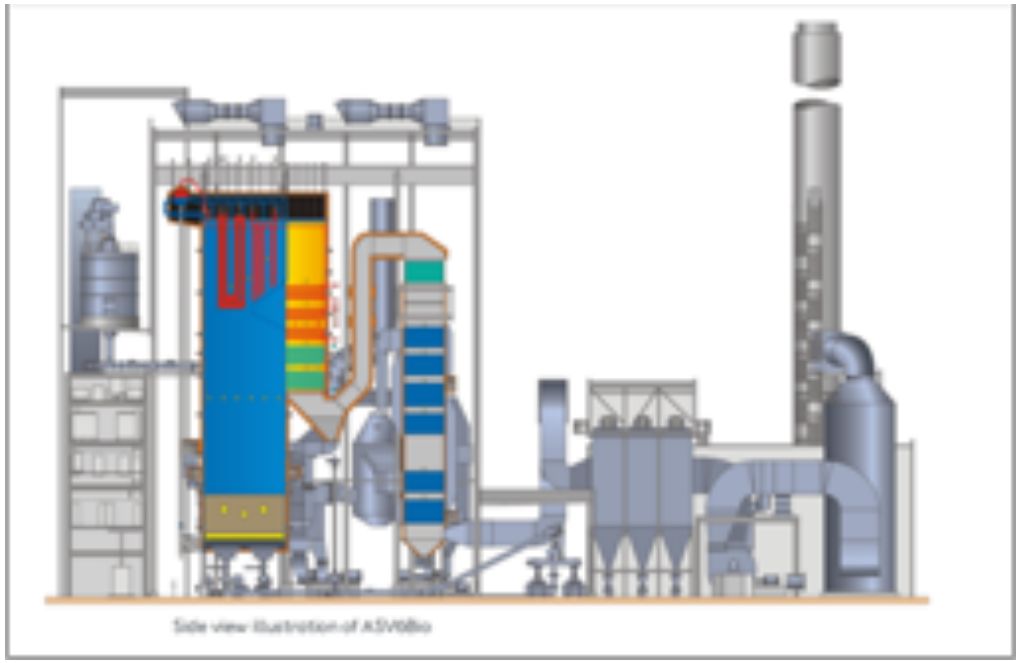
Effects of corrosion

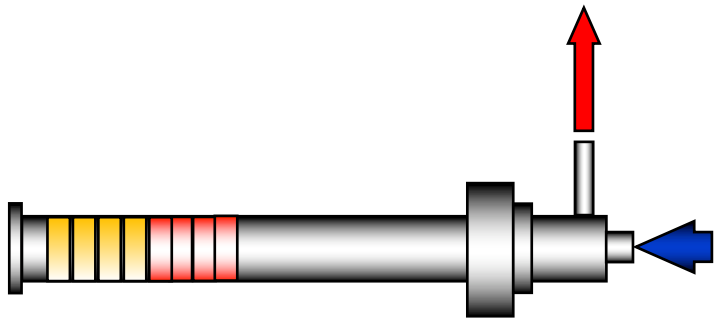
Applied research

Field studies

Collaboration with HTC1a

Biomass – characterize the deposits



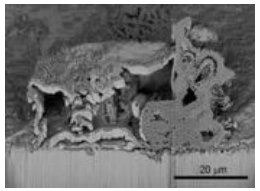


Characterize the environment

Research strategy – a two pronged approach

Fundamental research

Corrosion mechanisms



Mechanisms – model alloys
– rank corrosion resistance

Laboratory studies

Collaboration with HTC1a

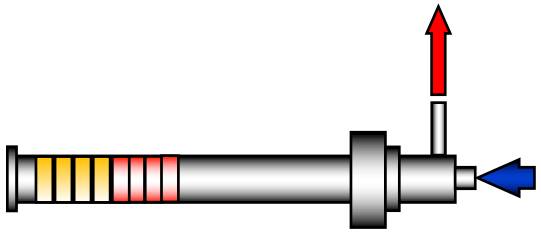
Strategy – model alloys

Tailor made model alloys

Ranking model alloys

Lab – collaboration with HTC1a

Most promising model alloys



Corrosion tests in the boiler

Challenges with FeCrAl alloys

Temperature

Applications

1400°C

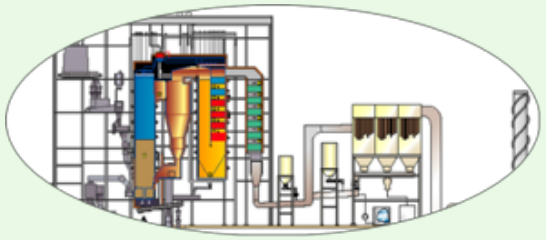
Heating elements

1200°C

1000°C

Boilers?

