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## Briquetting and pelleting the biomass – protection from fire and explosions

*Introduction of technologies that will produce up to 20% of energy from renewable sources is task that was set before our and all the other countries in the region, that aspire to EU accession. Biomass and production of briquettes and pellets are great advantages of our region. Production process has been processed throughout many studies, and this study focuses on safety and protection from adverse events that could occur during process.*

*With proper implementation of all precautions from aspect of work safety and fire protection, proper performance of all technical details during work on the machines and during assembly of the equipment, along proper electric installations, proper handling and maintaining equipment and also with strict adherence to the prescribed work guidelines, it can be considered that fire hazards and explosive hazards are eliminated, or diminished to a minimum. That means that these hazards are not present in normal work conditions and that they can only arise due to certain irregularities during work.*

*Prevention measures and their key aspects must be part of any serious study and technical-technological documentation.*

**Key words:** briquetting, biomass, fire prevention, explosion

### INTRODUCTION

Due to the diversities of raw material mainly consisting of wheat, barley, oat or rye straw, cornstalks, hay crops, residue of sunflower stalks and husks, pruning of fruit and vineyards, forest biomass, wood waste in wood processing etc., a complex machine technological procedure is involved in briquette making [1].

The importance of briquette making, in particular, has increased in recent days, when there has been experienced the increased shortage and price increase of oil and gas as conventional fuels. At the beginning, bio briquettes were mainly experienced for solving problems of waist surplus in some production areas like wood processing and others. Those industries used briquettes as energy sources. Today, biomass is increasingly used not only as an important indigenous energy source for production, but also as a commercial energy substitute for numerous users including consumer goods [2,3].

Following characteristics can be stated for this technology and its products:

1. Existence of huge source of renewable raw materials,

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2. Average bulk density of briquettes range from 900 and 1100 kg/m<sup>3</sup> and the possibility of a suitable packaging (foil, boxes, etc.) allows easy manipulation without contaminating the environment and the staff at work [1],
3. Caloric value of briquettes, depending on the raw material, is ranging from 14000 to 18000 kJ/kg pointing to be similar to a good type of brown coal [1],
4. Briquette combustion is very good, practically without smoke and no sulphur emissions, accompanied with low ash content, 2-3%,
5. Waste from the food industries (brewing spent grains, sediment sludge from oilseed processing, waste from the milling industry, withdrawn bread etc.) is a convenient raw material for briquette production for animal feed [4-8].
6. In plants for separation of waste after separation, organic waste comprise over 60% in the morphological composition therefore it can be used in briquetting process [9],
7. Existing combusting plants (various types of furnaces in households, smaller systems for heating buildings and manufacturing plants, etc.) enable the broadest application and use of briquettes as a source of heat,
8. Technological and technical concept simultaneously resolves: collection, transportation, preparation, drying, briquetting and packaging of final products,

9. Market demands provide opportunities for practically unlimited amount of briquettes on both domestic and foreign markets and achieved sales prices provide a good cost-effectiveness of production and also a positive accumulation.

#### PROTECTION FROM FIRE AND EXPLOSION

Fire protection measures, in accordance with running norms, are provided in plants for briquetting and pelleting. Risk of explosions must be defined from many aspects because although the explosions are very rare in this type of facilities, but when they occur, they cause catastrophic consequences usually with human losses and regularly with great material damage.

With proper implementation of all precautions from aspect of work safety and fire protection, proper performance of all technical details during work on the machines and during assembly of the equipment, along proper electric installations, proper handling and maintaining equipment and also with strict adherence to the prescribed work guidelines, it can be considered that fire hazards and explosive hazards are eliminated, or diminished to a minimum. That means that these hazards are not present in normal work conditions and that they can only arise due to certain irregularities during work.

If the fire breaks out in some dusty part of the plant, that doesn't mean that it will end up with the explosion, unless all the other factors are not present at a given moment that complexly cause the occurrence of the explosion. The most important factors for the occurrence of dust explosion are:

1. Type of dust - by origin, by chemical composition, by particle size distribution, by flammability characteristics,
2. The concentration of dust in the air,
3. Dust moisture,
4. Source of ignition, i.e. initiating spark.

#### TYPE OF DUST

Dust is by origin inorganic and organic. Dust of the ground, sand, etc. comes in object with raw material, while wearing some of the construction elements, additional forms of inorganic dust appear derived from cement, wall paints and similar materials. Organic dust arises mainly from basic raw material, i.e. wood or by comminution secondary agricultural raw materials.

