On-site slurry coatings for aggressive high temperature environments

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Motivation

Al source particles are deposited via slurry onto steels in order to produce an intermetallic aluminide coating after heat treatment, which protects the substrate from corrosion at high temperature.

Heat treatment

The heat treatment of a slurry coated component is usually performed in an inert atmosphere in a closed furnace (Figure 3).

In this project slurry coatings applied by surface heat treatments are developed, using an induction furnace (Figure 4a), a burner flame (Figure 4b), or a heating mat. Thus components can be coated locally, which minimizes the heat-affected zone of the component.

Approach

The goal of this project is the optimization of the industrial slurry coating process by developing a slurry coating which combines a non-toxic water-based slurry with a surface heat treatment in air.

Identification of limiting steel parameters

Slurry method optimization at laboratory

On-site slurry coating

Heat treatment in surrounding atmosphere

Non-toxic water-based slurry

Results

Aluminium (Al) coatings are developed on P91 (Fe, 9%Cr), Alloy 800 (Fe, 32%Ni, 21%Cr), and Alloy 602 (Ni, 25%Cr, 9%Fe, 2%Al) by Al slurries, which consist of several Al powders or Al powder mixtures. The heat treatment time is 5 minutes.

Heating methods

Depending on the shape, size, and application of components different heating methods for the coating manufacturing are needed. All tested methods lead to comparable coating thicknesses and quality. Higher temperatures result in an increase of the coating thickness.

Coating elements co-deposition

In order to improve the Al coatings, elements can be added to the Al powder to adjust the coatings for different corrosive high temperature environments. Ni, Co, Cr, and Si have been introduced into the coating.

Influence of steel composition

Al-based slurry (with or without co-deposition) is applied on P91, IN 800, and IN 602 and heat treated by induction heating between 700 and 1000°C.

- Ni-based steels show thicker and more homogeneous coatings
- Coatings manufacture improves when Ni is present in steels composition

Fig. 9: Different substrates coated with Al-Si slurry after heat treatment by induction at 1000°C in air.