Diffusion Coatings for Corrosion Protection of Ferritic-Martensitic Steels for Co-Firing Biomass with Coal

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Co-firing of biomass is a major step towards reducing CO_2-emissions from power generation and still offers to cover base loads. One drawback are the considerable challenges in terms of corrosion prevention because of high levels of chlorine and alkali species. In particular, superheater tubes inside the steam generator are subjected to increased corrosion rates and are prone to early replacement. In order to overcome low co-firing temperature limits and small biomass-to-coal ratios one option is to protect the metal surfaces of the firing chamber components against corrosive attack. This study deals with the evaluation of innovative diffusion coatings applied on selected steels commonly used as superheater tube material in order to shield the metal surfaces from high temperature corrosion.

The heat resistant ferritic-martensitic steel X20CrMoV12-1 is of great interest as a material for superheaters because it exhibits much higher heat transfer behaviour and a lower coefficient of thermal expansion, as well as lower costs in comparison to austenitic steels. However, its corrosion resistance in the combustion gas atmospheres of biomass or co-firing power plants is not sufficient. In this work, different corrosion protection systems have been developed in order to make ferritic-martensitic steels usable at temperatures above 500°C in such combustion gases. The first step was to apply a thin nickel layer. This interlayer serves as a nickel reservoir for the subsequent diffusion process of potentially protective elements such as Cr, Al and Si and to increase the protective surface properties against chlorine.

To establish a valuable ranking, coated and uncoated X20CrMoV12-1 samples as well as austenitic steel DMV 310 N samples were tested in different fireside corrosion atmospheres under ash deposits containing sulphates and chlorides. Results are discussed as a function of exposure conditions highlighting the improved corrosion behaviour of the coated steel.