Dust is typically mixture of inorganic and organic dust. Ratio of inorganic and organic dust in mixture is variable and normally the percentage of

inorganic dust is greatest on received place (unloading), and going further with receiving line, drying and comminution, it gradually decreases. As the explosiveness of dust increases as the ash content decreases, it should be considered that going from place of unloading explosion hazard increases onward.

Particle size distribution of dust is very influential factor on dust explosiveness. It is be considered that the dust is addicted to explosion if it has particle size less than 100 microns, and it is particularly dangerous if has particle size less than 60 microns.

On the places where dust is creating, clouds of dust consisting of very small airborne particles (aerosols) present hazard because they can lead, with beneficial influence, to primary blast. Shock-wave of primary blast will whirl up dust sediment in immediate area and will cause chain explosions with constant increase of explosive pressure and destructive power. From this viewpoint it is very important to prevent the creation of general dustiness in object and dust sediment on the walls, floors, cantilevers, machines and installations.

#### THE CONCENTRATION OF DUST IN THE AIR

The dust, as the flammable material, can burns in a variety of forms, from smoldering of sedimentary layer of dust, to the explosive burning. Between these two cases the turbulent dust in the air as a flammable mixture burns "regularly". According to the up to now published expert data, it may be noted that this area is still insufficiently studied, but based on the available data it can be carry out the following approximate conclusion:

1. For smoldering wood dust deposited layer thickness of 5 mm characteristic temperature is between 330 °C and 4700 °C. It should be noted that longer wood heating at lower temperatures produces a layer of pyroform coal because the temperature of 1300 °C already considered hazardous and under certain conditions it may exceed in the self-ignition.
2. Temperature of approximately 3000°C represents a critical self-ignition temperature of vegetal dust layer, thickness of 5 mm.
3. For the ignition of turbulent vegetal dust characteristic temperature is approximately 450°C, where depending on other factors, the flame front moves at a speed of 10 to 25 m/s.
4. The process of formation and development of wood burning is conducted in 6 characteristic phases:

Phase 1 - up to 80°C - water evaporation (drying)

Phase 2 - 80-160 °C - flammable gas developments as a consequence of the destruction of wood cells

Phase 3 - 150-270 °C - combustion of flammable gasses and resins with the appearance of flame and surface carbonization

Phase 4 - up to 300 °C - combustion of surface layer with equally rise of the internal temperature followed by mechanical disintegration of wood and creation of new burning surfaces

Phase 5 - 300-600 °C - overheating of the insulating, boarded layer and further destruction of wood material

Phase 6 - above 600 °C - intense burning with complete destruction of wood material.

5. For the explosive ignition of the vegetal dust cloud, the temperature above 800°C is needed. Rate of the explosive burning of dust cloud is several hundred meters per second, whereat the pressures of the explosion can reach destructive values.

As an indicator of wood combustion rate, serves the data of flame spreading rate which is about 2 m/min. Flammability, rate and intensity of burning is largely depend on the particle size of wooden mass, so it is much easier to ignite finer wood particles and intensity of burning will be higher because pulverous wood can reach combustion rate of 400 kg/m<sup>2</sup>/h developing flame temperature of about 1300 °C.

The most influential factor on the form of the dust combustion is the concentration of dust in the air. There is a certain area of the explosive concentration, typically for the dust, which range between lower and upper limit of the explosive concentration. Maximum pressures of exploitation appear at medium value of the explosive concentration, however in the light of explosion hazards and safety in this type of the facilities, there must be ensure by preventive measures that level of dustiness of the air be below lower limit of the explosive concentration.

At moisture content of 6.3% and particle size of 60 microns the lower limit of the explosive concentration of wood dust is 30 g/m<sup>3</sup>.

At reduced water content in the pulverous material (too dried) due to some irregularity in the work, the lower limit of the explosive concentration is lowered at 22 g/m<sup>3</sup>.

As the work places maintain at considerably lower level of dustiness (microclimate mode) using technical solutions with coherent preventive and in accordance with work safety standards, they can be considered safe.

## DUST MOISTURE

As the moisture content of dust is lower, the danger of the explosion is greater. It is considered that the dust with moisture content of 6.3% is very eligible for the explosion. It is essential to emphasize that afore mentioned moisture content can be expected under normal conditions.

Under the term of normal moisture means average technological moisture. The term "average" means that some particles may have higher or lower moisture than normal.

By friction of moving mass, just those driest and most critical parts will, by crushing and comminution, form the dust with few percents lower moisture content than normal. So it is notably recommended to reduce handling to a minimum, to perform transport on the shortest conveyor lines or in other words, to reduce internal friction in grainy mass to the minimum.

