CONSTRUCTION AND TESTING OF A 600 kW BURNER FOR SAWDUST IN SUSPENSION

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Rezumat. Pentru puteri termice mai mari de 500 kW arderea în suspensie a rumeguşului reprezintă soluția cea mai adecvată. Se au în vedere în special aspectele legate de uşurarea alimentării cu rumeguş, care devine total pneumatică. Un cazan cu ardere în suspensie este mai simplu şi mai uşor decât unul cu ardere pe grătar.
Cuvinte cheie: ardere rumegus, cazan cu ardere în suspensie.

Abstract. For units having a thermal power higher than 500 kW, the suspension burning of the sawdust is the most adequate solution. There are certain aspects to be considered regarding the ease of feeding of the sawdust, which becomes fully pneumatic. A suspension burning boiler is simpler and lighter than one with grate burning.
Keywords: sawdust burning, suspension burning boiler.

1. USAGE POSSIBILITIES

When burning solid biomass (in the form of sawdust) some difficulties arise due to the rate of the density to the mass flow required for producing a certain thermal power. Subsequently, when burning in a layer, the air admission is somewhat difficult for a correct distribution to the entire quantity of biomass existing in the furnace. As a rule, for the layered burning, even when using sawdust briquettes, the thermal power of 1 MW per unit cannot be surpassed. The heating of large volume buildings is considered, especially for agricultural farms or for greenhouses.

A humidity value higher than 20% worsens the ignition and inhibits the burning process. There is a direct connection between the humidity and the endurance of the power installations, represented by the excessive fouling of the furnace and its convective part. The suspension burning increases from 2.5 to 3.5 times the boiler installation endurance, due to the intensified burning.

The solutions to solve these difficult aspects of the energy valorization of the biomass represented by the forming of biomass pellets dried in a hot air current, to a 6-8% humidity value, have higher costs and cannot be applied to units of high thermal power.

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While in the field of energy valorization of wooden biomass by means of densification there are some achievements, the field of the suspension burning of sawdust is still in the incipient phase. That is because of the carrying of the sawdust particles to the flow limit of the air current (similar the pulverized burning of coal), by means of swirling burners.

Romania has a great potential for biomass (circa 14.5 million tons which can be energy valorized), but it has only partial achievements, especially in the field of burning technology with fixed and mobile grates.

This paper takes into account the influence of the new ecological fuel vector, with burning with floating in the air, on the quality of the ash resulting from burning. The new ecological fuel vector comprises the binomial: carrying air – particles form of solid biomass. The increase in the burning velocity permits the reduction of some pollutant components. If K_2O and CaO presence is reported in ash, the biomass ash could be considered to be an agricultural fertilizer and not a residual waste which must be stored away.

The testing objective is to achieve a complete and an ecological burning. Burning solid biomass, regardless of the technologies developed up-to-date, have the disadvantage of a great carbon monoxide emission. By means of completely carrying of the solid biomass by the burning air current, inside an

adequate height furnace, a massive reduction of carbon monoxide emission is estimated.

The increase in the burning velocity also reduces the fouling effects on the final heat exchangers of the power installations, contributing to the increase in the endurance of such installations.

From the social perspective, these achievements come to help the rural communities, which, with local renewable resources, could produce electricity and heat, with a competitive efficiency, similar to that on the energy market.

Automation is a defining component for the technology of suspension burning of the sawdust, imposing higher costs for the internal services (pumps, fans, feeders, etc.). As a result, besides the thermodynamic efficiency, the notion of economical efficiency is defined by:

$$\eta_{economic} = \frac{C_{et}}{C_{comb} + C_{ce}} \cdot 100, \%$$

where: C_{et} is the cost of the energy produced, C_{comb} – the cost for the fuel, C_{ce} – the cost of the internal services electrical energy. The operator cost is not considered since the boiler is to be fully automated. An important part in the fuel cost is that connected to the storage and to the transportation. These economical calculations are necessary in determining the costs of the heating of spaces using biomass.

2. THE BURNER CONSTRUCTION

In principle, an installation to burn sawdust in a pulverized state has the following components: a fuel bunker, for an autonomy range of 4 to 6 hours, a pneumatic system to feed the sawdust to the burner, a primary, secondary and tertiary air fan and also a flue gas fan.

The burner ensures a flow of 0.5 kg/s of sawdust, having a 15500 kJ/kg calculation calorific heat value.

The elemental analysis of the sawdust was:

$$C^i = 44{,}8\%, \quad H^i = 4{,}8\%, \quad O^i = 33{,}2\%,$$
$$S_c^i = 0\%, \quad N^i = 1\%, \quad A^i = 5{,}6\%,$$
$$W_t^i = 10{,}6\%$$

A primary air to the secondary air ratio of 0.5÷ 0.8 is proposed. The excess air ratio at the burner level is imposed in the limits: $\lambda = 1.2 \div 1.25$.

The burner has also a system of swirling blades for each of the air circuits.

The primary air velocity is recommended to be W_1 = 25 – 35 m/s, for the secondary air W_2 = 30–35 m/s, and for the tertiary air W_3= 20 – 30 m/s.

An alternative for the axial blades system using one with radial blades is proposed. The swirl ratio used for different jet categories was of 1.2 for the secondary air and of 5.4 for the tertiary air.

3. RESULTS FROM TESTING ON THE UPB PILOT BOILER

The burner presented in figure 1, was mounted on the Politehica University of Bucharest pilot boiler.

Fig. 1. General view of the pulverized state sawdust burner.

The active dimensions of the pilot burner are 1.2 · 1 · 5.9 m. The burner is mounted in the burner embrasure destined to the pulverized solid fuels (fig. 2). After the testing, the burner achieved the design thermal power of 600 kW.

Fig. 2. The embrasure of the UPB pilot boiler where the suspension sawdust burner was mounted.

The value for the thermal load of the furnace, during the testing, was q_v = 105 kW/m^3, a value which is inside the stability limitations for a furnace burning pulverized solid fuel (thermal load values over 80 kW/m^3 are recommended).

The CO emission was extremely low, under 80 ppm (the layered burning has CO emissions in the 600÷-4000 ppm range).

The 600 kW thermal power of the burner was imposed by the reduced size of the boiler embrasure (∅168). For a larger embrasure, the thermal power of the burner may be increased accordingly. A mention is made that an industrial boiler may have several burners, thus resulting in an increased thermal power. An estimate is made regarding the construction, without major difficulties, of boilers having a thermal power up to 10 MW.

The installation start-up was made by heating using natural gas, cold start using an ignition spark not being recommended by the authors because of the excessive fouling of the heat exchangers.

In the figure 1 a general view of the sawdust burner is presented, in which its self sustaining construction is to be remarked. The burner is leaned against a side wall of the pilot burner before being mounted.

In figure 2 is presented the constructive part of the burner to be mounted in the furnace embrasure.

The details for the swirling blades are presented in figure 3.

Fig.. 3. Detail of the burner construction, pointing out the axial blades for the swirling of the tertiary air.

4. CONCLUSIONS

In order to burn sawdust in suspension a 600 kW thermal power burner was developed. Tests for the energetic performances of the burner were carried out by means of implementing it into a medium power pilot boiler. The experimental results confirmed the technological benefices of burning the sawdust in suspension, leading the way to enlarging the thermal power range of this variant of burners.

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