Abstract

Although underground coal gasification is still in development, it is also supposed to be a very perspective technology. Gas produced by use of this method may be in the future applied to many branches of industry such as chemistry, metallurgy and energy production, provided that different requirements about its parameters will be fulfilled. Many characteristics of product gas are strongly connected with its composition. Therefore, problem of optimization of UCG technology becomes an especially important issue. In context of using syngas for particular aims, earlier mentioned optimization could be understood as a choice of the best scope of input parameters and appropriate proceeding of process.

The work presented was concentrated on application of product gas in energetic processes, where substrates should be as caloric as possible. Therefore thesis about possibility of maximization of syngas heating value via appropriate choice of proportions of converting medium components was postulated.

Issues connected with chemistry of UCG, groups of factors effecting this process and the most important parameters of gaseous fuels were described in theoretical part of work. Besides, main methods of modeling of UCG (concentrated on prediction of properties of product gas) and examples of computer software used in simulations of this problem were presented.

The aim of work presented was determination of optimal composition of gasifying medium which permits for production of syngas with maximal heating value. Two models of process were used – equilibrium model constructed in MATHEMATICA software and CFD model implemented in ANSYS FLUENT software.

Equilibrium model was applied for preliminary and general analysis of UCG. On this stage of researches basics relations between composition of product gas and parameter of fuel and converting agent and temperature and pressure in reactor were determined. Obtained results also allowed the scope of input data to be reduced for following simulations. Moreover information about syngas composition (given from model) was subsequently used for determination another parameters (caloricity, adiabatic combustion temperature, flammability limits), which should be known when gas is applied as fuel.

CDF model was used for particular and detailed analysis of UCG process. Data about changes of process in function of time and spatial distributions of some parameters were obtained from model. Consequently, characterization of stages of process and division gasifying channel into different zones (in terms of temperature and syngas composition) were possible.

Determination of syngas composition (and temperature on outlet) for different amounts of steam in gasifying medium was the fundamental aim of work presented. Subsequently, lower heating values were calculated for each product gas compositions. It was observed that the most calorific gas were produced when concentrations of oxygen and steam in oxidizer were equal respectively to 70% and 30%; thus the thesis of work was proved. Furthermore, it was seen that heating value of product gas did not decrease significantly together with changing of proportions of O_2 and H_2O in converting medium, provided that amount of steam on inlet did not exceed 75% (in this situation another criterion of optimization of process could be chosen, for example maximal amount of H_2 or CO). However, when amount of steam in oxidizer is greater than 75%, then thermal conditions in reactor become worse (due to absorption of heat in endothermic reactions of H_2O dissociation) and consequently caloricity of syngas also decreases.