

Software for Automated Production Line of Peat Briquettes

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Abstract. The article examines the software development of peat briquette production. Integrated peat development is one of the important tasks of peat industry. The importance of peat as local raw material increases with the increase in demand for various products. The production efficiency can be improved with new automated peat processing technologies based on advanced engineering. In view of market and technology requirements the peat industry development is hampered by slow development of automated peat processing and utilization technologies. The acceleration of technological progress can be achieved by designing automated lines of advanced peat processing. In accordance with this mission the development of technological process monitoring parameters is of great importance thanks to the possibility of end product physicochemical properties being predicted and managed to make efficient use of peat products for energy needs. The software with an intuitive interface for automated production line of peat briquettes has been developed. This provides means for managing and controlling the peat briquette production process.

1 Introduction

Russia has significant peat reserves. Management and integrated development of peat is one of the important tasks of peat industry. The increased demand for peat as a local fuel and raw material for various products leads to its energy value increase, with the development and improvement of peat production technologies as well as extensive use of peat and peat products taken in view. The significant issue of technological processes of production, processing and peat use [1-3] is peat structure formation in the process of heat-and-mass transfer. To increase the production efficiency the current peat processing and drying technologies [4-6] are to be improved and new technologies are to be sought around the results of modern research and engineering achievements.

In new market conditions and due to continuous changes in peat production technology requirements as well as wide peat variety the industry development is hindered by the lagging pace of the improvement and development of peat production, processing and use technologies. The acceleration of technological progress in the peat industry can be achieved with in-depth research and engineering solutions. Thus the problem of studying the change regularities of peat physical properties in its processing and drying becomes relevant in connection with solving the problems of predicting peat physicochemical

properties and their controlled management to use peat products for power industry and other applications better and more efficiently.

The automated production line makes up a complex dynamic system which behavior in practice requires a mathematical description and a time consuming programming [7-8]. An automated technological process can monitor the parameters of peat briquette production process such as temperature, humidity, filling level, dust content, processing degree [9]. It can be done with a direct digital control. All the monitored parameters of a technological process are transmitted in full from sensors to a master industrial controller which computes control signals for actuators. The control issues are of special priority for mining technologies. This is primarily due to the following features of peat production:

- the complexity and high speed of technological processes
- explosion and fire hazards of processed substances [9-10]
- high temperatures and high pressure of the flow process [11]
- high sensitivity of a process number to technological mode violations [12].

It is necessary to take into account that not all technological parameters are available for direct and continuous measurement [13-16].

2 Results

The automated technological process of peat briquette production is a complete production cycle with peat stuff at the input and peat briquettes at the output (Figure 1).

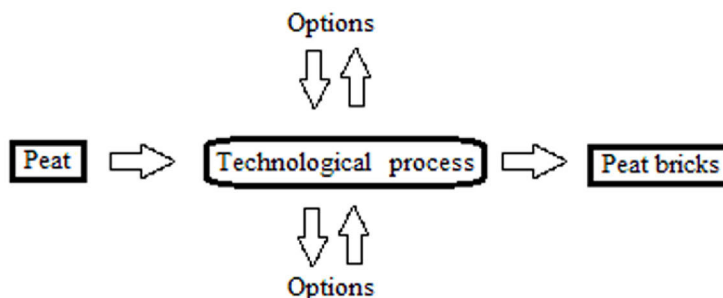


Fig. 1. The flow chart of peat briquette production

Briquetting is a process of turning milled peat into regular-shaped pieces. The technological process is divided into four stages which are interconnected (Figure 2).

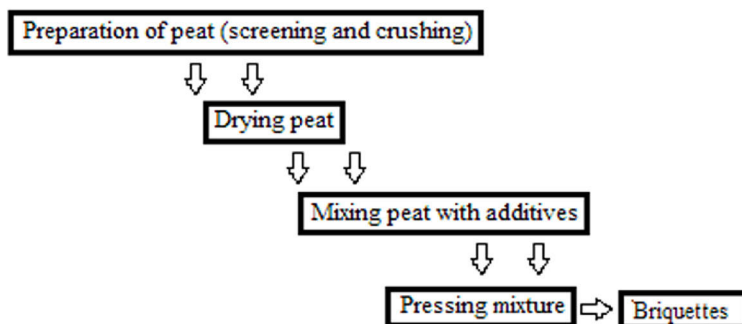


Fig. 2. Technological stages of the peat briquette production

Transferring equipment and the peat level in a charging bin (bunker) are controlled at the peat preparation stage.

Peat mass drying is one of the major stages where the end product quality is determined. The humidity and dispersiveness of dried peat, the discharge of peat being fed, the temperature in a drying chamber are measured and controlled at this stage.

