Annals of Warsaw University of Life Sciences – SGGW
Forestry and Wood Technology No 72, 2010: 261-264
(Ann. WULS-SGGW, For and Wood Technol. 72, 2010)

Improvement of Industrial Equipment for Wood Biofuel Production

A.O. SAFONOV[1], V.V. BELYKH[2]
The Dean of the faculty of wood processing technology of Voronezh State Academy of Forestry and Technologies,
8, Timiryazeva str, Voronezh, Russia.
Head of procurement and marketing department of Department for Presidential Affairs of Federal State Unitary Enterprise "Construction Association", Arkhangelskoye, Krasnogorskiy dist., Moscow region.

Abstract: *Improvement of industrial equipment for wood biofuel production*. The article is devoted to development of the system of automatic equipment control. Research has been referred to increase of technical and economical effectiveness of biofuel production. Energy saving for pressing is 30-35 %. In aggregate all the advantages provide sufficient of general technical and economical effectiveness of the process.

Keywords: biofuel, equipment, process, technology, wood.

Quantity of small-scale enterprises in the world is growing, volume of processed wood is increasing every year. In connection with it, the question of target processing of the waste materials into biofuel [1]. However special-purpose equipment for processing of dispersed wood waste into biofuel is rather expensive and needs additional expenses, connected with its maintenance. Such inputs are low-profit for most of middle and small wood processing enterprises. At present, a following tendency is marked: lines, which are used in agriculture for pelleted feeds production, are being re-equipped, for getting wood biofuel [2]. Such a complex, intended for pelleting grasses, as a rule, can be equipment, examined in this article. This equipment includes: drum drier with loading conveyor, mill for refinement, bunker, press-granulator, quenching chamber. While installing specialized matrix with ruggedness, necessary resetting of drier drum and including the second additional mill into the line, the complex manages to granulate dispersed wood waste into quality biofuel, in conformance with EU standarts.

During the research the analysis of the current automation system has been made. Controlling of batcher, conveyor, getting raw material into a bunker, transfer conveyor of hot granules, conveyor of cooled granules, bunker fanner, feeder screw, screw conveyor of non-granulated mass, quenching chamber and non-granulated mass blower is made form the control board. Registration of rotation frequency of a screw conveyor and current strength in a chain are displayed in a control board. Switching on of all above-mentioned equipment is made manually with the help of buttons "On/Off" on a control board. Necessary rotation frequency of feeder screw is driven by hand on a board of electronic frequency converter, built in control board.

However, such production is non-fireproof and quality of biofuel (wood pellets) widely varies, depending on different factors, which can be divided into controlled and uncontrolled.

Controlled regulated parameters of technological process are: speed of supplying wood shavings, rock compound of raw material, moisture of supplying shavings, temperature of press matrix, breakup of raw material.

Uncontrolled parameters are: atmospheric humidity, atmospheric temperature, raw material temperature.

In this case, output parameters of technological process, characterizing production effectiveness, are as follows: combustion value of the pellets, prime costs, useful output of final product, crumbliness.

We examine influence of output parameters on technical and economical rates of the process. Speed of supplying depends on raw material characteristics – its humidity, fractional

structure and matrix temperature. When the moisture of raw material is higher (more than 10%), it is recommended to increase speed of supplying to reduce intensiveness of moisture processing.

In this case, when average raw material fraction size exceeds 3 mm, speed of supplying must be reduced for necessary strength of finished pellets. When matrix temperature is not enough (less than 50^{o}C), speed of supplying must not be high. It is connected with the difficulty of lignin plasticization in raw material.

Lignin, contained in wood, is a binding agent while pressing. During the pressing process raw material goes through press matrix, which highly heats because of roller friction on matrix, so the lignin in wood melts. After pellets go through cooling operation, lignin hardens again and provides necessary strength of final product.

Moisture of supplying shavings defines final moisture of pellets and, as the result, their strength. When raw material is hypermoistured (more than 16%), it is difficult to lead technological process, because the pellets really go-off from matrix.

If moisture of raw material, supplying into press is 12 – 15 %, when ready pellets are crumb, unstrengh and can not be qualified final product. If moisture of raw material is less than 7 %, pellets also don't have necessary strength characteristics. It can be explained by lack of binding moisture for lignin, necessary for strength link of wood compounds. Lack moisture of raw material can be compensated by moisture processing.