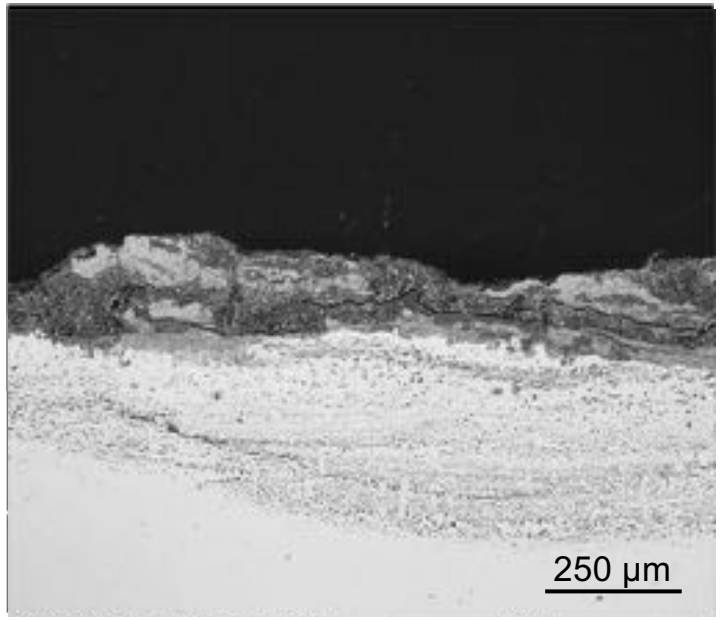
800°C



600°C

400°C

An α-alumina scale forms at temperatures above ~900 °C that protects the alloy



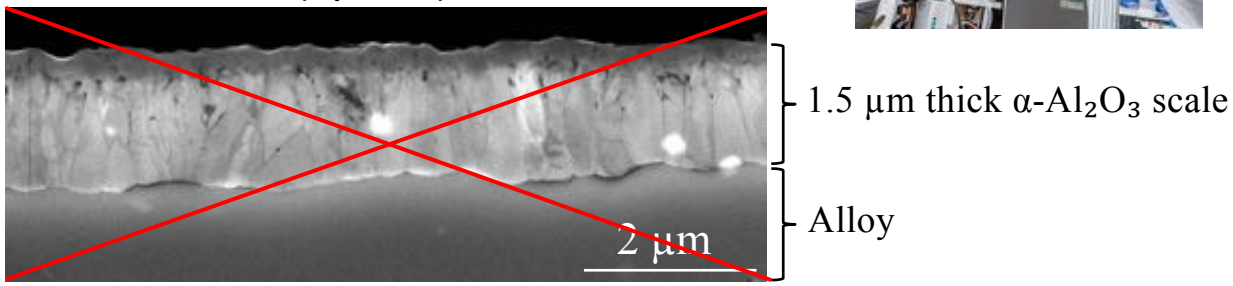
At lower Temperatures

- Metastable forms of alumina may form
- Not as protective as α-alumina

Different stages of oxidation:

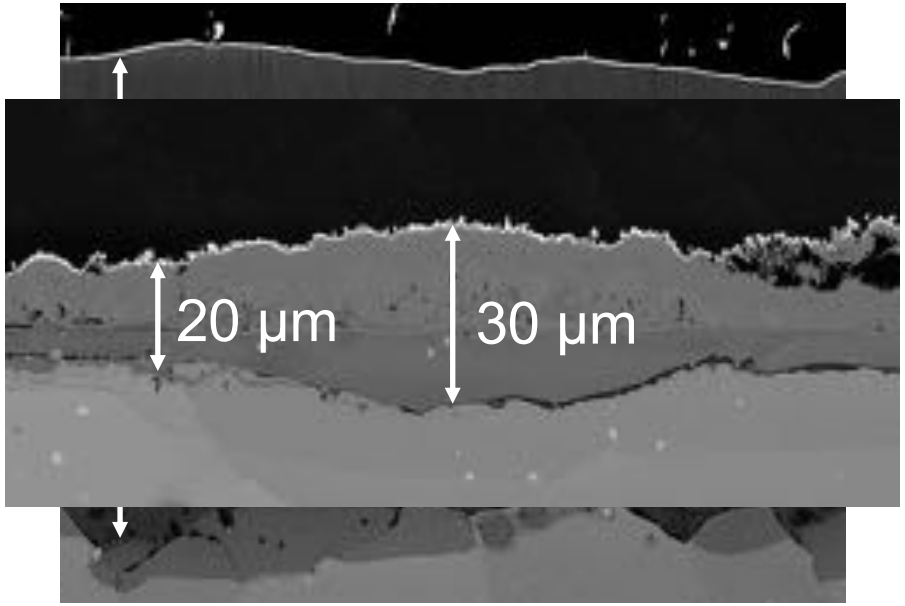
- Primary protection
  - Thin protective oxides
    - Chromia
    - Alumina

