EFFECT OF WOOD CALORIC VALUE AT AIR TEMPERATURE IN PRE-HEATER

Peter Ďurčanský – Michal Holubčík – Milan Malcho

Abstract

The increasing energy consumption in the world may be solved by use of alternative energy sources in micro-cogeneration. The use of renewable resources, including biomass, represents a possible contribution to solve this problem. New heat source is required to follow a number of technical regulations and recommendations by design. The proposed combustion furnace is intended for combustion of biomass, either piece, or in the form of wood biomass. But the combustion is not only affected by design of furnace, but also by fuel and its properties.

Key words: *Biomass, combustion, furnace, nonconventional cogeneration unit*

INTRODUCTION

The heat source is determined as furnace for burning biomass, in form of a wood pieces, or pellets. Transport energy from the combustion of biomass to a working fluid is providing a heat exchanger connected to that heat source.[1] In the design of the heat exchanger should be taken into account all the conditions imposed on the heat exchanger and the desired properties. [2], [3] Most often the investigation of the heat transfer focused on heat transfer surface. This proposed small heat source should be used for energy transport from the combustion of biomass to a working fluid in hot air engine. But the heat transfer and the burning process is also affected by fuel, which can play a main role and influence the operation of a heat source. [4] Use of unsuitable fuel can lead to damages, to clogging of heat surfaces and eventually to malfunction of that heat source.

MEASURING FACILITY

The furnace should be used to energy transfer from the combustion of the biomass through a heat exchanger disposed in the boiler in the flue gases. Experimental measurements of the heat source are focused at verification of the boundary conditions but also to determine the real characteristics of the proposed device. Also, attention was paid to setting the boiler parameters, especially the amount of air supplied to the furnace. Finally the measurements were made to verify the influence of fuel type at furnace working conditions under different settings. The boiler was placed in the test room and plugged in, as shown in Fig. 1. In the combustion chamber, thermocouples are placed as in Fig.2, which allows to follow course of temperature in the plane before entering hot flue gas exchanger.

University of Žilina,Univerzitná 8215/1, 010 01 Žilina
e-mail: peter.durcansky@fstroj.uniza.sk

[5], [6] At air inlet were placed anemometers, which recorded a rate of air flow to the boiler. Air flow is therefore measured by the indirect method.