The levels in dried peat bins, the performance of a scraper conveyor and a mixer are controlled at the mixing stage.

The total duration of drying is calculated by formula (1)

$$\tau = \tau_{in} A_d A_c A_h \quad (1)$$

where τ_{in} is the initial duration of drying peat raw materials from initial humidity of 60% to 12% in the chambers; A_d , A_c , A_h are coefficients for drying modes A_d , intensity of circulation A_c , initial and final humidities A_h .

For A_d the following values are set:

- soft mode –1,70
- normal mode –1,00
- forced mode – 0,80.

The pressing stage provides for automatic alternation operations and control over performance press.

An automatic line of the peat briquette production is given in detail in the functional flow diagram of the technological process of the production in question (Figure 3).

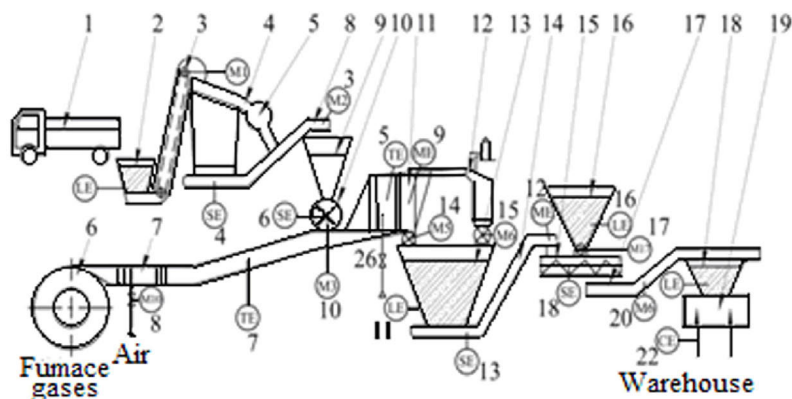


Fig. 3. Functional flow diagram of the automatic peat briquette production line

Initial peat is delivered to the shop by vehicles (1) and discharged into a charging bin (bunker) (2) over the bucket elevator (5). Raw material can be delivered in wagons or containers. Double screen (4) segregates fractions of 10-20 mm out of a stream and then they are processed in hammer crusher (5), with the collected coarse rejects being sent to livestock farms. The developed peat is fed by a scraper conveyor (8) to a batch bin (9) of a continuous drying plant (11). The peat is dried up in hot air which is pumped by a forced fan (6) to the humidity value of no more than 25%, with the temperature in a heat generator (7) being 110-140°C. Peat from a dryer enters a storage bin (13), so do small fractions of peat deposited by drying agent in a cyclone (12). Dried peat from a storage bin (13) and additional components from a weighing hopper (16) are fed at regular intervals to a mixer (15) by a scraper conveyor (14). The developed mixture is delivered to a bunker (18) of a press (19) through a scraper conveyor (17).

Pressed briquettes come to carton-, plastic-, or paper-packaging line in baffle boxes (20). Finished products are delivered to a warehouse by electric cars.

Technical process is rather complex for software implementation [16, 17]. It contains a large number of control and monitoring elements. Software for the automatic line has an

intuitive interface (Figure 4). The program interface consists of several panels and tabs with the established production configuration, the setting-up of technological process parameters, the schedule control and the description of graphic elements.

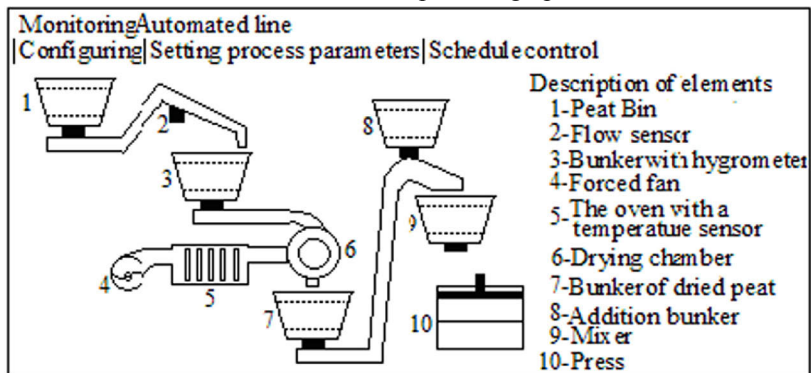


Fig 4. Interface of the control program for the automatic peat briquette production line

3 Discussion

To implement the automated line the following technological elements were chosen: a peat bin, a double screen, an addition bunker; a bunker with a hydrometer; a forced fan and a peat dryer, a bunker of dried peat, a mixer, a press. When required (if the level of peat in a charging bin is below minimum), the automatic sensor gives a signal to fill the bin up to the maximum permissible level. Double screen segregates fractions of 10-20 mm and then they are fed to a hammer crusher for further processing. Ratio of large and small fractions is one of the options available for monitoring. Solids flow sensor (impeller) carries out the control. Peat humidity is measured in the bunker after crushing.

