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THE MODEL FOR DETERMINATION OF THE TEMPERATURE AND THE GAS COMPOSITION OF BIOMASS GASIFICATION PRODUCTS BY THE USE OF MATERIAL AND ENERGY BALANCES

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Abstract:
The paper presents the model for the analytical determination of the temperature and the gas composition of biomass gasification products in downdraft gasification reactors at atmospheric pressure. The temperature and the gas composition were determined by the use of material and energy balances.
Key words: *biomass, gasification, gasification temperature.*

INTRODUCTION

The main disadvantage of the existing models for prediction of downdraft gasification gas composition is only applying the material balance equations. Analytically gained results for the temperature and the gas composition by the use of material balance equations are acceptable only for the precise relation between moisture content of the biomass and the amount of carbon that is used as a heat source for occurring of gasification reactions, apropos for the definite heat loss through sensible heat of gasification products.
The model modification, presented in this paper, is done by applying the equation of energy balance and the homogeneous reversal equation:

$$CO_2 + H_2 \Leftrightarrow CO + H_2O$$

MODEL FOR DETERMINATION OF THE BIOMASS GASIFICATION TEMPERATURE

The assumption made for determination of the temperature and the gas composition of biomass gasification products is that in the reduction zone of downdraft gasification reactor these reactions take place:

$$C + 2\,H_2 \Leftrightarrow CH_4 \quad (1.1)$$
$$C + CO_2 \Leftrightarrow 2\,CO \quad (1.2)$$
$$C + H_2O \Leftrightarrow CO + H_2 \quad (1.3)$$
$$CO_2 + H_2 \Leftrightarrow CO + H_2O \quad (1.4)$$

The difference between this and other models is that this model includes the fourth homogeneous reaction (1.4).

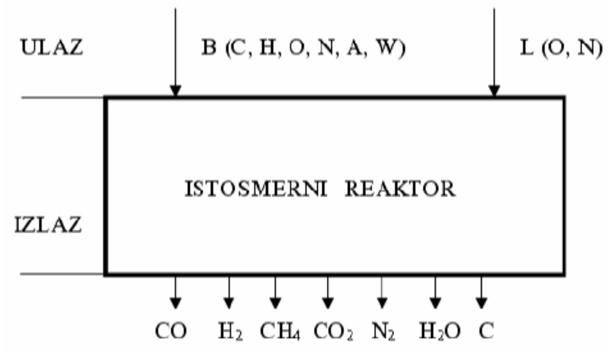

Figure 1.1. Downdraft reactor scheme

B (kg) – the amount of the fuel that enters in the reactor
W (kg/kgB) – the moisture content of the fuel
L (kg/kgB) – the amount of air that enters in the reactor
X_{CO}, X_{H2}, X_{CH4}, X_{CO2}, X_{N2}, X_{H2O}, X_C (kmol/kmol) – the mole fractions of the reactions products at the equilibrium mixture.
This is a complex mathematical problem that requires solving the system of eight equations with eight unknowns. The seven unknowns are the mole fractions (X_{CO}, X_{H2}, X_{CH4}, X_{CO2}, X_{N2}, X_{H2O}, X_C) and the eighth is the gasification temperature.
The additional assumption, which states that whole amount of the biomass hydrogen, is used as the heat source for the reactions in the reduction zone is introduced.

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