Fouling and Corrosion Measurements in Retrofit CFB with Increasing Share of Waste



**Public Workshop** 

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## Fouling and Corrosion in Retrofit CFB with Increasing Share of Waste

#### **Motivation and focus**

#### **Big picture**

- Power & industrial decarbonization
- Alternatives for existing coal-firing fleet
  - A change in fuel diet is the first choice to reduce the carbon footprint of existing power plants

#### This work

- Partial or complete substitution of coal with waste-derived fuels (SRF)
  - + Low or negative price
  - + Permanent availability
  - + Moderate carbon footprint

Evaluate fouling and corrosion in retrofit scenarios with partial or complete substitution of coal with SRF



## Fouling and Corrosion in Retrofit CFB with Increasing Share of Waste

### **Presentation Outline**





#### Retrofitting Fluidized Bed Power Plants for Waste-Derived Fuels and CO<sub>2</sub> Capture (EU-RFCS)

- Goal to improve the sustainability of existing FB power plants via:
  - Substitution of coal by waste-derived fuels
  - Integration of CO2 capture technologies



### **Pilot tests**

 CFB 1MW<sub>th</sub>, TU Darmstadt, Germany



### **Field tests**

 CFB 139 MW<sub>th</sub> + 75 MW<sub>e</sub>, CHP, Poland

![](_page_2_Picture_14.jpeg)

# Fouling and Corrosion in Retrofit CFB with Increasing Share of Waste Methods

![](_page_3_Picture_1.jpeg)

#### Fouling and corrosion probes

- Air cooled
- Several base and WOL metal alloy coupons
- Exposures in furnace and convective pass

![](_page_3_Picture_6.jpeg)

# Online corrosion monitoring system

 Based on linear polarization resistance method

![](_page_3_Picture_9.jpeg)

#### Analyses and characterization

- Visual inspection
- Material loss weight
- Composition by SEM-EDS

![](_page_3_Picture_14.jpeg)

# Pilot tests

CFB 1 MW<sub>th</sub> at TU Darmstadt, Germany

Fuels tested:

- 1. 100% coal
- 2. 80 wt-% SRF + coal
- 3. 100% SRF
- SRF (Solid Recovered Fuel) was processed from municipal, commercial and industrial wastes, origin from Germany
- Coal was Polish bituminous class

![](_page_4_Picture_8.jpeg)

## Pilot tests – Furnace

#### CFB 1 MW<sub>th</sub>, TU Darmstadt, Germany

![](_page_5_Picture_2.jpeg)

![](_page_5_Figure_3.jpeg)

#### Composition

- Addition of SRF increases alkali (Na, K) chlorides
- With 100% SRF HMs (Cu, Zn) may have also contributed to corrosion
- Coal co-firing lowered Cl in the deposit

![](_page_5_Figure_8.jpeg)

#### **Material loss**

Highest material loss with 100% SRF

![](_page_5_Picture_11.jpeg)

## Pilot tests – Convective pass fouling probe

#### CFB 1 MW<sub>th</sub>, TU Darmstadt, Germany

![](_page_6_Figure_2.jpeg)

loose

![](_page_6_Picture_3.jpeg)

deposit on lee-side

deposit all around, more around, more attached

![](_page_6_Figure_6.jpeg)

![](_page_6_Figure_7.jpeg)

![](_page_6_Figure_8.jpeg)

#### Fouling and material loss

- ✤ Increase with addition of SRF
- Mainly due to alkali and HM compounds
- Coal has counteracting effect, but limited

![](_page_6_Picture_13.jpeg)

## Pilot tests – On-line corrosion probe

CFB 1 MW<sub>th</sub>, TU Darmstadt, Germany

![](_page_7_Picture_2.jpeg)

- Before HX
- Exposure continuous during all testing period
- Target surface T: 450 °C
- During 100% coal firing, corrosion was below the detection limit.
- Corrosion increased quickly after SRF was introduced and further increased with 100% SRF firing
- Main corrodent alkali chlorides

deposit mainly on wind-side

![](_page_7_Figure_10.jpeg)

![](_page_7_Picture_11.jpeg)

# Field tests

CFB 139 MW<sub>th</sub> + 75 MW<sub>e</sub>, CHP, Poland

#### Fuel mix tested:

- 1.  $40 45 %_{LHV} SRF + coal$
- 2. 45 50 %<sub>LHV</sub> SRF + coal
  - a. w/o limestone
  - b. w/ limestone

### Both fuels originated from Poland

- SRF (Solid Recovered Fuel) was processed from municipal and industrial wastes
- Coal was Polish bituminous class

### Each fuel mix test lasted 5 days

![](_page_8_Picture_11.jpeg)

### Field test results

CFB 139 MW<sub>th</sub> + 75 MW<sub>e</sub>, CHP, Poland

![](_page_9_Figure_2.jpeg)

#### Furnace wastage

- Exposure 2 hours
- Target surface T: 325 °C
- Low alloy steel (2% Cr)
  - \* Test done with 1Cr coupon and 2.5 h exposure
- Ca, S, Al, Si; main corrodent alkali (Na, K) chlorides, found close to the metal surface
- Corrosion (14 m), combination of corrosion and erosion (19 m and 24 m)

![](_page_9_Figure_10.jpeg)

#### Convective pass wastage

- Location before 1<sup>st</sup> convective HX; subjected to sootblowing
- Exposure 48 h
- Target surface T: 450 °C
- Ca, S, Al, Si and alkali chlorides, traces Zn, Cu
- with LS: fouling highest (not shown here), highest Ca and Cl, highest wastage (corrosion-erosion)

#### 40 - 45 and 45 - 50 refer to SRF % in fuel mix with coal

![](_page_9_Figure_18.jpeg)

# Convective pass, on-line corrosion signal

- Target surface T: 450 °C
- Increase in SRF share increased corrosion signal
- Signal during LS feeding affected by increased sootblowing
- Composition of deposits similar to observed with fouling probe

![](_page_9_Picture_24.jpeg)

# Fouling and Corrosion in Retrofit CFB with Increasing Share of Waste Conclusions

![](_page_10_Picture_1.jpeg)

- SRF fuels derived from municipal, commercial, industrial wastes have a high impact on increasing fouling and wastage in a CFB boiler designed for coal
  - Pilot and field tests showed that impacted areas are in furnace and convective pass.
- Addition of SRF to boilers designed for coal is requiring some degree of retrofit, extent depends on % and nature of both coal and SRF. Regarding materials:
  - The best performing alloy in the furnace of the pilot test rig, was the WOL 22Cr-60Ni for which material loss was still moderate with 100% SRF.
  - The performance of the higher alloyed grades materials (18Cr-11Ni, 25Cr-20Ni and 22Cr-60Ni (WOL)) in convective pass was quite similar. However, for them to be applicable with 100% SRF, temperatures would need to be lowered.

![](_page_10_Picture_7.jpeg)

## REBECCA

Retrofitting Fluidized Bed Power Plants for Waste-Derived Fuels and CO2 Capture

## Acknowledgment

This project has received funding from the Research Fund for Coal and Steel under grant agreement No 101034024

# REBECCA

![](_page_11_Picture_5.jpeg)

![](_page_11_Picture_6.jpeg)

# Thank you

For more information, please visit: www.shi-fw.com

![](_page_12_Picture_2.jpeg)

![](_page_12_Picture_3.jpeg)