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THE EFFECT OF SWIRLING FLOW ON CO-FIRING PROCESS OF WOOD PELLETS AND PROPANE

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ABSTRACT

The use of biomass for energy production has a lot advantages comparing with fossil fuel: it is CO_2-neutral fuel, employment creation, reduction of dependency on imported oil. At the same time biomass combustion has disadvantages: not high efficiency comparing with natural gas, which can be explained by high moisture content, dissimilar structure, heating value. However, there are some optimization possibilities influencing energy efficiency and emission levels: combustion temperature, residence time, fuel feeding, combustion in swirling flame flow etc.

Formation of swirling flow provides enhanced fuel mixing with air flow and completes combustion of volatiles. The main aim of the investigation is to analyze the influence of swirling flame flow formation on temperature, composition field and heat production rate. During experiments wood pellets were co-fired with propane. From previous experimental studies was concluded that biomass and propane co-firing promotes faster wood pellets gasification and ignition of volatiles.

The special pilot device (3 kW) was created where wood fuel can be co-fired with propane. The pilot device contains wood fuel gasifier, sectioned water-cooled combustor and propane burner. The complex measurements of temperature changes (K), heat rate (kJ/s) and emissions at different rate of air and propane (l/min) supply are carried out.

It was provided high air swirl number (S > 0.6) during the experiments that caused the formation of central recirculation zone. It was concluded that recirculation zone promotes the enhanced mixing of the flame compounds at the initial stage of swirling flame flow formation, promotes reverse heat/mass transfer up to wood pellets layer enhancing wood pellets heating, gasification and burnout of volatiles. A slight decrease of nitric oxides' concentration is detected in the swirling flame flow combustion zone that could be explained by gradual air swirl flow mixing with volatiles flow formatting relatively low temperature of combustion zone.