Raw material breakup essentially influences on technological process efficiency. Than less the breakup, than higher the efficiency. For getting nominal efficiency, size of particles at input on line of drying and reducing must be not more 25x25x1 mm, and at the output in press-granulator - 2x1x1 mm. In connection with it, at enterprises there are hammer mills for getting necessary breakup compound from large waste materials.

Press matrix temperature, during the production process varies from the temperature of environmental air till 95 ^{o}C. Matrix heating takes place under the influence of high pressure and friction on matrix walls of pressing valves in production process. It defines melt intensiveness of lignin and quantity of biofuel.

Combustion heat is a quantity of heat, escaping through a full firing of 1 kg of wood. This index depends on density of biofuel, i.e. quantity of wood in unit of volume.

One of the main characteristics of effectiveness of most productions is prime cost (C), which depends on energy consumption (C_e), needed for equipment functioning, transport and storage cost of raw material (E), divided by volume of final product (V):

$$C = \frac{C_e + E}{V}, \text{€} \qquad (1)$$

Energy cost is calculated according to a formula:

$$C_e = \left(P_g + P_s + P_{ct} + P_f + P_{tc} + P_{tb}\right) \cdot C_{kh} \qquad (2)$$

where P_g – granulator power consumption; P_s –power consumption of a screw, getting raw material into granulator, kilowatt; P_{ct} –power consumption of transporter, getting raw material into bunker, kilowatt; P_f –poaer consumption of a fan in quenching chamber, kilowatt; P_{tc} – power consumption of transporter in quenching chamber, kilowatt; P_{tb} –power consumption of transporter, which move made pellets from press to big-bagy, kilowatt; C_{kh} –cost of energy unit, €.

Useful output of biofuel is quantity of production divided by whole volume of raw material. This characteristic is very important for evaluation of whole effectiveness of the process of fuel production. It depends on losses volume and quantity of defective goods.

Crumbliness is a characteristic of final granulated product to destroy under the influence of external factors. This characteristic is important for biofuel transporting to a consumer. Biofuel must keep initial size and form, what is a condition of effective automation of boilers for its firing. In other case, fuel delivery into fire chamber may be break and, as the result, firing process is broken too. In this case, volume of heat energy, getting in a time unit, is not stable, what can lead to irregularities in a heat supplying system.

Take into account this number of factors, influencing on technological process, is possible only using automation control system over the granulating process. The following scheme of automation control system over the granulating process of dispersed wood raw material into biofuel is suggested (fig. 1).

