Abstract

Gasification of solid carbonaceous materials is a technology of a prospective importance for the energy sector, especially in terms of the sustainable development criteria. Furthermore, the efforts undertaken in order to reduce the dependence on fossil fuels result in the increasing interest in the technologies of co-processing (i.a. co-gasification) of coal and renewable fuels.

This dissertation investigates the influence of the heating rate applied in the pyrolysis of coal and biomass blends on the reactivity of chars in the process of air gasification. Coal and selected types of energy crops: *Miscanthus giganteus, Sida hermaphrodita, Helianthus tuberosus and Salix viminalis* as well as blends of coal and 25, 50 and 75wt% of *Miscanthus giganteus* or *Helianthus tuberosus* biomass were applied in the pyrolysis and air gasification experiments performed in the thermogravimetric analyzer SDT Q600. The pyrolysis of homogenous fuel and fuel blends samples, in the inert gas atmosphere and with the application of different heating rates (1, 10, 50 and 100K/min) preceded the air gasification of obtained chars under isothermal conditions at the final pyrolysis temperature (973K). Mass changes were recorded by the TGA instruments and the obtained thermogravimetric curves were applied in the calculation of the reactivity values for all chars tested. The experimental values of fuel blends reactivities, R_{50} and R_{max}, as well as the char yields, W_k, were compared to the values calculated with the application of an additive model and based on the experimental data acquired in the tests of gasification of particular fuel blend components. Char reactivity variations with the conversion rate were also determined.

The experimental results showed that the heating rate applied in the pyrolysis have an impact on the reactivity of fuel blends chars in the process of air gasification. Increase in the reactivity (both, R_{50} and R_{max}) with increasing pyrolysis heating rate was observed for chars of coal and *Miscanthus giganteus* biomass fuel blends. In case of blends of coal and *Helianthus tuberosus*, containing 25 and 50wt% of biomass, the increase in the char reactivity was reported with the increasing pyrolysis heating rate. The opposite trend was observed for chars of fuel blends of higher *Helianthus tuberosus* biomass content. All chars obtained by co-pyrolysis of coal and *Miscanthus giganteus* biomass showed higher reactivity values than the ones calculated based on the thermogravimetric curves obtained for the respective fuel blend components. The differences between the experimental and predicted values of reactivities R_{50} and R_{max} depended on the pyrolysis heating rate (the smallest variations were observed when the heating rate was 1K/min) and a fuel blend composition (the smallest variations were observed for chars of fuel blends of 75wt% of biomass content).

The variations between the predicted and observed values of reactivity of coal and *Helianthus tuberosus* fuel blends chars depended on the mass ratio of particular fuel blend components. The most significant variations were reported for chars of fuel blends of 25 and 50wt% of biomass content, and the heating rate of 10K/min when the values of reactivities R50 and Rmax were higher than predicted. For chars of fuel blends of coal and *Helianthus tuberosus* biomass (25:75 mass ratio), the biggest difference between the experimental and predicted reactivity values was observed for the heating rate 1K/min; the predicted value was higher in this case. The profiles of reactivity vs. char conversion rate showed some differences, implying the influence of the heating rate applied on char properties. The differences in char yields with various heating rates adopted were also reported. The experimental values of char yields varied from the ones predicted based on the additive model.

The extension of the methodological approach applied in the study on the influence of the pyrolysis heating rate on the reactivity of chars in air gasification in terms of the application of the industrial gasification conditions and other techniques of chars characterization could enable to determine other important factors and char properties influencing chars reactivity in the co-gasification process.