

ABSTRACT

The aim of this dissertation is to analyse the thermal and structural properties of solid fuels during oxygen combustion in a circulating fluidized bed. Particular attention has been paid to experimental research on the oxygen combustion process of solid fuels such as brown coal, hard coal and anthracite. Different approaches, such as, technical and elementary analysis, pressure-mercury porosimetry (PMP) and scanning electron microscopy (SEM) were used to determine key fuels properties.

The combustion process was performed in a circulating fluidized bed in the air (which was the reference case) and in O₂/CO₂ mixtures with oxygen concentration up to 40%. Temperature measurements of a coal grain surface and in a grain's centre, measurements of ignition time, volatile matter combustion time, char combustion time and total combustion time were performed during the experiment. PMP and SEM methods were used to analyse solid fuel chars in order to establish the impact of solid fuels combustion on their internal and surface structure.

The oxygen concentration in the oxidizing mixture has a significant impact on the combustion process of solid fuels in the circulating fluidized bed. During the combustion process in a mixture of 40% O₂/60% CO₂, the total combustion time of grains of all tested fuels was significantly reduced. Also for such a case, the highest temperatures of the grain's centre and its surface and the shortest ignition and combustion times of volatile parts were recorded. On the other hand, in the mixture of 21% O₂/79% CO₂, lower temperatures of the grain's centre and its surface together with the longest ignition times, combustion of volatile parts and total combustion time of all tested fuels were observed.

In the second part of the work, the measurements of thermophysical properties of solid fuels were carried out using the Laser Flash method. The analysis was performed for a wide temperature range from 25 to 1000°C for all fossil fuels selected in the first part of the work.

Measurements performed with the use of LF method provided interesting results extending that allowed extending the current state of knowledge (which was a key motivation to undertake such research activities) about the thermal properties of fossil fuels mined in Poland.

To sum up, the conducted research program and the obtained results will certainly contribute to better understanding of the differences in the combustion process performed under different oxygen concentrations. Moreover, the data obtained from the conducted measurements can be used as a reference for numerical models used in simulations of thermal conversion of fossil fuels.