Objective of the project

An analysis of high-temperature corrosion process of steel separately in gas phase and while deposits and low-melting eutectic mixtures are present on the surface of the material is the main purpose of the project. Based on experimental results: corrosion rate and corrosion products qualitative and quantitative analysis the corrosion process reactions model will be proposed. Obtained results will be compared with principles and assumptions of an active oxidation model which is widely described in the literature. Preliminary thermodynamic calculations shows that steam concentration also influences the corrosion process mechanism. In the project influence of steam on corrosion process in gas and solid phase will be analyzed as well.

The research to be carried out

First an analysis of chlorine and alkali and heavy metals in the fuel will be performed. Selection of biomass species and waste dedicated for power industry use will be performed (preferably high-chlorine fuels) – biomass (straw, waste wood, sewage sludge, waste (so called "dry" municipal waste). All data will determine the assumptions for the corrosion experiments. Next, several steel grades used in boiler technology will be selected for corrosion experiment. All steel grades selected will be placed into horizontal furnace, but only coupons with the highest mass change after experiments will be further analyzed. Experiments will be carried out for 168h (7 days) in gas phase rich in corrosive agents (HCl and/or SO_2) and in solid/molten phase in form of chlorides and sulfates of alkali and heavy metals and its mixtures (especially Na, K, Zn and Pb – specific compounds will be selected based on fuel analysis performed at the beginning of the project). After the experiments a mass change of steel coupons will be determined and they will be prepared for further analysis of corrosion products. Obtained results will be used for equilibrium calculations by means of parametric equations and compared with phase stability diagrams for iron and chromium oxides, chlorides and sulfates at given temperature. During the corrosion experiments, the influence of steam concentration on corrosion process will be analyzed as well.

Reasons for choosing the research topic

Many observations of real scale units and lab experiments as well proves that high temperature corrosion is a fact. However the reaction sequence and the influence of corrosive species in gas phase and in solid phase separately on corrosion process is unclear. The most popular model of high temperature corrosion- an active oxidation model, raises many questions among scientists. Also an influence of steam on corrosion process is usually neglected. Many experiments were carried out for different, more or less complicated gas phase composition, solid phase composition, temperature range and materials. Although corrosion process depends upon many parameters and it is needed to analyze step by step the influence of all corrosive agents in gas and solid phase, their interactions and influence of other parameters (steam content, low-melting eutectic mixtures formation, reducing or oxidizing conditions) on the corrosion process in the same conditions. Because even small difference in process conditions like: temperature (some of deposits may be melted) or material (addition of chromium change completely the influence of steam on corrosion process) can change the mechanism of the process. Experiments are carried out mainly for the conditions and fuel composition interesting for given region, not for explanation of corrosion process nature. What's more interesting thermodynamic calculations in equilibrium state shows that the chlorine corrosion process in gas phase for parameters present in power boilers has now thermodynamic basics, but the heat exchanging surfaces damage is observed.

The experimental data can be further used in applied, commercial researches, a model of corrosion might be used to minimalize process of the corrosion in power boilers or further developed by some experiments with corrosion inhibitors, however it is not the subject of this project.