Corrosion-erosion behavior of new Fe-based coating materials for chlorine-rich biomass combustion: Role of Ni, Si and B

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Biomass to energy conversion: Characteristics

- Fig. 1 Principal pathways of potassium and chlorine compounds in a biomass-fired boiler redrawn after [1].
- Corrosion: formation of porous, non-protective oxide scales
  - Gaseous CI and K compounds (via "active oxidation")
  - Molten alkali chlorides (as dominant species) depositing
    - Sulfation of alkali chlorides or reaction between chlorides and metal
  - Formation of eutectics with low melting temperatures ⇒ fluxing of protective oxide scales
- Erosion: removal of corrosion-resistant oxide layers followed by accelerated corrosion of the unprotected substrate [2-5]

Approach: Model alloys ⇒ corrosion-erosion performance of the bulk materials

- Ingot samples were tested in diagrams of biomass-fired furnaces,
  - Primary, tertiary superheater, reheater, economizer, etc.

Results of test 1: Corrosion performance

- High Si: Fe-based and FeNi-based alloys corrosion (no erosion)
- Low Si: Fe-based and FeNi-based alloys corrosion (no erosion)

Results Test 2: Corrosion-erosion performance

- No agglomeration of ash observed
- Spalled scale gets lost in the surrounding ash ⇒ therefore, qualitative mass change diagrams
- Test 2: 332 h at 550°C
- Test 2: 1052 h at 550°C

Corrosion vs. corrosion-erosion performance

- Common elements: Nb, W, and B
  - Refractory metal borides (i.e. white phases in grey scale micrographs) are resistant against Cl corrosion
  - Duration of experiments > 1000 h
  - Low Si model alloys:
    - Ni reduces the corrosion rate
    - Erosion enhances the corrosion rate of Ni-containing alloys
    - Fe-based (Ni-free) alloys ⇒ more resistant against corrosion-erosion
  - High Si model alloys ⇒ comparable performance independent from the Ni content
  - Decreasing the corrosion rate ⇒ no significant effect of Mo; Si is more effective
  - Reference material IN 625:
    - Best performance for Cl corrosion
    - Worst performance for combined corrosion-erosion attack

References:

Graphical data and images are described in the text.

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