TECHNOLOGY FOR ENERGETIC USE AND DISTRIBUTION OF ENERGY FROM BIOMASS

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ABSTRACT

This paper deals with possibilities of using biomass as a source of energy for heating and production of electricity. Firstly the paper mentions products made from biomass. The most common types of solid biofuel are pellets and wood chips. Secondly the paper describes the ways how to extract energy from solid fuels. Especially it focuses on three types of combust: burning pulverized fuel, grate firing and fluidised bed firing in relationship with co-combustion of biomass and coal.

1. INTRODUCTION

Humans used fuels from biomass as source of heat for thousands years. In developed countries biomass was replaced two years ago by fossils fuels. Fuels produced from biomass are pure renewable energy source that does not contribute to the issue of emissions of climate change. The advantage of the biomass is its local availability opposite to fossils fuels. In addition managed production of biomass assists the diversity of the landscape and care about it. Growing biomass can also help the development of the region, as due to glut of food significantly increases the role of energy crops in agriculture. [1]

2. FUELS FROM BIOMASS

2.1. Fuels

The most exploited fuels:

- poplar
- willow (also separate branches)
- wood chips
- wood waste from industry (furniture etc.)
- forest waste (fallen branches, tree barks, tree cones etc.)
- hay
- straw
- hemp
- corn
- sugarcane [2]

2.2. Pellets

Parameters

- Calorific value: 14-17 GJ / tonne
- Max. ash content: 7 %
- Max. water content: 20 %
- Max. sulfur content: 0.4 %

Figure 1 – Pellets

Pellets are produced by high-pressure molding of wood waste. Necessarily it doesn't have to be only sawdust. A sorrel or hay may be used as well. 2 % supply of pellets may contain 1 cm large pieces of soil, sand, forest soil and other natural materials. Diameter of supplied pellets is 12 mm and pellets mustn't contain any chemicals.

2.3. Wood chips

Parameters
- Minimum calorific value: 7 GJ / tone
- Max. ash content: 7 %
- Max. water content: 55 %
- Max. sulfur content: 0.4 %

Figure 2 – Wood chips

Wood chips are a product of wood waste or secondary raw material. 2 % supply of wood chips may contain 1 cm large pieces of soil, sand, forest soil and other natural materials. The size of pieces of biomass shouldn't exceed 20 cm. Total supply contains 10 % of fine fraction. Wood chips mustn't contain any chemical substances or preparations. [3]

3. TYPES OF BIOMASS BOILERS

The biomass is burned in boilers producing heat and light. The energy is converted to the heat of working medium – water or oil. Then it is utilized for heating or producing of electric energy using a turbine and a generator. Except a fuel the boiler must be fed by a constant flow of oxygen (air). Air supply can be used for partial regulation of a temperature level in the boiler. Ways for the flow of air are divided into primary and secondary. The primary way is mainly used for support of burning on a grate or the air may be mixed directly with the fuel. Secondary branch leads the air above the grate to promote complete combustion and to improve the quality of released combustion products.

The working medium can be classified according to the temperature:
- Warm water (less than 110 °C)
- Boiling water (over 110 °C)
  - Saturated steam
  - Overheated steam

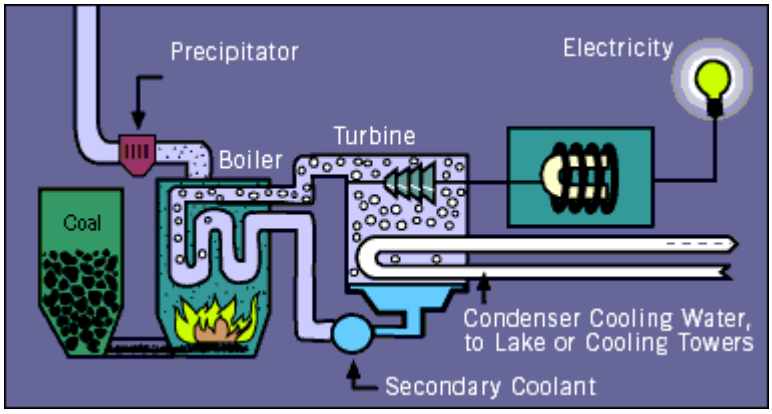

Figure 3 – Coal-fired boiler power plant diagram

The main parts of a boiler:
- Combustion place – type of a fireplace, type of a burner
- Fuel preparation part
- Unit for removing unburned pieces