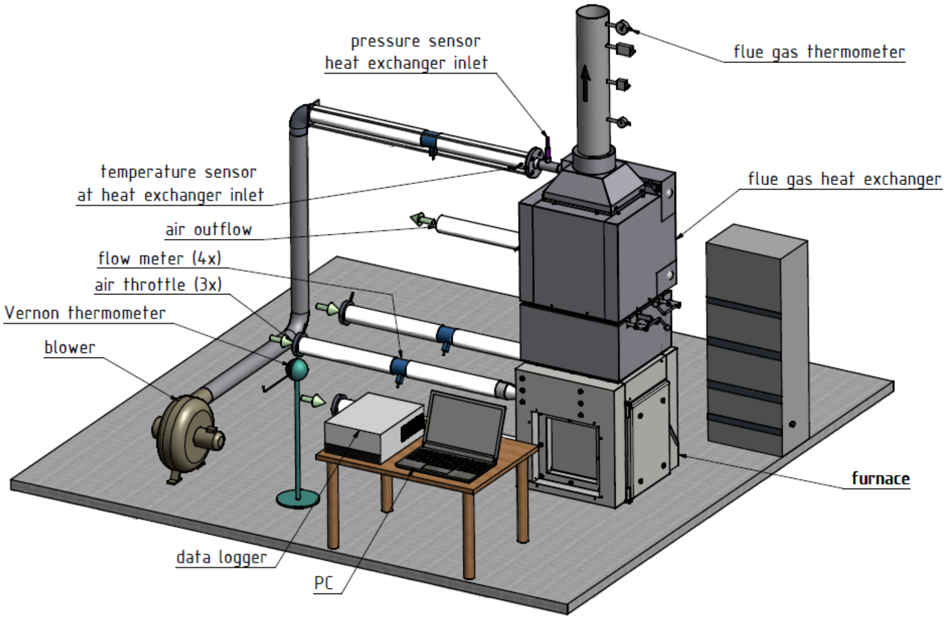

Fig.1: Measuring facility

Heat exchanger located in the upper part of the biomass furnace was connected with blower, which forces the air into the heat exchanger, thus ensuring the flow of air through the exchanger. Observed was the speed of air flow into the heat exchanger, the air temperature at the inlet and outlet of the heat exchanger and also the pressure at the exchanger. Also ware placed thermometers into the burning chamber to observe the temperature at heat exchanger inlet. All data from the sensors were recorded with logger. Thermal power was measured by direct method, with the same mass flow of air through the exchanger. As fuel was used wood of different tapes and briquettes. The wood was used in form of pieces. Also the shape of the wood played role. Larger pieces burned less intensive and last longer, but with lower temperatures. Briquettes have burned differently, because they have defined shape and the burning briquettes burn together more intensive as if they were distributed in the combustion chamber. Loading fuel into the boiler is carried out manually via the front of the front door. The fuel is burnt on the hard metal grid, which is composed of individual grate bars separated by spaces to supply the air. It provides a sustainable layer of burning fuel required for combustion and combustion air with optimal air overflow. The supply of combustion air is conducted through one primary and two secondary supply tubes. The air affects the release of the gaseous fuel component and is required for oxidation of the fuel. The secondary air is supplied to the combustion area and the air affects the burning fuel and combustible gases. The secondary air is required for complete burnout of volatile matter. The secondary combustion air is most important for biomass burning, because it affects the quality of fuel combustion and emissions.

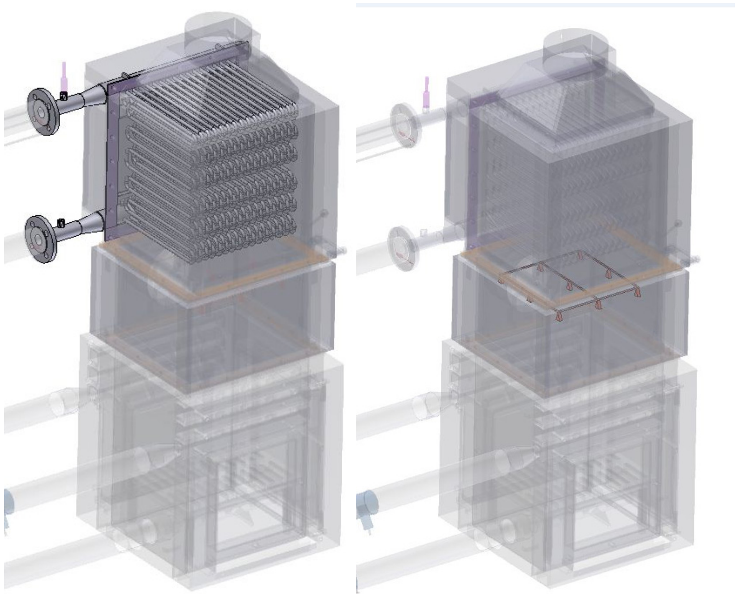

Fig. 2: The placement of thermometers in burning chamber under the heat exchanger

RESULTS

The performance measurement of the furnace was performed with different wood of similar weights, where the varied amount of combustion air was supplied by changing the position of the control baffles. All wood types have had alike 12% humidity. For this test, we have monitored the temperatures in the burning chamber and the total power output of the heat exchanger. The furnace was at first preheated, the time of preheating was in range from 19 to 25 minutes. Average temperatures in the burning chamber are shown in Table.1.

Tab. 1 Average temperatures in burning chamber with different wood.

Fuel	**Fuel mass [kg]**	**Max. average temp. [°C]**
Birch wood	2.6	487
Spruce wood	2.604	460
Spruce briquettes	2.61	536
Beech	2.68	524

The wood was used in form of pieces. Also the shape of the wood played a significant role. Larger pieces burned less intensive and last for longer timer, but with lower temperatures in the burning chamber. In Fig. 3 is shown the actual power output from the heat exchanger. The exchanger is designed at 8 kW power output. As we can see, the different wood types have different power output. The spruce is burning very intensive in the beginning, but after short time the power decreases. Otherwise, the birch and beech have longer power growth to the maximum and they also keep the high power output for longer time.

