Wrocław, 23.10.2017

BEHAVIOR MINERAL MATTER DURING COMBUSTION AND CO-COMBUSTION OF SOLID FUELS

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The development of power industry, both domestic and foreign, is related to the cost reduction of energy production by increasing the power units efficiency, reducing environmental hazards and increasing the operational reliability of power plants. One of factors influencing the design and operational issues of all solid fuel boilers is the amount of ash in the fuel. During combustion process the mineral matter is influenced by complex processes of physicochemical transformation. This may cause a number of risks for proper operation of boiler equipment, such as the formation of slag and ash deposits on heated surfaces, increased erosion as well as corrosion, problems with the storage and management of ashes and others. All these factors lead to lower energy production efficiency, reduced equipment availability, increased environmental risks and increased manufacturing costs. It is therefore crucial to know the mechanism of physicochemical processes involved in the transformation of mineral matter during combustion of different types of coals and other solid fuels. According to this, various laboratory and technical methods as well as numerical calculations are sought to predict the scale of the risks causes by ashes that may occur during the combustion of new, unknown fuels. The research also aims to develop various remedies that can reduce such risks.

The main aim of the study is to recognize mechanism of mineral matter transformation included in solid fuels during the initial phase of sintering process and to know the mechanism of fuel type and combustion parameters on slag and ash deposits formation processes on boiler heating surfaces. The detailed aims are also relate to the impact of the mineral matter transformation process on factors such as coal type, co-combustion of coal and biomass, change of combustion atmosphere, the application of mineral additives to reduce slagging and fouling process.

In the thesis of work is postulated that based on complex tests on the laboratory scale it is possible to recognize and predict the behavior of the mineral matter transformation during sintering process and recognize mechanism of slag and ash deposits formation during combustion and co-combustion of solid fuels.

Boiler coals (bituminous and brown coals) used in Polish power plants was chosen as the basic fuels. In addition, alternative fuels in the form of biomass of different origins were also tested. The research material was selected in such a way that the diversity in the composition and energy parameters were significant. The research was carried out with the use of advanced laboratory facilities, including advanced measuring equipment and internal research stations.

On the basis of studies carried out, it has been found that both solid fuels and their ash have different elemental composition and physicochemical properties, which directly influence the behavior of mineral matter transformation. The initial changes in ash during heating were determined by sintering temperature methods: standard Leitz and non-standard - strength, density and pressure drop. The comparison showed large variation in obtained temperatures, where non-standard methods indicated a lower sintering temperature each time. Measured by the sample change of physical parameters, it was possible to more accurately determine the initial transformation temperatures simultaneously indicating that the first changes in ash occurred at the crystalline structure level and were not related to the external shape of the sample. The study analyzed eutectic mixtures formation of coal fuels indicates the distinct stages of particular mineral compounds sintering process. The

influence of biomass on the mineral matter transformation processes for both biomass and coal mixtures in various mass ratios was also recognized. Biomass ash has been identified as having lower sintering temperatures and, consequently, much higher tendency to slagging and fouling on heated surfaces, particularly with significant $K_2O + P_2O_5$ content. For coal/biomass mixtures, behavior of ash cannot be determined from the weight ratio. No significant effect of the atmosphere on the mineral matter transformation processes within the composition and amount of crystalline phase was found by diffractometric investigations, however, it was shown that the amount of ash can rise significantly. The study provides results of research on the influence of mineral additives on the processes of ash layers formation on heating surfaces and sintering itself. Significant influence of some minerals was observed on decrease of ash resistance to sintering (increase of sintering temperatures) and to weaken the structure of sinter. The relations between sintering temperature and ash mass loss as well as concentration of Na, K, Ca and Mg components were determined.

Experimental investigations and the analysis of obtained results confirm that it is possible to recognize behavior of mineral matter during combustion and co-combustion of solid fuels

23/10/2017