Performed at the physics department at Chalmers



Breakaway oxidation

- Secondary Protection
  - Iron-rich oxide



Strategy – model alloys

- Most promising model alloys made into probe rings and tested in the boiler.
- Best primary AND secondary protection!
- Compare oxidation resistance with existing materials

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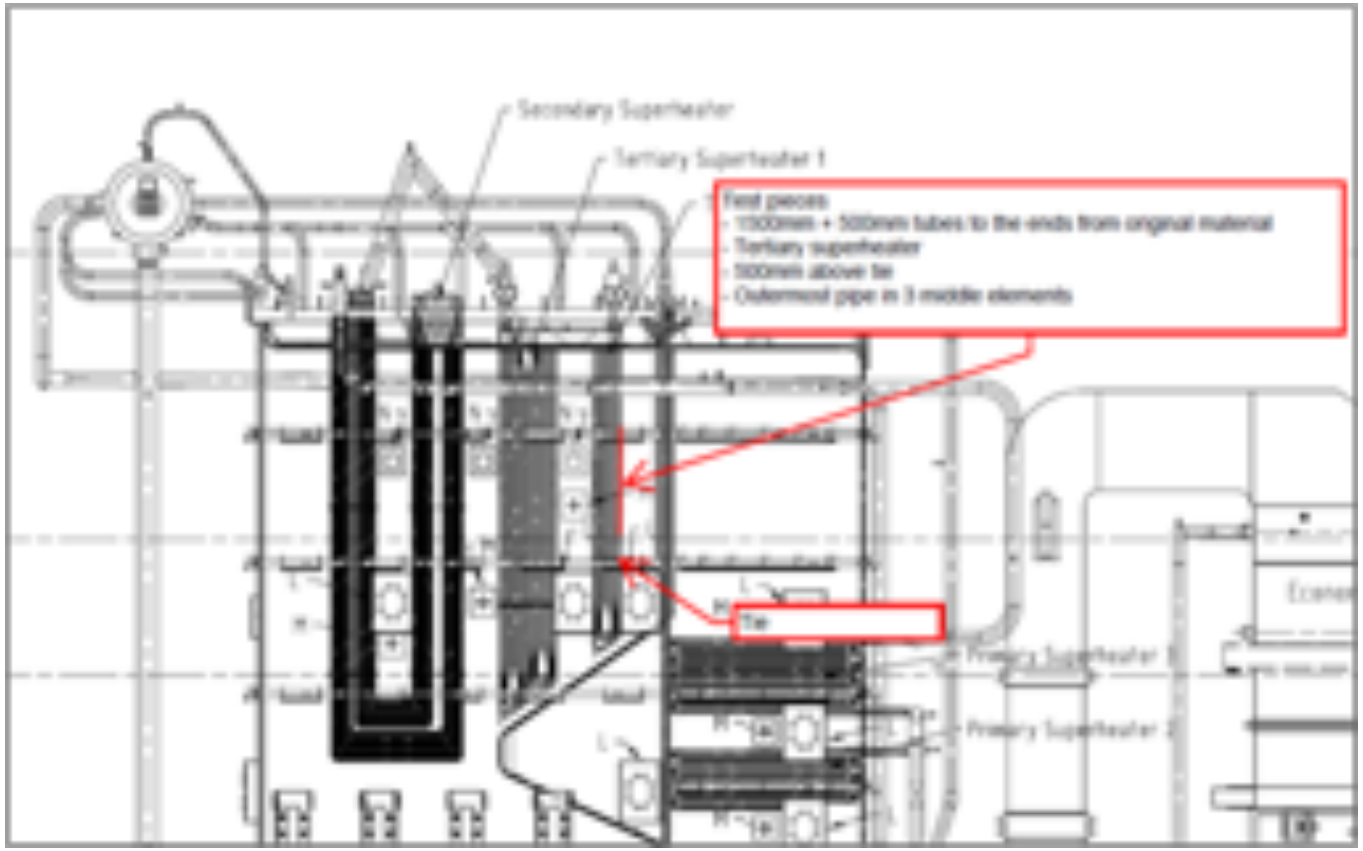
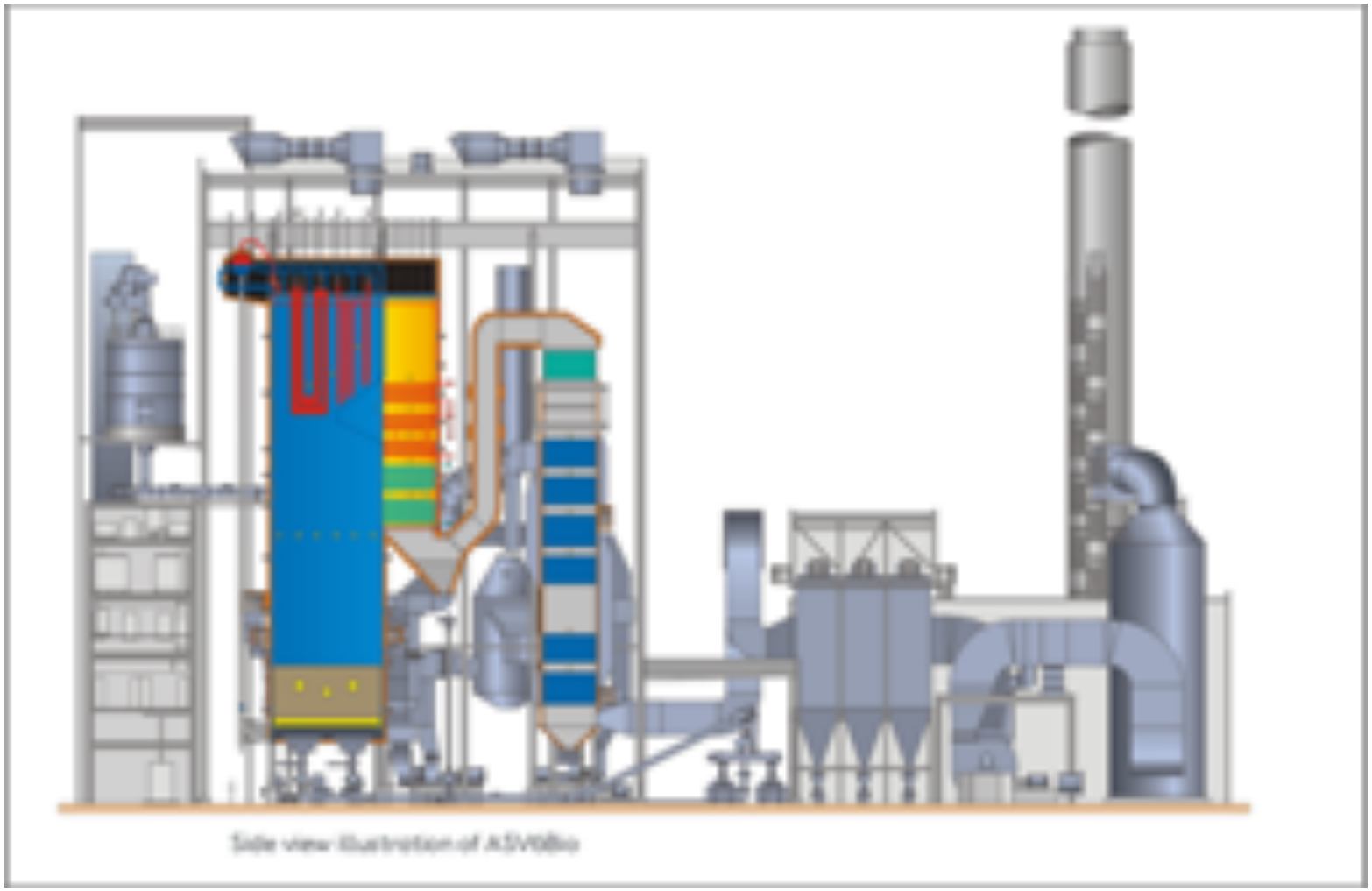
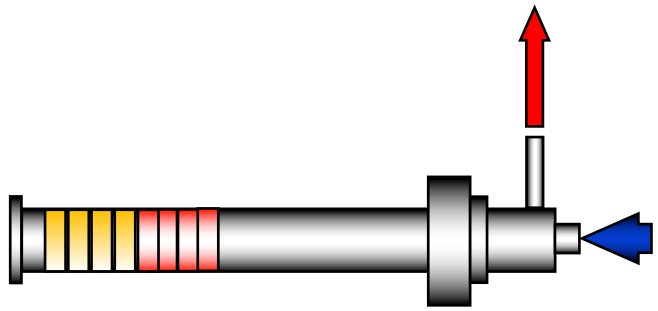
New boiler - Superheater test tube installations

