Achievements and Expectations in the field of the Energy Willow Use

Lucian Mihaescu, Gabriel Negreanu, Gheorghe Lazaroiu, Ionel Pisa,
Viorel Berbece, Ion Oprea, Sandor Bartha, Arpad Domocos

Achievements and Expectations in the field of the Energy Willow Use: *The paper presents the current achievements for the use of the energy willow chops, with a range of 0-30 mm in a series of a fuel fully controlled hot water boilers, in the range of 30-1000 kW_{th}. For electricity generation, the emphasised solution is a power plant in the range of 100-200 kW, that can add value to an energy willow surface of 90-180 hectares. It is a good example of decentralized generation, reducing the cost of fuel transportation.*

Key words: *Energy Willow Chops, Combustion, Power Plant.*

INTRODUCTION

Romania has a forest area of 30 % of its territory and a high agricultural potential. As a result, efforts are being made today for energy recovery from biomass. The policy of forest protection has stopped the massive deforestation. The main woody biomass sources are now the seasonal trimmings and the waste from forest or fruit-grower activity. In the last few years, a remarkable new option has been chosen by the private entrepreneurs: the energy willow crops, with a surface of about 1200 hectares.

Generally, the use of biomass as energy source is more advantageous if the consumer is closer to the crops. The wooden biomass potential of the Country is about 14,8 billions of tones/year, focusing on the hill and mountain areas.

ACHIEVMENTS IN THE HARNESSING OF ENERGY WILLOW

Following the first energy willow crops from 2008, the ERPEK firm (located in Sfântu Gheorghe – Covasna County) has begun, in association with the Center of Thermal Researches of the University Politehnica of Bucharest, the research on the energy characterization and appropriate combustion technologies for this important resource.

Simultaneously, valuable assessments regarding the storage, transportation and distribution of the willow chops have been made.

The first mechanical harvesting took place in Covasna county, Poian village, on February 2013, with a yield of 50 t/ha. Actually, the willow acreage is about 100 ha. The harvesting equipment was a (Klass) multifunctional harvester equipped with a harvesting head (John Deere), designed especially for willow, with a productivity of 1 hectare/hour.

The characteristics of the harvested energy willow were:

- density: 250 kg/m^3;
- wetness: 50 %;
- ash content: 0,6-0,8 %.

After drying in an enclosed space, the characteristics were:

- density: 160 kg/m^3;
- wetness: 20-22 %;
- low heating value: 16500-17000 kJ/kg.

The combustion tests were performed in the Center of Thermal Researches laboratories, that are equipped with a hot water boiler of 40 kW made in Romania by ERPEK company (figure 1). ERPEK Company manufactures thermal boilers with thermal power of 30-1000 kW_{th}.

The boiler has an integrated system for flame fluidization and two serial feeding screw systems. The chopped willow wetness was 14% and the LHC 17500 kJ/kg

The flame fluidization is made by the fuel combustion in air-flow inside the combustion chamber located downside the furnace (figure 2). For higher power, the willow chops burning technology is similar to that of pulverized coal.

The hot water boilers of medium power (400 and 500 kW) are manufactured by ERPEC Company from steel plates in welded technology, with a large furnace and a sup-

plementary heat exchanger. In order to obtain a higher combustion temperature, a refractory mantle covers the furnace that contains a mobile grate. In figure 3 is shown a representation of this type of boilers, and in figure 4 the mobile grate.

Figure 1. The ERPEK boiler of 40 kW

Figure 2. The flame inside the boiler furnace

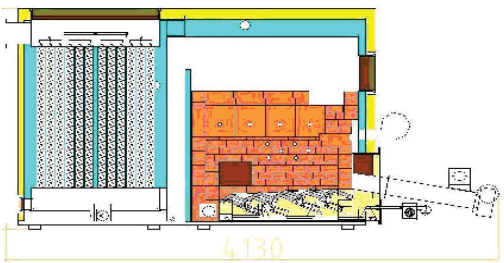

Figure 3. Representation of a medium power ERPEK boiler

Figure 4. The mobile grate of the boiler

The vertical heat exchanger is manufactured from steel tubes and is immersed in the water room of the boiler. The wooden biomass is brought by mean of a screw system, controlled by a photoelectric cell and transported by the mobile grate across the furnace floor. According to the fuel characteristics (granulation and humidity), the grate stroke and velocity are carefully adjusted. Another input of the furnace is represented by the secondary air flow, that allows not only a complete combustion, but have also a cooling role for the external walls of the boiler.

In figure 5 is presented an efficient storage and supply solution with willow chops: there are two containers supplying a common screw system, allowing the replacement of one of them (empty) with another (full). In figure 6 are shown the willow chops in a transportable container.

Figure 5. Mobile biomass containers

Figure 6. Willow chops in container

In February 2013 a test campaign revealed the efficiency and the pollutant emissions of the medium boiler. In figure 7 is presented the variation of the boiler efficiency in the range of 50-100 % power. At rated load, the efficiency is about 90 %.