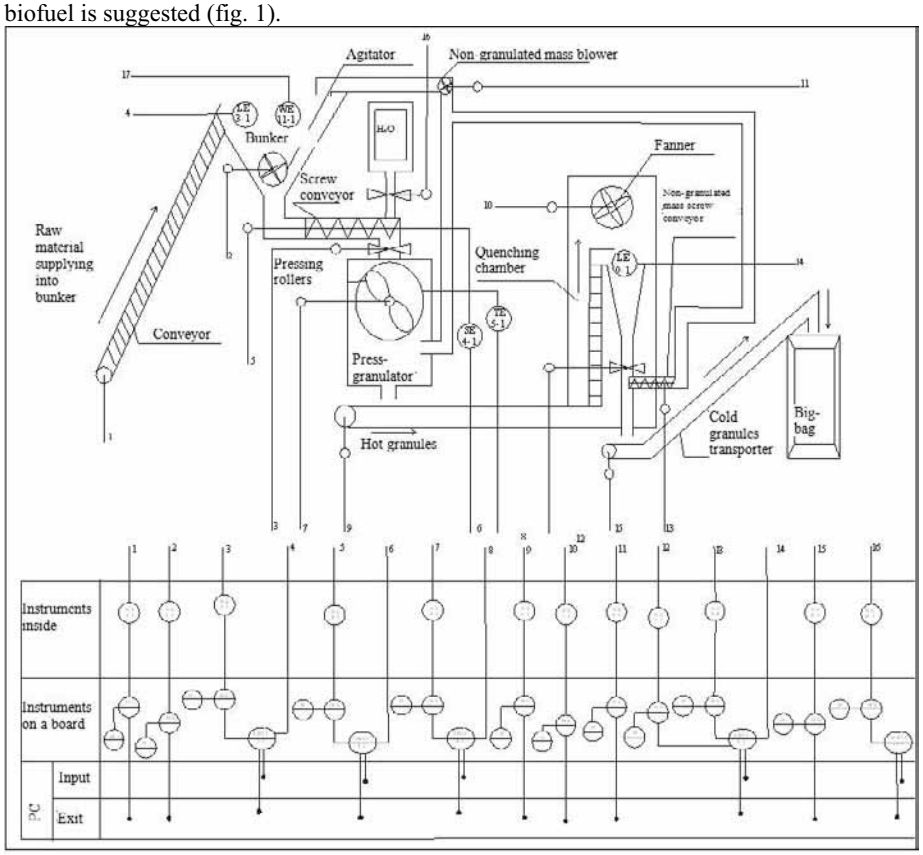

Fig.1. Scheme of automation of technological process of granulation of reduced wood raw material.

Complex action begins from conveyor energizing, which supplies granular wood materials into bunker. At the same time agitator, which prevents packing of supplied material, switches on. When the bunker gets the necessary level of raw, press rolling automatically turns on. Matrix heating occurs in several minutes. After this time passes, automatically and sequentially electric motors of non-granulated mass blower, conveyer, which provides transporting of hot granules into quenching chamber, chamber blower switch on. At the same time the valve, supplying raw materials into press, opens. In dependence with working condition, the necessary rotation frequency of screw conveyer, supplying raw

into press, is installed with the help of frequency regulator. For preventing fire risks, connected with smoldering of upper layer granules at press output, an automatic matrix temperature decreases, which heats under the influence of high pressure and friction force between press rollers and matrix. Automation system previews constant temperature changes of matrix during processing. If temperature override the accepted value, rotation frequency of press rollers automatically increases, what leads to decreasing of matrix temperature. So, fire risks in manufacturing is lowered.

Quantity of finished granules directly depends on moisture of granular wood particles, supplying in press granulator. When this value is exceeded, finished granules have higher index of crumbliness and looses necessary characteristics while transporting. When the moisture contain is not sufficient, lignin, being a cohesive material, doesn't spread uniformly in all raw material mass and finished granules are fragile. Besides, in this case, matrix wear is high, because of raised friction between raw and cavity. Thus, humidity detector of granular materials is installed and according to its measurement results, water supplying into screw chamber is regulated before pressing operation. Thus, automation system provides the best humidity value of raw, supplying into press granulator. The system provides it in real time mode, without suspension of production and independently of equipment functioning.

As it was mentioned above, at the press output, granules are fragile and contain large quantity of residual moisture. Because of it they are sent to quenching chamber. When supplied granules get the ceiling level in a bunker of quenching equipment, control signal is given for opening of actuating mechanism, discharging cooled granules on a conveyor and for opening screw conveyer, off taking non-granulated mass. At the same time control signal is given to a conveyor electric motor, moving the finished granules into packing bags – big-bags.

Thus, suggested method of automation control under the process of biofuel production from granular raw materials supports safe functioning of all equipment. Suggested system allows to provide defined moisture of finished product, and also to exclude smoldering of upper layer granules, what increases the quantity of biofuel. The way of automatic control expects energy and resources saving, which are used in processing. According to preliminary estimates, energy saving in press processing of different materials is about 20%. In a whole, all above-mentioned advantages provide general efficiency, increase technical and economical effectiveness of the process.

REFERENCES

1. http://biofuel.by/ru/pellets_made/ogm15.
2. Rasev, A.I. Some usage problems of wood waste materials in fuel granules production [Text] / A.I. Rasev// BIOENERGETICS. – 2007. - № 2(7). – pp.40-41.

Streszczenie: *Unowocześnienie aparatury do przemysłowej produkcji biopaliw.* Artykuł prezentuje rozwój sstemu automatycznej kontroli produkcji, z naciskiem na poprawę technicznej i ekonomicznej wydajności produkcji biopaliw. Oszczędność energii na prasie wyniosła 30-35 %. Ujmując całościowo, wszystkie unowocześnienia dająwyniki wystarczające do zastosowania w procesie produkcyjnym.

Corresponding author:
The Dean of the faculty of wood processing technology of Voronezh State Academy of Forestry and Technologies,
8, Timiryazeva str, Voronezh, Russia.
E-mail address: aosafonov@gmail.com (Andrey Safonov).