## SOURCE OF IGNITION

When all the previous requirements met in a part of the facility, in order to the set of circumstances that led to catastrophic consequences, there is a need for an ignition source or initiating spark of sufficient intensity and duration. Possible ignition sources are mainly: open flame, electrical devices and drive units, static electricity and mechanical friction.

Under an OPEN FLAME as a cause of ignition means all the types of open fires, gas and electric welding, matches and smoking, outdoor heaters and electrical resistors etc. Dust deposited on a surface heated above 200 °C will start smolder, and it may cause ignition of dust clouds. Particularly great danger represents electric lamps without protective glass as proper fitting. For this group of risk, the proper prevention is conclusively important for the safety from the explosion.

ELECTRICAL DEVICES AND DRIVE UNITS can be the cause of the creation of initiating spark. Electrical devices and drive units such as electric motors, electromagnets, motor reducers, micro-switches and other electrical devices must be made at the appropriate level of care, according to the regulations for this type of facility.

STATIC ELECTRICITY may present a very great danger. Area of creation an electrostatic charge is very broad, and describing it would require a lot of space. It is important to highlight that the efficient nullification of electrostatic charge must be ensured.

Mechanical friction as a source of the ignition due to temperature rising, has very wide diapason of dangers such as: the presence of ferromagnetic impurities in bulk, slipping of the drive rollers on the belt conveyors, improperly deviations of parallelism and coaxiality of the axis which cause additional bearing and heating load, etc.

Safeness from unwanted consequences can be achieved if the facility has been properly installed, maintained during exploitation and if maximum application of preventive measures is ensured as well as control over the implementation of them.

## CONCLUSION

The use of biomass for heating buildings is a technique that is known to man since ancient times. This technique has not been started in a large part due to its energy inefficiency compared to fossil fuels. Facilities for the production of briquettes and pellets require a great financial investments, but they are not securing the return on investment because the inefficiency of the old facilities. Without profitability, the development and modernization of the plants for briquetting and pelleting was missing. Increased efficiency of plants for briquetting and pelleting was achieved with the introduction of the bed boiler with a fluidized combustion in the liquid ash regime as well as with highfrequent drying in the increased under pressure regime. Hereby is provided a quality product, high-energy usage of raw materials for heating, production of small amounts of ash (between 1 and 2%), utilization of thermal energy from the production facility that was losing so far through the exhaust system, drying wet raw material to the required level of moisture, the full automation of the production process and the necessary protection as the humans as the environment in which the plant operates. Protection of people, environment and property is goal in every technical and technological system, including this one for briquetting and pelleting.

This study provides necessary fire protection measures in accordance with applicable regulations. Risk of dust explosion is explained in many aspects, in order to achieve a higher level of prevention, because the explosions are very rare in this type of facilities, but when they occur, they cause catastrophic consequences usually with human losses and regularly with great material damage.

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## IZVOD

### BRIKETIRANJE I PELETIRANJE BIOMASE – ZAŠTITA OD POŽARA I EKSPLOZIJA

*Zadatak koji je postavljen pred našu zemlju i sve zemlje u regionu, koje streme ulasku u EU, je uvođenje tehnologija koje će proizvesti i do 20% energije iz obnovljivih izvora. Biomasa i proizvodnja briketa i peleta su velike potencijalne prednosti regiona. Sam proces je kroz više radova obrađivan, a ovaj rad je osvrst na bezbednost i zaštitu od neželjenih događaja u toku procesa.*

*Pravilnom primenom svih preventivnih mera sa stanovništva zaštite na radu i protivpožarne zaštite, pravilnom izvedbom svih tehničkih detalja na mašinskoj tehnološkoj opremi i pri montažnim radovima, pravilnom izvedbom elektroinstalacija, strogim pridržavanjem propisanih pravila za rad, pravilnim rukovanjem i održavanjem opreme ispravnom stanju u funkciji kompleksnog postrojenja, može se smatrati da su požarne i eksplozivne opasnosti eliminisane, odnosno svedene na minimum. To praktično znači da ove opasnosti nisu prisutne u normalnim uslovima rada i da one mogu nastati samo usled izvesnih nenormalnosti u radu.*

*Mere prevencije i svi ključni aspekti moraju biti deo svake ozbiljne studije i tehničko-tehnološke dokumentacije.*

***Ključne riječi:*** briketiranje, biomasa, zaštita od požara, eksplozija

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