- Device for heating the combustion air
- Device for transporting air flue
- Heat exchangers
  - water heater (economizer)
  - system, steam overheater, reheater (for steam boilers) [4]

3.1. Pulverized boilers

Benefit of this type of boiler is that it can burn also less quality coal. The performance and the size are the maximum possible. Firstly the fuel is pulverized into a fine powder which is transported pneumatically to the burner and combustion chamber. A hot air blows the fine powder within constantly burning. The difference of granulation or smelt type is especially in temperatures. Granulation type has lower temperature, that's why a slag comes out in solid state. Pulverized boilers are the most widely used type in energetic. [3]

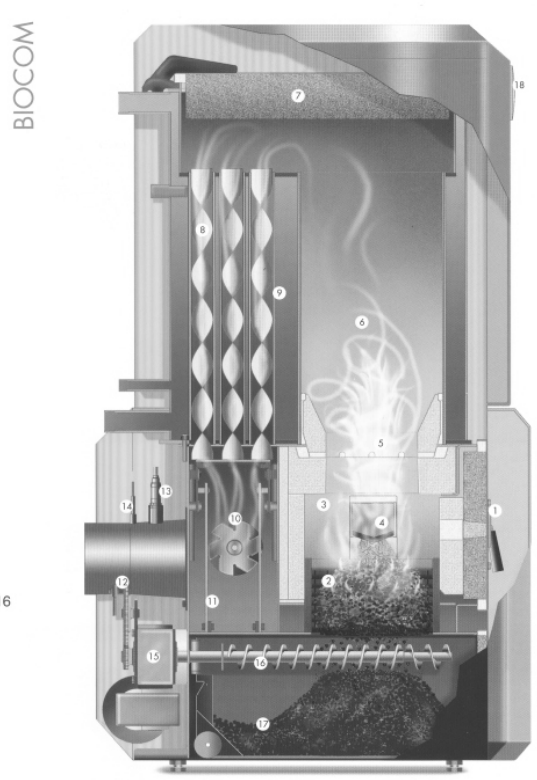

Figure 4 – Pulverized boiler

Pulverized fireplace for solid biomass combustion

Production of powder is limited and problematic. But fireplaces don't need so great performance. Pulverized boilers aren't usually devised for combusting separate biomass. A mix of pulverized coal and a biomass is used as a fuel. And the most commonly used products from biomass are pellets. Pellets are produced by pressing of milled wood or similar materials. The greatest benefits are the high calorific value 15 MJ/kg, easy manipulation and low amount of water about 12 %. Biomass is added to the furnace via separate gate up the gate for the pulverized coal. When pellets are 1-2 cm small they don't crush. Pellets are mixed with a coal in definite ratio in a boiler. Pellets are one of the best ingredients for pulverized boilers. [3]

3.2. Grate boilers

Grate firing is the oldest combustion system for solid fuels at all. Burning is realized in a layer by filtration method. The depth of the layer and its permeability for the air depends on performance. The boiler consists of a combustion chamber, which is limited by walls and front and rear arches, broiled with the fuel hopper and the fuel damper, firebridge clinker, slag hopper and feed device and air control. The mechanism is based on a grate which is consists of a support structure with grids. Some types have traction for better manipulation with a fuel and an ash. The construction shape depends on many factors, for example a calorific value of the fuel, grain size, caking, amount of the water, air input and slag output. [3]

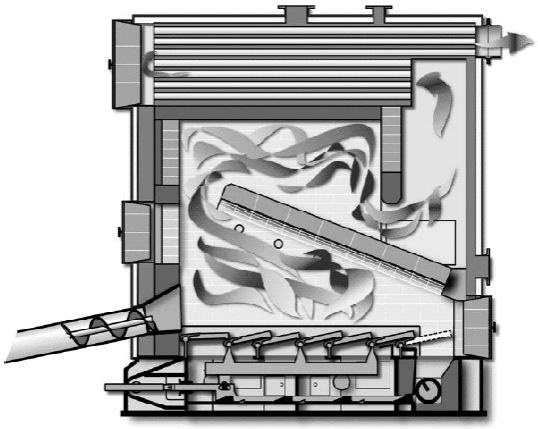

Figure 5 – Grate boiler

During the combustion a grate performs the following functions:

- Ensuring an air feeding over the entire length so as to reach the most perfect combustion
- To support the fuel of specific size and permeability
- Drying of the fuel and preheating on ignition temperature
- To remove the slag
- To control the power as needed [3]

Grate firing of biomass

Grate firing is one of the most used methods for burning biomass. It can be combusted even that biomass which wouldn't burn in a fluidized bed boilers, such as biomass with higher humidity, or with a mixture of non-combustible elements. It is usually used for lower powers and for heating rather than generating of the electricity. [3]

3.3. Fluidized bed boilers

The principle of fluidized bed boiler is based on the principle of bubbling fluidized bed or layer. A crushed fuel suspended in a hot, bubbling fluidity bed of ash and other particulate materials by jet of hot air and exhausts, which holds fuel particles in a specific layer according to its size and weight. As the particles burning, they are changing its size and rising up. This process is based on a balance between weight and aerodynamic resistance. Because of a funnel shape of the fireplace, the speed of flue gases is gradually increasing. The fuel is fed through the bottom of the fireplace screw feeder. Then the fuel is subsequently stratified to different levels according to particle sizes. Larger particles are burned in the tight part of the combustion chamber, where the air flow has a higher speed. The particles in different layers oscillate around the equilibrium position, even in the extended part of the boiler. The air is fed similarly to the grate firing – from the gaps at the bottom of the boiler. Above the lower part of the funnel-shaped bottom is a space with a constant cross-section, where the smallest particles drop. The solid combustion residues go further from the fireplace with the flue gases. [3]

Fluidized bed combustion of biomass

The principle remains similar to combustion of a coal. The biomass and the coal are mixed, so the biomass is co-combusted with the coal. Or in different case biomass can be only fuel with no additives. The most common fuel is wood chips. Pieces of wood chips mustn't exceed 2 cm due to formation of fluid layers. Larger pieces would fall down and cause some problems in fluid cloud. The main difference is in performance. The performance of fluidized bed biomass boiler is about to 60 MWt. The combustion temperature is 500°C and steam capacity is 50 t/h. [3]

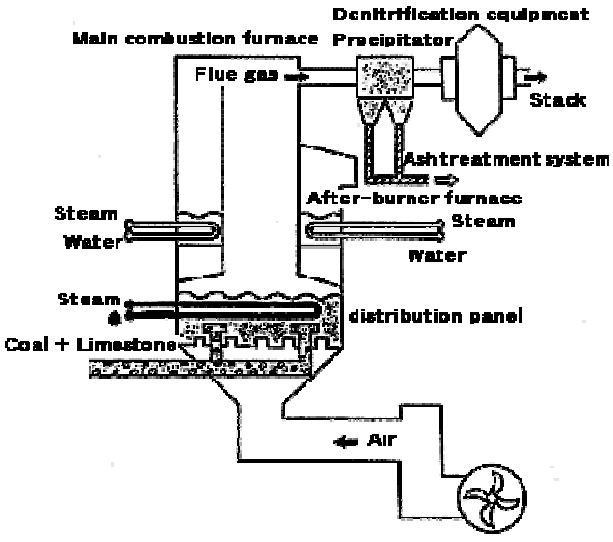

Figure 6 – Fluidized bed boiler

4. CONCLUSION

Because biofuels have smaller energy density than fossil fuels, it deals with big amounts biomaterials. This biomaterials are continuously imported from nearby areas, sometimes from farther distance about 200 km. So using separate biomass with no additive in great energetic sources has devastating impact on the landscape.
Co-combusting of biomass is profitable thanks to support of renewable sources of energy. It enables regulation of pollution in the fuel, especially amount of SO_2 emissions and residual ash can be reduced. [5]

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