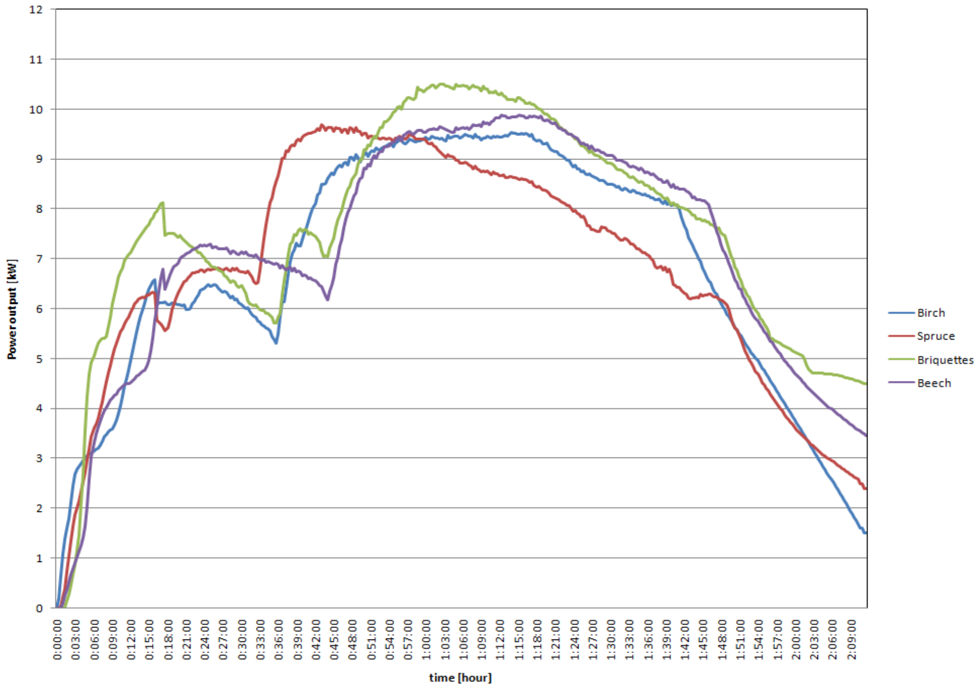

Fig. 3: Power output from heat exchanger with different wood sorts

CONCLUSION

Measurement of performance parameters were carried out under different conditions with different types of fuels. Tested was birch, spruce, beech wood and spruce briquettes. The measurements confirmed influence at heat exchanger. The spruce is burning very intensive in the beginning, but after short time the power decreases. So for a constant power output must be the fuel fed at shorter time period. The birch and beech keep the high power output for longer time, so the fuel amount can be smaller.

Acknowledgements

This work was supported by the projects VEGA 1/0548/15 “The impact of bark content and additives on mechanical, energy and environmental characteristics of wood pellets”, KEGA 046ŽU-4/2016 “Unconventional systems using renewable energy” and APVV-15-0790 “Optimization of biomass combustion with low ash melting temperature”.

REFERENCES

[1] Ďurčanský, P., Lenhard, R., Jandačka, J. *Comparison of mathematical models for heat exchangers of unconventional CHP units.* Acta Polytechnica: journal of advanced engineering, 2015.

[2] Kasanický, M., Lenhard, R., Malcho, M. *Optimization of atypical heat exchanger with using CFD simulation*. Žilina, Transcom, 2015.

[3] Tomáš Brestovič, Natália Jasminská, Marián Lázár. *Application of analytical solution for extended surfaces on curved and squared ribs.* Acta Mechanica et Automatica. Vol. 9, no. 2 (32), 2015.

[4] Kapjor, A., Hužvár, J., Ftorek, B., Smatanová, H. *Analysis of the heat transfer from horizontal pipes at natural convection*. AIP Publishing, 2014.

[5] Hyhlík, T. *Method of vortex structure identification in axisymmetric flow field.* Manufacturing Technology, vol. 15, no. 5, 2015.

[6] Procházka, Pavel P., Uruba, Václav. *Stereoscopic PIV measurement of boundary layer affected by DBD actuator*. Experimental Fluid Mechanics 2015. Liberec, 2015.