Constructive Layout of a Multifunction 400kW Boiler for Wooden and Agricultural Biomass

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Constructive Layout of a Multifunction 400kW Boiler for Wooden and Agricultural Biomass: *The boiler has a flame tube construction and burning on a mobile grate with water cooled fixed bars. It is also destined to burn straw briquettes, its construction allowing temperature control at the end of the furnace, in order to avoid overheating above the 850°C value. A mechanical cleaning system allows ash removal from the convector during operation.*

Key words: *Wooden and Agricultural Biomass Burning, 400 kW Multifunction Boiler, Constructive Layout, Mechanical Ash Cleaning System.*

INTRODUCTION

The 400 kW multifunctional boiler for use of wood waste and agricultural biomass as fuel and, makes the transition to medium and large thermal power for the flame tube type of boilers. In the figure 1, the boiler is presented in its manufacturing execution phase.

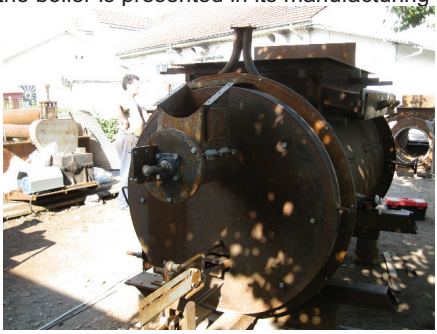

Figure 1. Genereal view of the 400 kW boiler casing

The boiler is an extension of the 150 kW one, made by the same "E. Morarit " company in Romania and in two years of operation it had a remarkable behavior.

It was intended to have a construction with flame tube and partially cooled mobile grate, in order to maintain the temperature at the end of the furnace below 850°C to remove adherent deposits of ash in particular the burning of cereal straw. This was achieved using a very demanding full automation system, too.

CONSTRUCTIVE AND OPERATION PARTICULARS

For both boilers, cleaning spiral metal elements were inserted in the convection heat exchanger tubes that produced an intensification of the heat exchange by swirling, and also cleansing of ash deposits by means of axial movement driven by a very complex mechanical system.

The boiler construction has a Ø1040 diameter cylindrical shell, in which it is mounted a Ø860 flame tube diameter. The minimum distance between the two cylinders is 70 mm. The boiler has an active length of 1900 mm for the mantle – figure 2. Figure 2 highlights also the secondary air supply pipe. For each hole location there is a manual control system with an obstruction pin shutter.

Figure 2. Longitudinal view of the boiler casing

Fuel for the operation calculations is represented by straw briquettes from the north-eastern Romania, having the following quality:

C^i = 42,1%, H^i = 6,6%, N^i = 0,6%, O^i = 33,4%, W^i_t = 11,9%, A^i = 5,4%.

Lower heat value: 16980 kJ/kg.

Ash composition cenuşii:

SiO_2 = 56,9%, Al_2O_3 = 5,4%, MgO = 3,1%, CaO = 4,1%,…….

Active volume of the furnace is 0,5 m^3.

The boiler can also use:

- wooden waste with maximum moisture of 20%;
- sun-flower stems chops;
- corn stems chops.

Inside the flame tube is inserted the grate, which comprises:

- a fixed 270 mm wide bar, water-cooled;
- a row of mobile cast-iron bars 270 mm long and 70 mm wide;
- a water cooled fixed bar 56 mm wide;
- a row of mobile cast-iron bars;
- a water cooled fixed bar;
- a row of mobile cast-iron bars.

All fixed and mobile bars have the above mentioned dimensions. The fixed bars have lateral clearances for the primary air inlet. In figure 3, the grate construction is presented.

Figure 3. The fixed and mobile grates assembly

The convective heat exchanger has a rectangular shape, with three flue gas ways

and it is placed above the boiler mantle, as illustrated in figure 4. The mobile grates are driven by a gear rack system. Another rack drives the fuel pusher rod, placed continuing the grate, being a system that controls the air quality.

Secondary air gets in above the burning area, through three orifices placed left and right to the grate, with Ø15 in diameter.

Figure 4. General view of the convective heat exchanger

Figure 5. The position of the sliding trays for the ash deposits capturing

Figure 6. Ash deposits cleaning elements chain driving system

In figure 5 the sliding trays for capturing the ash deposits are underlined. The heat exchanger pipes have an inside diameter of 53 mm. In figure 6 it is presented the chain driving system for the cleaning elements of the ash deposits and also the driving gear system. The boiler calculated efficiency is a high as 90% for the straw briquettes. This value should be adjusted in function of the type of used fuel.

CONCLUSIONS AND FUTURE WORK

The boiler is in the final stage of manufacturing, and it is to be mounted for heating industrial spaces. After its commissioning, operation, endurance and pollutant emission tests will be concluded. Stepping up to the 400 kW power range will result in a significant relative unit price [euro/kW] reduction.

In order to further increase the market value of the 400 kW boiler, a cogeneration variant will be developed, with higher live steam pressure, enabling thus, the use of a small power steam turbine driving an electrical generator and the consequent payment of the so-called “green certificates” for electricity generation using renewable resources.

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