- Four test tube materials to be installed to the tertiary superheater
- Straight tubes, hottest part of the tertiary superheater
- Installation during September 2018



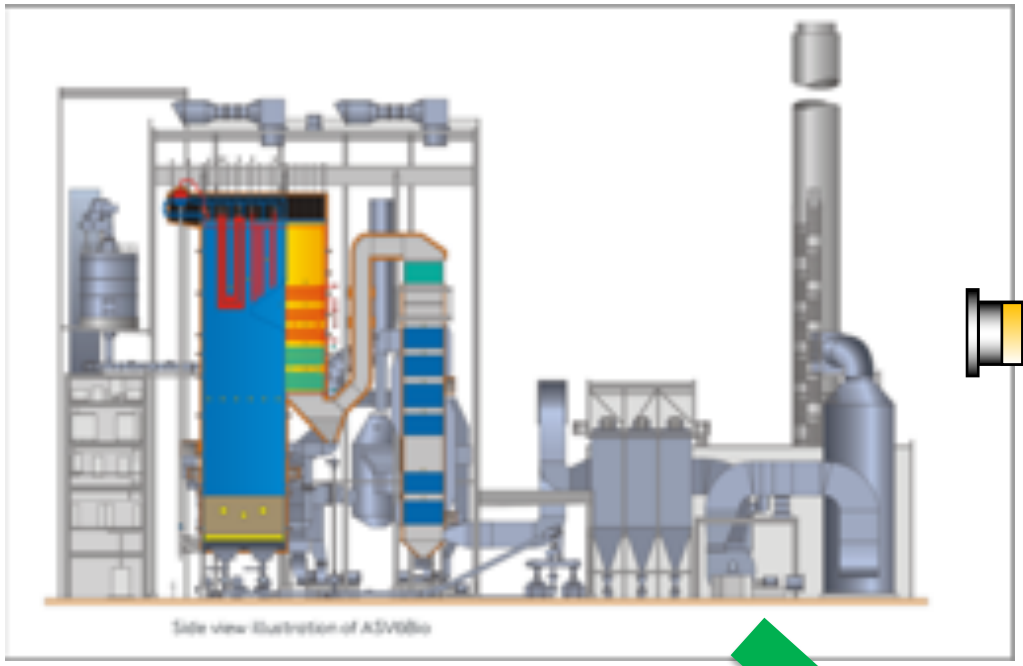
Characterize the oxide microstructure in lab/probe/fixed installed samples – modelling perspective

