TECHNOLOGIE FOR THE PRODUCTION OF PELLETS IN THE *Axel Trade 2009 Ltd.* COMPANY

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ABSTRACT. Biomass is a widely available renewable fuel that has advantages over fossil fuels, such as low sulfur and ash content. It ranks third as the world's energy resource after coal and oil and is the primary source of energy for more than half of the world's population, being able to absorb carbon dioxide during growth and release it during combustion, which is the same amount of CO_2 and helps recycle carbon in the atmosphere and does not contribute to the greenhouse effect.
The article examines an opportunity to get acquainted with the technological process in the production of pellets, considering the sources of biomass, the raw material used, and its delivery. The necessary preparation of the material before entering the main process has been studied. The process of converting the raw material into pellets was investigated. Special product standards and certification have been reviewed.

Keywords: biomass, technological process, pellets, production standards, certification.

ТЕХНОЛОГИЯ ЗА ПРОИЗВОДСТВО НА ПЕЛЕТИ ВЪВ ФИРМА „Аксел Трейд 2009“ ЕООД

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РЕЗЮМЕ. Биомасата е широко достъпно възобновяемо гориво, което има предимства в сравнение с изкопаемите горива, като например ниско съдържание на сяра и пепел. Тя се нарежда на трето място като енергиен ресурс в света след въглищата и нефта и е първичен източник на енергия за повече от половината население на света, като може да поглъща въглероден диоксид по време на растежа и да го отделя по време на изгарянето, което е същото количество CO_2 и спомага за рециклирането на въглерода в атмосферата и не допринася за парниковия ефект.
В статията се разглежда възможност за запознаване с технологичния процес при производството на пелети, като са разгледани източниците на биомаса, използваната суровина и нейната доставка; проучена е необходимата подготовка на материала преди постъпването му в основния процес; изследван е процесът на преобразуване на суровината в пелети; направен е преглед на специалните продуктови стандарти и сертифициране.

Ключови думи: биомаса, технологичен процес, пелети, продуктови стандарти, сертифициране.

Introduction

Biomass is a widely available renewable fuel that has advantages over fossil fuels, such as low sulfur and ash content. It ranks third as an energy resource in the world after coal and oil (Bapat et al., 1997).

Biomass of plant origin can absorb carbon dioxide during growth and release it during combustion, which is the same amount of CO_2 and thus helps recycle carbon into the atmosphere and does not contribute to the greenhouse effect. All this means that biomass burning is carbon neutral (Klason and Bai, 2007).

Biomass fuels, including wood, wood waste, straw, manure, sugarcane, and many other by-products of various agricultural processes are still the main source of energy in much of the developing world.

The subject of the present study is familiarisation with the technological process in the production of pellets.

To achieve the goal, the following tasks from the technology of pellet production have been solved, such as:

- The sources of biomass, the raw material used and its delivery were examined;
- The necessary preparation of the material before entering the main process has been studied;
- The process of converting the raw material into pellets was studied;
- Special product standards and certification were reviewed.

Theoretical part

1. Sources of biomass

Biomass feedstocks include special energy crops, agricultural crops, forest residues, aquatic crops, biomass processing residues, household waste, and animal waste (http://www.seps.sk/zp/fond/dieret/biomass. html; Madadian et al., 2012).

One of the most common and effective ways to apply biomass is by increasing its bulk density, which can be achieved by mechanical or thermochemical compaction (Abdoli, 1984). The possible advantages of densified biomass are as follows:

- Burning rate can be comparable to that of coal;
- Burning is possible in grate-fired boilers;
- Even combustion can be achieved;
- Particulate emissions can be reduced;
- Possibility of spontaneous combustion in storage is reduced;
- Transportation and storage become more efficient (Balatinecz, 1983)).

Generally, any process that results in lower physical density and higher energy density can be considered a densification process. Compaction increases the bulk density of biomass (40–200 $\frac{kg}{m^3}$ / 600–800 $\frac{kg}{m^3}$) and improves handling, transport, storage, and combustion properties and improves shape regularity. Densified biomass can be in the form of pellets, briquettes, bales, pucks, sawdust, charcoal, and bio-oil (Nalladurai et al., 2009).

A decisive criterion for the fuel properties of the energy source is its level of drying, as well as the moisture content of the fuel. In order to be able to calculate and compare these characteristics, two physical measurement parameters have been introduced – water content (w) and fuel moisture (u).

