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Environmental impact of sawdust briquettes use - experimental approach

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Abstract

In the last decade, with increasing global energy demand, pollutant emissions' level, resulting from the process of energy conversion has been increased significantly. With the intensifying activities of wood exploitation has also increased the wood-waste amount resulted from this process. The situation being given, in the present paper is shown the pollutant emissions impact upon environment, as a result of the conversion process from sawdust briquettes in thermal energy, taking an experimental approach. Meanwhile are presented also the results obtained by analyzing the impact of physical and chemical properties, for the available raw material, upon pollutant emissions quantity generated after combustion process.

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Keywords: Thermal energy; solid biomass; environmental emission; pollutant emission; sawdust briquettes

1. Introduction

Increasing population number and raising the living standard has determined the continual increase on energy demand from conventional sources and implicitly to the diminishing of fossil fuels reserves. The statistics [1] show that there is a correlation of raw energy total consumption trend with population evolution, in 1860 – 2010 interval. Thus the global population increased from 0.98 billion inhabitants in the year 1800 at 6.79 billion inhabitants in the year 2010, and primary energy consumption from 20 EJ in 1800 at 536 EJ in 2010.

The long-term estimates [1] show a forward increase in the world population up to 9,46 billion inhabitants in the year 2100 which leads to a significant increase in primary energy consumption. The continued growth of primary

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energy consumption, rediscovers an acute problem, namely that being the depletion of fossil fuel reserves, more over because worldwide, at the present moment, over 50% of primary energy comes from conventional energy sources.

Another serious problem facing mankind is the impact of fossil fuel use on the environment. Due to the discharge of harmful substances into the environment, carbon cycle in nature is strongly affected. This is supported by statistics indicating an increase in CO_2 emissions of 200 million tons emitted annually into the atmosphere in 1850 to 29 billion tons emitted annually into the atmosphere in 2004 [2].

Given the above, the problem of using renewable energy sources is an issue of global importance. Under these conditions the biomass, characterized by a high availability across the planet, with an overall potential of approximately 2900 EJ / year [1], by its renewable and last but not least by reduced quantities of pollutant emissions resulted after its conversion.

Sawdust is one of the major waste resulting from wood exploitation and processing, which stored in un-controlled conditions may be an important factor of environmental pollution. But at the same time is one of the main sources of biomass for the production of solid fuels for generating heat in both centralized system, in co-generation installations and in a decentralized system for residential use, in classic boilers for thermal energy generation.

Converting biomass in general, and the sawdust in particular has beneficial effects on the environment. However as with any source of energy will result pollutant emissions with negative impact on the environment and on biological systems. The resulting pollutants from sawdust briquettes conversion in heat energy are ash and air pollutants emanated through the combustion gases: carbon monoxide (CO), volatile organic compounds (VOCs), nitrogen oxides (NOx), sulfur oxides (SOx) and particular emissions (PE). Among these in the literature [3, 4] are indicated NOx and SOx as dominant components in emissions configuration.

The most adverse impact upon human health is due to the emissions of NOx because it damages the human respiratory system. The existing data [4, 5] show that NO> 3ppm leads to a quantifiable measures of damage to the lungs health, while a value of 0,1ppm cause lung irritation and decreased pulmonary operation causing the development of asthma. The NO_2 high concentrations affects the production of hemoglobin, restricting the oxygen in human tissues. On the other hand NOx emissions have a negative impact also on the ozone layer: it produces ground-level ozone (photochemical smog) and destroys naturally occurring ozone high in the atmosphere [3, 5]. The SOx emissions, by reacting with atmospheric oxygen, lead to the formation of acid rains and snowfalls. Due to the lower amount of sulfur in the chemical composition of solid biomass it produces a small amount of sulfur oxide emissions (SOx) resulted from the conversion into thermal energy. The CO_2 produced in the process of wood burning is considered part of the carbon cycle in nature, not being regarded as air pollutant. For more than 80% of the particulate matter are in the form of ash driven by the combustion gases (fly ash) of which 40% have a diameter <10μm. Of these, the technical literature [4] indicates that 20% is laying on the ground and all the rest is released into the atmosphere where can cause health problems.

The main goal of the paper is to determine the environmental impact of using wood chips briquettes for the generation of thermal energy for residential buildings. For this purpose, by means of an experimental approach, have been determined the main physical and chemical characteristics of the briquettes used in order to analyze the quality of fuels used and to determine the amount of ash in fuels' composition. Also, has been carried out a variation analysis, to determine the concentration of NOx throughout the combustion cycle. Considering that in the technical literature [4, 5] it is noted that NOx emissions resulting from the combustion process are formed by 95% of NO, there has been made also the analysis of changes in emissions of NO during one complete cycle of operation correlated with the temperature of resulting gases from the chimney, and also the physical characteristics of the briquettes (i.e. the length).

2. Method and Material

For carrying the experimental research, a laboratory bench has been made, to simulate the conditions for sawdust briquettes burning to generate thermal energy for residential buildings with area less than 100m2 (Fig. 1). The boiler used to burn the sawdust briquettes has a nominal capacity of 23,7 kW, the combustion chamber has a thermal power of 35,4kW. The combustion chamber has been designed to supply large pieces of wood and is equipped with classical grate. Loading it shall be processed manually by the top door, on the grate. Combustion control was achieved by varying the amount of the combustion air (i.e. excess air - λ) via a thermostat and a chain which ensures