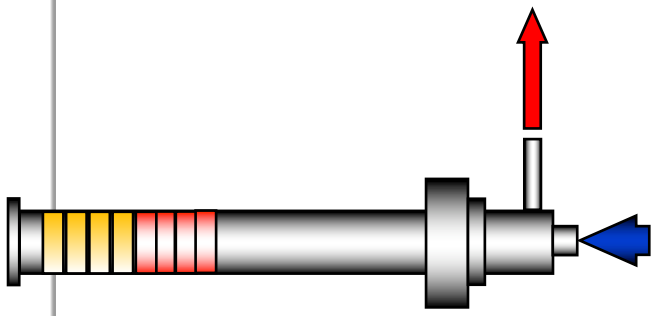


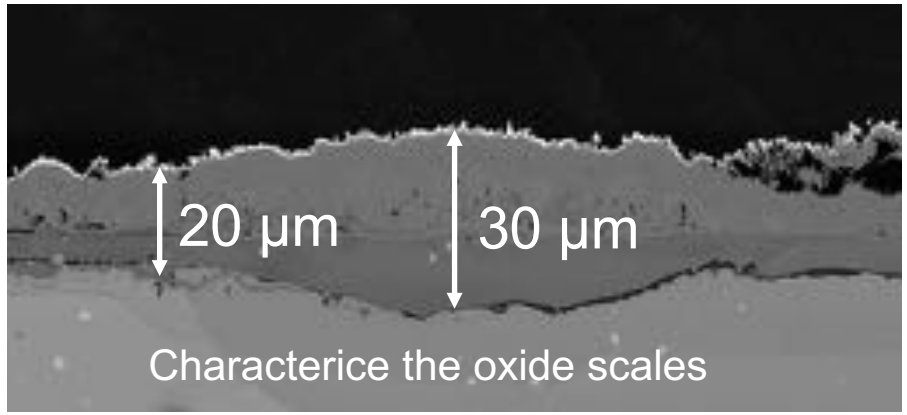


Samples of same material - probe

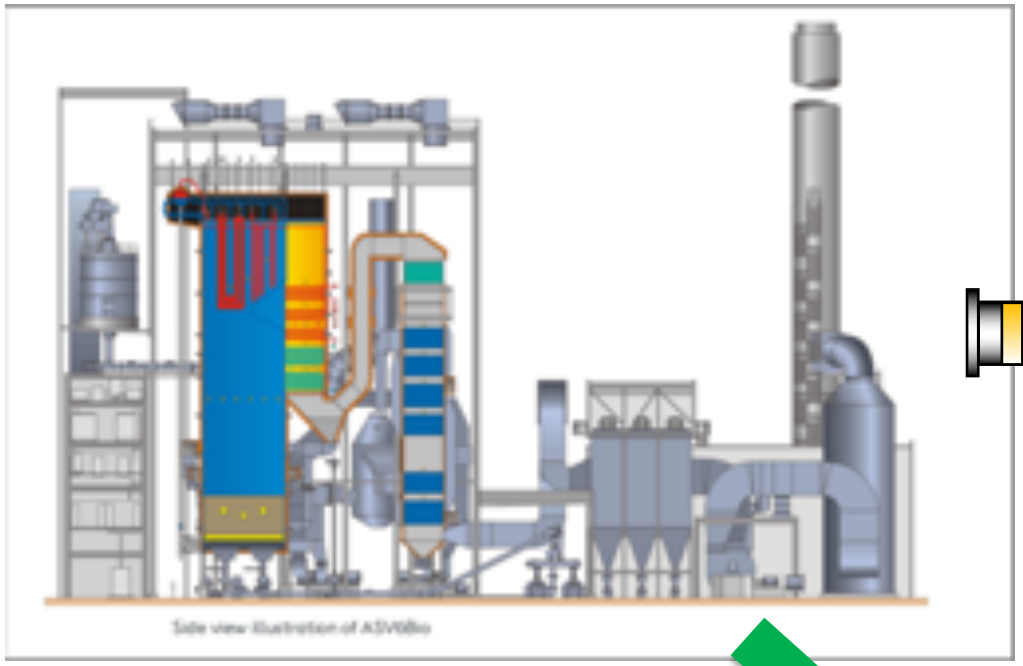
Characterize the oxide microstructure in lab/probe/fixed installed samples – modelling perspective

