# COMBUSTION CHARACTERISTICS OF THE PELLETIZED RENEWABLE FUEL FOR CLEAN AND EFFECTIVE ENERGY PRODUCTION

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**Summary.** Experimental study of combustion characteristics of the different types of pelletized biomass (wood, wheat straw, wheat lignin) is carried out using the propane flame flow to initiate gasification of the biomass and swirl-stabilized flame flow to complete combustion of volatiles. The correlations between the combustion characteristics, elemental composition and heating values of pelletized biomass at different stages of the swirl flame formation and different air supply rates are derived and analyzed.

## INTRODUCTION

Utilization of different types of biomass for energy production is still restricted because of the low energetic density of biomass, dissimilar structure, and high moisture content, variations in their elemental composition, ash content and heating values. Pelletizing reduces moisture content, increases energetic density of biomass and provides greater homogeneity of composition in comparison with raw biomass and decreases the logistic expenses. In order to achieve clean and effective combustion of pelletized biomass, it is essential to provide optimization of the combustion conditions and understand the correlations between the main characteristics of the pelletized biomass and combustion dynamics of the biomass. This study covers complex measurements of the main characteristics of the different types of pelletized biomass (agriculture straw, lignin, wood biomass) using proximate and ultimate analysis of the biomass and complex experimental study of combustion characteristics determining the correlations combustion characteristics and main characteristics of palletized biomass at different rates of air supply in the combustor.

### 1.1. Experimental set-up

The experimental study and optimization of the combustion characteristics of the swirling flame flow was managed using a small-scale pilot device that is composed of a biomass gasifier and combustor [1]. The process of biomass gasification and ignition of volatiles is initiated using the additional heat energy supply into the biomass by propane flame flow. The swirl-stabilized flame of volatiles is developing downstream of combustor. The complex measurements of the combustion characteristics and optimization of combustion conditions involve a test and optimization of the heat production rate, combustion efficiency and the formation of emissions (CO, $H_2$, $CO_2$, NO, $NO_2$, $NO_x$) for different types of pelletized biomass at different rates of the biomass gasification and different air supply rates using gas analyzer Testo 350 XL to provide the local measurements of the flame composition and date plate PC-20TR for on-line calorimetric measurements of the cooling water flow to estimate the variations of the heat production rate at different stages of biomass combustion. The proximate and ultimate analysis of the pelletized biomass is carried out using the methods that are described in [1].

### 1.2.Results

Kinetic study of the combustion characteristics for three different types of pelletized biomass (wood, wheat straw and wheat lignin) has shown that the time-dependent variations of the flame temperature,

composition and heat production rates during the burnout of palletized biomass are strongly influenced by the elemental composition, heating values and energetic density of pellets. At the air supply rates close to stoichiometric (4-5 $m^3$/kg) faster rate of gasification and ignition of volatiles is observed for the wood biomass pellets (Fig.1), determining higher peak values of $CO_2$ and heat production rate (Fig.2-a) with correlating decease of CO emission to acceptable values (60-90ppm) during the burnout stage of pelletized biomass. More lasting combustion with pronounced ignition delay indicates palletized wheat straw lignin (Fig.1), indicating higher levels of $NO_x$ emission that strongly depend on $N_2$content in the biomass (Fig.2-b).

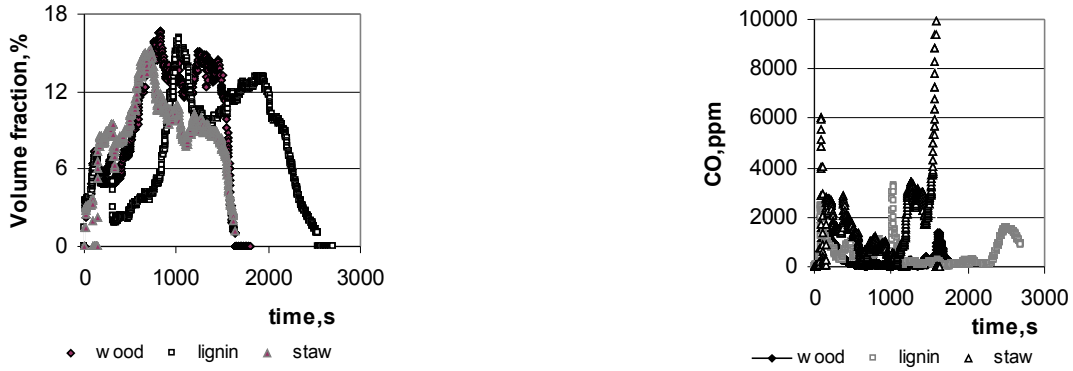


Fig. 1. The time-dependent variations of the composition of flame reaction zone for different types of pelletized biomass.

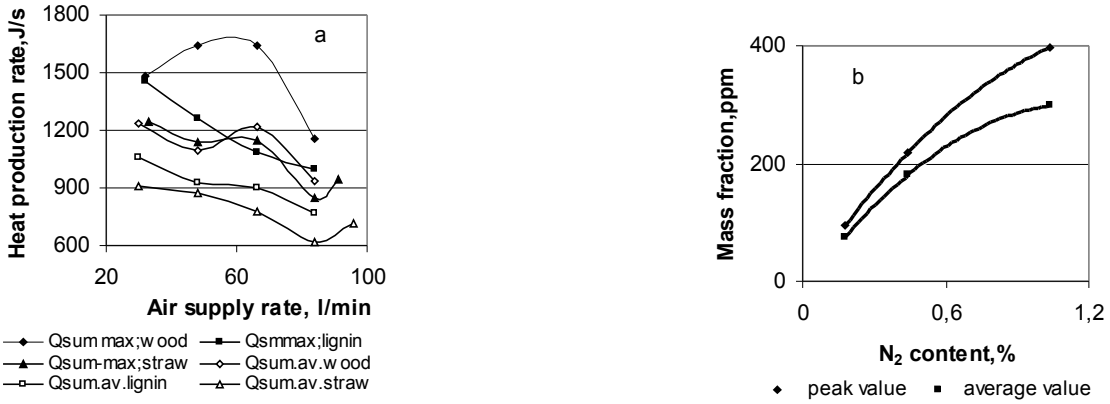


Fig. 2. a) The effect of air supply rate on a rate of heat production . b) correlations between the mass fraction of produced Nox and nitrogen content in the pelletized biomass

### 1.3.Acknowlegments

The authors would like to acknowledge the financial support from the European Regional Development Funding 2.1.1.1. "Support to Science and Research". Project Nr. 2010/0241/2DP/2.1.1.1.0/10/APIA/VIAA/006.

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