GAS COMPOSITION AND EXERGY EFFICIENCY DETERMINATION AT CARBON BOUNDARY POINT IN THE DOWNDRAFT BIOMASS GASIFICATION PROCESS

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Abstract: *Biomass as a renewable energy resource has a great energetic potential. There are a lot of incentives all over the world, such as for example CDM program, for implementation of waste biomass. This paper focuses on the wood chips gasification in an idealized downdraft equilibrium gasifier. The model for determination of carbon boundary temperature and other important parameters at carbon boundary temperature such as gas composition, exergy efficiency of the process was developed. The purpose of this paper is to determine upper limit for exergy efficiency that should be expected from the downdraft gasification process in dependace of moisture content in wood chips. In addition to this, to diagnoze if and what kind of measures should be taken with wood chips' moisture prior to the gasification process. In the model idealized gasifier is used in which chemical equilibrium is achieved, ashes are not taken into consideration and heat losses are ignored.The gasification efficiencies are calculated at carbon boundary temperature, where exactly enough air is added to achive complete gasification and avoid carbon in the solid residual. It is shown that the exergy efficiencies are lower than the energy efficiencies, and also, that exergy efficincies decrease with the increase of moisture content in the biomass. Also it is shown that overall exergy efficiency of the process decrase with slower rate than exergy efficiency based only on chemical exergy. For wood chips with high moisture content exergy efficiency could be improved by drying the biomass prior to gasification process.*

Keywords: *Biomass, wood chips, gasification, chemical equilibrium, carbon boundary point,exergy efficiency, energy efficiency.*

1. INTRODUCTION

According to [1] Serbia has relatively large biomass energy potential. The total excess biomass energy potential is estimated at 115 000 tera Joules per year (TJ/year) of which 50 000 TJ/year accounts for the local wood waste, while the remaining amount of 65 000 TJ/year accounts for agriculture waste. This work is focused to wood chips that are nowadays piled and wasted. Huge amounts of wood chips are deposited especially during summer period of year into rivers, and cause great environmental problems in the area of Kraljevo. Also, from huge piles of wood chips there are methane emissions that are caused from the anaerobic biomass decay. This methane emissions and wind dispersion are the main reason why wood chips are not allowed to pile just for the heating season.

Biomass gasification is an interesting energy conversion technology where this biomass could be used. Gasification is the process of gaseous fuel production by partial oxidation of a solid fuel. This means in common terms to burn with oxygen deficit. The gasification of coal is well known, and has a history back to year 1800. The oil-shortage of World War II imposed an introduction of almost a million gasifiers to fuel cars, trucks and busses especially in Scandinavian countries [2].

The main differences concern how reactants and products are moved around in the reactor, and the resulting reaction conditions. The reactors may be operated at atmospheric pressure or at higher pressures,

The Kyoto protocol emphasizing the need to combat carbon dioxide emission has also been an impetus for the interest in biomass gasification. Carbon dioxide emissions from using biomass as a fuel are perceived as neutral because this carbon dioxide is fixed by photosynthesis in a relatively short period.

Gasification belongs to thermochemical conversion processes together with combustion, pyrolysis, and liquefaction.

As a medium for gasification air, pure oxygen, water vapor, carbon dioxide and hydrogen can be used. In practice and in commercial applications air and water vapor are the most common, but also there are cases where pure oxygen is used as a gasifying medium.

The product of gasification is synthesis gas that consists mainly from carbon monoxide, carbon dioxide, methane, nitrogen, hydrogen and water vapor. The heating value depends on the gasification medium, solid fuel characteristics, gasification process and the temperature in the gasifier. The gas is used for electricity, heat and fuel production.

The types of gasifiers are various, but may be divided into three main groups [3]: entrained flow gasifiers, fluidized bed gasifiers (bubbling/circulating) and fixed bed gasifiers, where the last is subdivided into: counter-current (updraft), co-current (downdraft) and cross-current moving bed.

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