ABSTRACT

Gasification is a process of thermochemical conversion of resources containing carbon to gas that is a mixture of combustible components (mainly CO, H_2, CH_4) and ballast (mainly CO_2, N_2, H_2O) in the presence of controlled amount of oxygen and/or steam. The purpose of the gasification process is the production of gaseous fuel with the largest calorific value or gas for chemical synthesis with a specific ratio of carbon monoxide to hydrogen. The origins of coal gasification technology date back to the 19^{th} century. Coal gasification is a complicated process consisting of the following stages: evaporation of moisture, pyrolysis and char gasification. The composition and energy properties of the obtained gas are mainly depending on the type of gasifying agent, the type of fuel and process parameters such as temperature and pressure. Gasification is a highly endothermic process, and the use of oxygen as a gasifying agent increases the costs of running the process.

The development of modern gasification technologies is aimed at improving the efficiency of the process. This possibility is provided by application of excess heat from other processes for preheating the gasifying agent before introducing it to the bed. An interesting solution could be to use for this purpose nuclear reactors of HTGR type (high-temperature gas-cooled reactor). These reactors are characterized by low thermal power (up to several hundred MW_e), the ability to produce high pressure steam of high temperature and high temperature of the coolant (helium) on outlet (750–950°C). These reactors therefore give the possibility of using heat accumulated in the coolant in other energy-intensive processes, for example in coal processing technologies.

The scientific purpose of the work was to determine the effect of preheating gas reactants before introducing into the bed on the efficiency of the coal gasification process. The utilitarian purpose was to demonstrate the possibility of using excess heat to warm up the gasifying agent.

I carried out research on the reactivity of ten char obtained from Polish hard coals in the gasification process with air at 700°C, 800°C and 900°C using a thermogravimetric analyser. On this basis, I selected coal for further research and carried out gasification of the obtained char product by various gasifying agents, i.e. air and a mixture of steam and oxygen at 700°C, 800°C and 900°C in a laboratory installation with a fixed bed reactor. As part of my doctoral thesis, I designed and built a new heating system for the installation enabling the control of reactor heating with the possibility of independent heating of gasifying agents to a pre-set temperature before putting them into the bed. The use of heating zone regulation has made it possible to simulate the use of excess process heat, for example from high

temperature reactors cooled with helium used in the nuclear power industry. The analysis of the influence of the preheating of gas reactants before the introduction into the bed on the efficiency of the char gasification process I carried out as a function of the process temperature (700°C, 800°C and 900°C) and the type of gas reactant (air, mixture of steam and oxygen).

The use of excess process heat in gasification of coal to pre-heat the mixture of steam and oxygen before introducing it into the bed improves the efficiency of hydrogen production throughout the entire temperature range studied. There is therefore a prospect of using excess process heat in coal gasification for pre-heating of the gasifying agent before it is introduced into the bed.