The dryer temperature is kept within the range of 110 to 140°C:

Humidity > 60 % – temperature grows

Humidity 25-60 % – temperature reaches 125 °C;

Humidity < 25 % – temperature drops.

Peat after drying is fed to the seventh bunker, with the humidity being < 25 % and the consistency being reduced to a normal state.

Addition bunker contains sawdust and plant raw materials.

To comply with the proportions, components are fed to a mixer when a bunker filling level is above the minimum level.

From the last bunker a peat mixture comes to the press. The press makes briquettes.

The control program for the automated peat briquette production process can set up and monitor the following parameters:

- bunker capacity (in litres)

- output stream (liters per second, movement speed)

- filling of a bunker to its minimum level (% , a starting signal of bunker filling)

- filling of a bunker to its maximum level (% , a termination signal of bunker filling up).

It is also possible to configure:

- the percentage of coarse fractions in peat raw materials (over 10 mm)

- the peat supply from a vehicle (peat is fed to the first bunker when the charging level is minimal)

- the supply of additives (additives are fed to the fourth bunker when the charging level is minimal).

The program interface changes in the course of technological process. It displays the levels of bunker filling, the work of a press (by a color-change indicator), the outgoing stream, and the feedstock supply. Changes in graphic display under different parameters of a technological process are given in Figure 5.

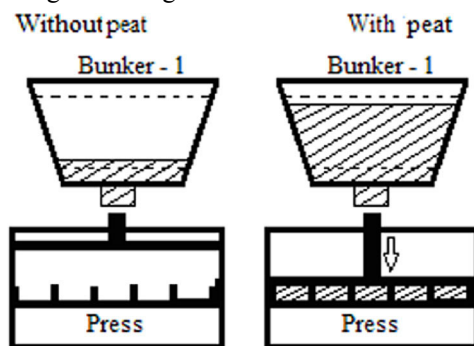


Fig. 5. Changes in a graphic display under different parameters of technological process

Software builds graphics, securing the values of different parameters of a technological process (Figure 6).

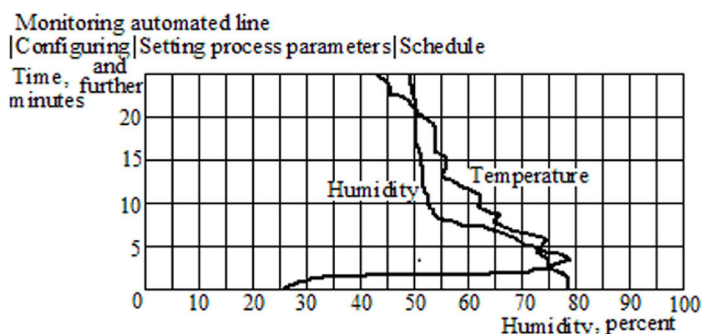


Fig. 6. Graphic display of the drying chamber temperature versus peat humidity

According to Fig.6, an operator watches the dashboard charts to monitor the current status of technological parameters of peat briquette production on a real-time basis. An operator can scale the image using the mouse wheel button. The horizontal axis of a line chart is marked from 0 to 100, the vertical axis shows time. It displays up to five parameters simultaneously. There are altogether eight parameters:

- first five parameters show the filling of each of the five bunkers (from 0 to 100%)
- peat humidity (from 0 to 100%)
- percentage of coarse fractions
- dryer temperature (from 100 to 150°C).

The operator interprets the display parameters and produces configuration of the automated process control systems.

The main factors of increasing revenue by means of drying control are as follows:

- increase in efficiency / reduction of drying period
- improvement in the quality of peat briquettes
- saving of energy.

Currently the improved management of the drying process is connected with the performance improvement of a drying chamber. Energy saving, in its turn, is also achieved by drying chamber performance improvement.

4 Conclusion

The process control is connected with the technological advances in mining. The possibilities of automatic control and creating automated production lines bring about:

- automatic control of technological parameters and maintaining the optimum operation modes;
- automatic prediction of the technological process;
- production capacity increase, improvement in the quality and volume of peat products;
- cutting down the costs of raw materials and energy per product unit;
- security of technological process, reduction in number of operating regime disturbances;
- technological process reliability improvement (due to the reduction of downtime), lifetime extension of technological equipment;
- prevention of environmental pollution by industrial wastes.

The efficiency of an enterprise with the automatic peat briquette production line is determined by the quality of finished products and security of supply.

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