The water content (w) is obtained from the crude mass. It expresses the water in the biomass and combines the dry biomass m_B and the water content m_W in it:

$$w = \frac{m_w}{m_B + m_w}$$

In contrast, the fuel moisture u (= moisture content) is obtained on the basis of its dry mass. It is defined as the mass of water (m_W) present in the fuel, referred to its dry biomass (m_B):

$$u = \frac{m_w}{m_B}$$

Fuel moisture (u) can be converted to water content (w). For example, 50% water content corresponds to 100% moisture in the fuel. Moisture values above 100% are therefore possible.

In practice, the water content (w) is usually calculated in the energy sector.

The calorific value of wood decreases linearly as its water content increases, as shown in Figure 1.

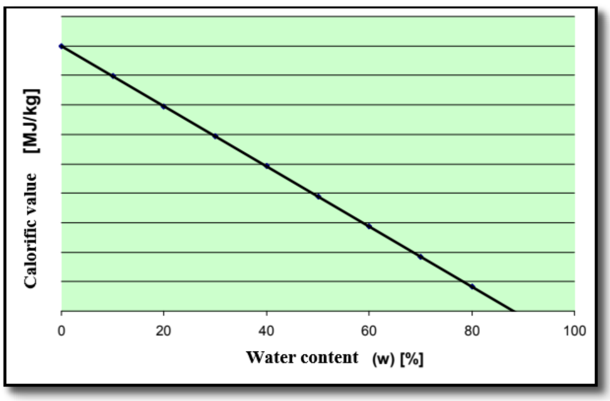

Fig.1. Dependence of the fuel's calorific value on its water content

The values of the calorific value and heat of combustion parameters are important data for the properties of the fuel. Calorific value H_u (lower heating value) indicates the amount of heat that is released during the complete combustion (oxidation) of the given fuel. This value does not include the so-called heat of condensation (heat of vaporisation) of the water vapour contained in the exhaust gases. Almost the same amount of heat is required for evaporation as would be given off for condensation, i.e. the calorific value H_u decreases with increasing water content.

Unlike H_u, the heat of combustion H_o (higher heat value) is actually the heat that is released during combustion, but also includes the heat of condensation of water vapour released during combustion that can be used.

For solid biofuels, the heat of combustion is higher than the calorific value by about 6% (bark), 7% (wood) or 7.5% (agricultural produce) on average.

2. Palletisation plant.

2.1. Technology.

The production of wood pellets involves the application of various types of equipment besides proper process and method. Typically, the production of pellets includes the following steps: raw material supply; screening of pollutants from the raw material; coarse grinding of wood; drying and possibly repeated intermediate storage; hammer milling; conditioning; pressing of the raw material; cooling of the pellets; filtration of fine particles; storage; packaging; delivery of the pellets.

Figure 2 is a schematic view of the aforementioned processes linked together to form a pellet plant.

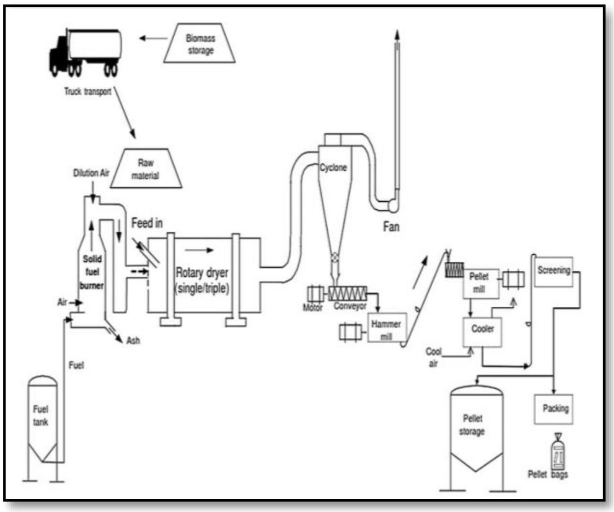

Fig. 2. General diagram of a pellet plant

2.2 Special product standards - three quality classes (A1, A2, and B) are defined for wood pellets. On the fuel market, the highest quality of pellets is class A1. To meet this level, wood pellets must fulfill, among other things, the following conditions:

- They must be produced only from unprocessed chemical raw materials;
- The length and diameter of the pellets must be within the prescribed limits;
- The moisture content must amount to a maximum of 10%;
- The ash content must not be more than 0.5%;
- Pellets must be particularly resistant to abrasion. The proportion of dust particles in them (i.e. particles with a diameter of less than 3.15 mm) in a given batch should not exceed 1%. In addition, maximum content values of various elements (nitrogen, sulphur, chlorine, heavy metals) are prescribed.

Practical part

For practical application of the theoretical part of the present development, the production process in the *Axel Trade 2009 Ltd* company will be considered.