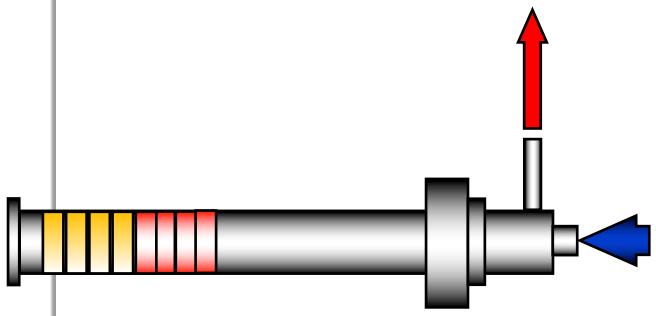






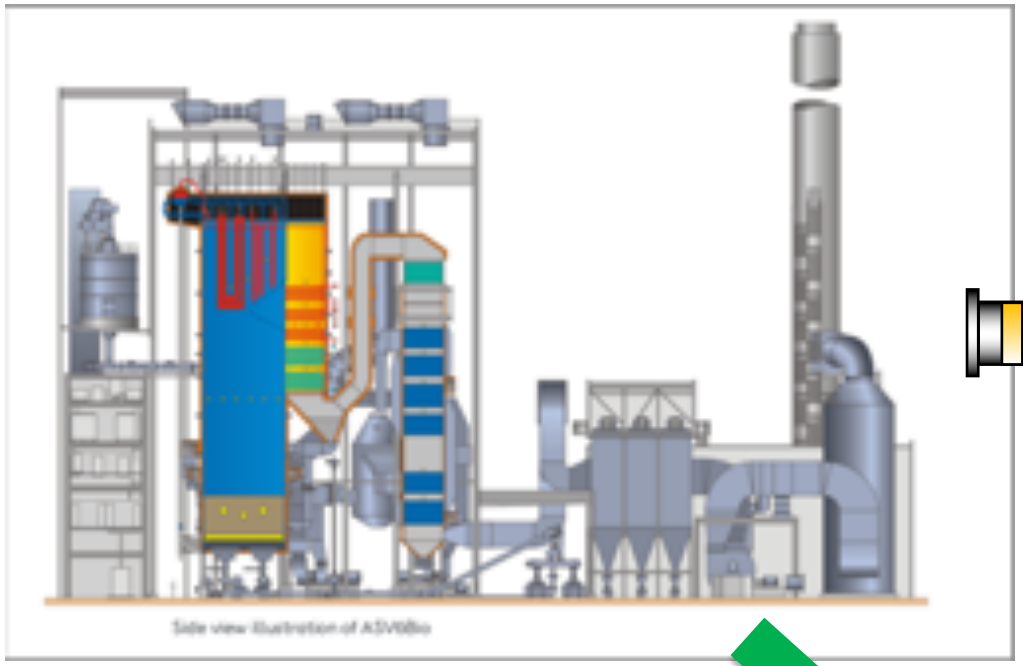
Characterice the oxide microstructure – modelling perspective

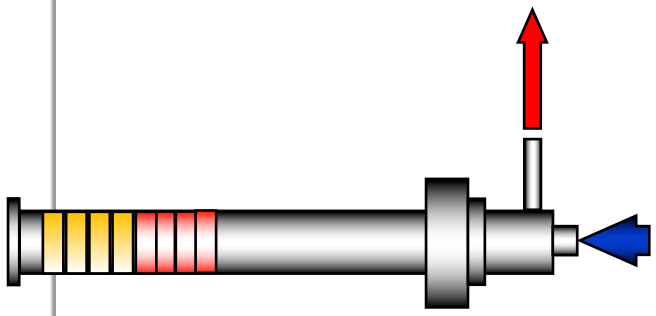


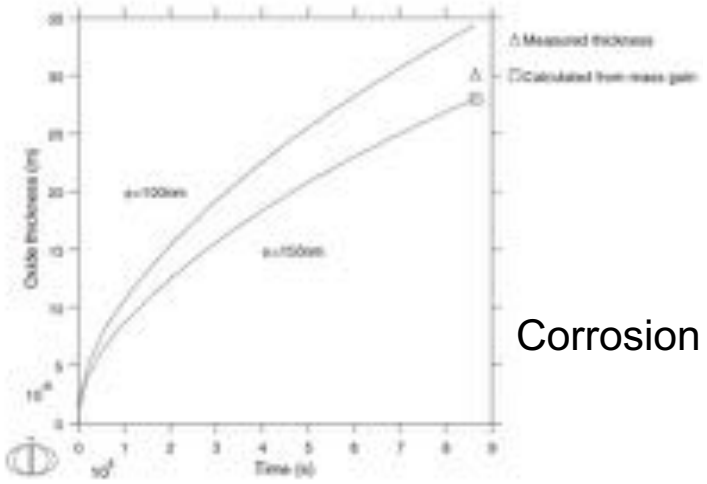


Model the oxide scales

Characterice the oxide microstructure – modelling perspective







Corrosion rate

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thank you
danke
謝謝
ngiyabonga
teşekkür ederim
спасибо
dank je
gracias
bedankt
dziękuję
mochchakkeram
go raibh maith agat
obrigado
sukriya
kop khun krap
arigato
dakujem
grazie
terima kasih
merci