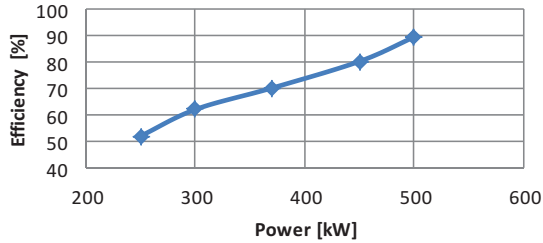

Figure 7. Boiler efficiency at part-loads

The pollutant emissions are within the environmental norms. Thus:

- CO = 10-98 mg/m^3, for O_2=11%;
- NO_x=40-120 mg/m^3, for O_2=11%;
- SO_2= 0-300 mg/m^3;
- dust <47 mg/m^3.

EXPECTATIONS FOR ENERGY GENERATION

In order to produce electricity from energy willow chops, including cogeneration, a 100-200 kW steam turbine power plant has been chosen. To exploit plantations over 30-40 ha, it appears necessary to achieve low size power plants. Such a grove could ensure the production of minimum 100 kW for about 3500 hour /year. This project aims to achieve a boiler of 1 t/h of superheated steam, which can be connected to a turbine of 100 kW. In figure 8 is shown the schema of the plant.

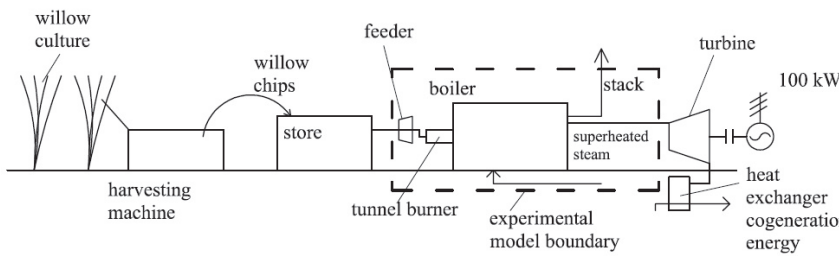

Figure 8. Complex technological flow of the plant

The scientific and technical challenge is to solve the combustion problems for the energy willow chops with the size of 0-30 mm directly resulted from harvesting in a low thermal power boiler plant. For this purpose, the boiler will have attached to the furnace a tunnel burner that will achieve about 75% of the combustion, the rest being completed in the combustion chamber that will be designed in rectangular shape, with cooled walls of the evaporator system. The boiler will be of natural circulation, with drum and, therefore, with the steam superheater in serpentine shape. Natural circulation boiler allows salts purging and, therefore, a lower level of water treatment, which is important for a local energy producer. The boiler has a modular construction, the burner provided with bunker fuel, the power system and the proper automation representing a module, and the boiler heat exchangers representing another module. The burner will have to achieve an enhanced combustion, and, because there are no cooling elements, the thermal effect necessary for ignition and combustion processes will be achieved by plating the vault with fire bricks.

The boiler must allow the exhaust and the capturing of ash. It shall be noted that ash is a useful agricultural fertilizer, which can be turned on the plantation. In figure 9 is presented a view of the boiler.

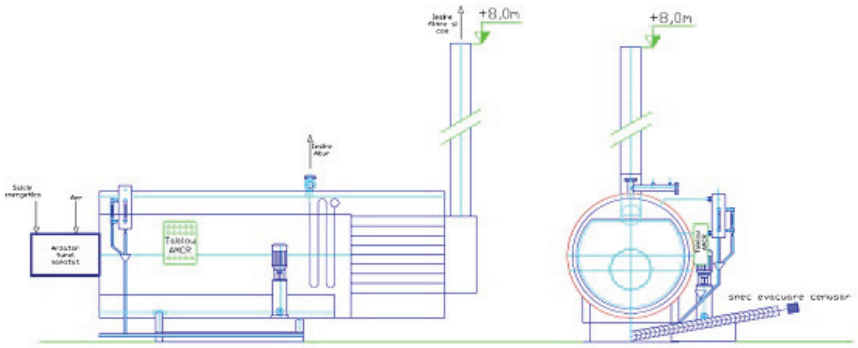

Figure 9. Sketch of the future boiler

CONCLUSIONS AND FUTURE WORK

The paper presents the achievements and the development directions in order to use the solid biomass potential in Romania, especially for the energy willow.

Our opinion is that the most difficult technical problems to be solved are those related to the transport and storage of the biomass.

If the range of 30-1000 kW of hot water boilers is well known and appreciated in Romania and abroad, a new stage should be approached, that means a power plant (1-2 t/h steam boiler + 100-200 kW_e steam turbine), located near the energy willow crops.

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About the autors

Mihaescu L., Negreanu G., Lazaroiu G., Pisa I., Berbece V., Oprea I., are professors with University Politehnica of Bucharest, Splaiul Independentei nr. 313, sector 6, Bucuresti, Romania, RO-060042, E-mail lmihaescu@caz.mecen.pub.ro, Tel. +40214029158.

Domokos A, vice-president Green Energy Association, e-mail greenenergy55@gmail.com

Bartha S., vice-president Green Energy Association, representative of SC ERPEK SA.

This paper has been reviewed.