The wood used to make the pellets is taken from nearby forest clearings. Unprocessed logs are delivered to the premises of the processing plant by means of heavy-duty trucks. Upon entry to the site, they must be weighed using a scale. Once the truck enters, it is guided to the unloading area, where specialised machines assist in unloading and later loading onto the assembly line. Before entering the main process, the raw materials must go through a process of screening and coarse grinding. After this stage, the raw material obtained is of relatively uniform size pieces. The raw material formed after coarse grinding is transported for storage in the wet product hopper, which is shown in Figure 3.

Fig.3. Wet production hopper

A belt conveyor is used to feed the wood to the next stage of the production process – the drying system.

The material is transported into the drum shown in Figure 4 by a screw feeder or chute, and the speed is controlled using sensors.

Fig.4. Tumble dryer (front) and chute (rear)

The continuous rotation of the housing and its inclination cause the material to move towards the exit end. The dried material is discharged from the cyclone at the end of the dryer and stored in the dried material hopper (Fig.5).

Fig.5. Discharge cyclone and hopper for dried material

A 4 MW stove is located parallel to the wood chipping process, which provides the necessary heat for the dryer to process the wood.

The next step is moving to the fine grinding process to reduce the particles to the desired size. The material is moved by means of a screw conveyor shown in figure 6 and is poured directly into the hammer mill.

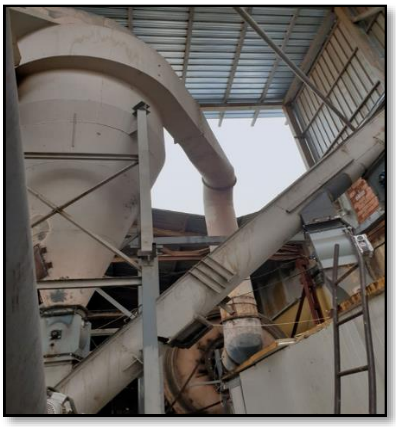

Fig. 6. Screw conveyor to hammer mill

After breaking the raw material into fine particles, they are drawn out by means of an air flow generated by a reverse cyclone (Fig. 7) and thus the fine material reaches the conditioning process.

Fig. 7 Reverse cyclone

In the conditioning chamber, the raw material is mixed at a high speed together with other admixture until the desired result is achieved. The higher speed results in better mixing of the raw material and additives. On the other hand, in order to minimise crushing and abrasion, the speed of the agitator should be kept as low as possible.

From the conditioning process, the mixture is routed and distributed between three pellet mills, one of which is shown in Figure 8.

Fig. 8. Pellet mill

The total combined output of the machines is approximately 2.5 tons per hour, nearly 60 tons per day, and over 20,000 tons per year. After the mixture is pressed into the desired shape, the finished granules are sucked from the mills through return pipes and down through discharge pipes to the equipment for the next stage of cooling.

The materials entering the cooling section are pellets and fines generated in the previous sections. During the cooling process, the pellets are air-cooled to the desired temperature and moisture content, thereby reducing their brittleness. Air flow in the cooling process can pick up smaller particles and larger particles remain with the pellets. Both types of generated fines (carried by air flow or remaining with the pellets) must be separated. On leaving the cooler, they go through a rapid pressing process using vibrating screens, as shown in Fig. 9:

Fig. 9. Cooler with a vibrating screen

This serves to screen the quality output from the defective one when dropping the pellets into the cooler, as well as to take it to the transport conveyor belt, illustrated in Figure 10, and the elevator. The air used to cool the pellets leaves the cooler containing fine particles and enters the dust collection system where it is cleaned through filters.

Fig. 10. Belt conveyor

The last step of the production process is the packaging of the produce. The packaging system includes a conveyor belt, a hopper, a dosing filling system, and weighing scales. The pellets are fed into the hopper by a belt conveyor, and the dosing filling system shown in Figure 11 controls the feed flow into the bag.

Fig. 11. Dosing filling system

Pellet packing equipment fills the bags based on the desired weight. The bags then move along a conveyor to the sealing station where each bag is sewn shut. At the end of the process, the bag comes out sealed and is unloaded.

Main findings

The report examines a technology for the production of pellets, considering the sources of biomass, the raw material used, and its supply. In addition, the necessary preparation of the material before entering the main process is studied and the process of converting the raw material into pellets ~~was~~ discussed. Special product standards and certification have been reviewed.

Conclusion

The article describes a technology for the production of pellets and shows the equipment for its implementation.

The presented solution is a complement to the existing technologies for the production of pellets. This solution can also be extended to produce other types of compacted biomass.

Future research on the topic will includes optimisation of some stages of the technology described.

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