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ENGINEERING SCIENCES

ANALYSIS OF HAZARDS AND DEVELOPMENT OF ACTIONS FOR THEIR DECREASE IN THE FACILITIES FOR PRODUCTION OF SOLID BIOFUEL IN TERMS OF EXPLOSIVE AND FIRE DANGER

Candidate of Technical Sciences, Senior Lecturer Tsymbal Bohdan Mykhailovych

Ukraine, Kharkov, National University of Civil Protection of Ukraine,
Department of Labor, Man-Made and Environmental Safety

Abstract. *This paper gives the analysis and estimation of physical and chemical hazards and risks of fire and explosive production of solid biomass fuel from plant biomass. As a result of the analysis and assessment of the hazards, the rating of the hazards and causes of emergencies has been obtained. With the help of modern, standard techniques, hazardous factors and risks have been identified that exceed the permissible value and can lead to emergency situations. To prevent emergencies, the ways to manage and control the parameters of the technological process of producing solid biofuels that affect security have been presented, as well as the measures to prevent them have been analyzed and proposed.*
Keywords: *extruder, hazards and risks, solid biofuels, plant biomass, equipment, physical hazards, chemical hazards, fire and explosive production, heat-resistant pliers.*

Statement of the problem. For Ukraine and the whole world, the production of solid biofuels from plant biomass is a promising area, but modern technologies and equipment have proved to be quite dangerous. Failure to understand this, both in terms of designing and operation of these productions, leads to accidents and explosions with severe consequences. Dust explosion is the worst consequence of the presence of vegetable dust, other than ignition, fire, smoke, destruction and damage to buildings and structures, machinery and equipment, accidents and fatalities among workers and the population and development of occupational diseases. Therefore, in order to ensure explosion and fire safety, prevention of emergencies of anthropogenic nature, it is necessary to study the hazards and risks and to improve the measures of technical safety, which makes it the relevant area of the research.

Analysis of latest studies and publications. The paper [1] presents an assessment of the dangers of dust and gas emission in the processing of grain wastes; this work establishes the significant excess of dust concentration, methodology for dust processing, its extrusion transformation from a dispersed structure into granular one; an effective press extruder is presented, which allows to reduce dust formation, fire hazard, but it does not solve the problem of the generation of harmful gases and other dangers.

In the analysis of the production process, the paper [2-3] has found that explosions and fires of technological equipment cause dust and hot particles of compressed wood moving within the production lines of fuel pellets. To detect sparks, it is necessary to install sensitive detectors operating in the infrared area. The introduction of integrated fire prevention solutions at fuel pellet production facilities should provide for the timely detection of sparks, their effective extinguishing and safety monitoring system. This method takes into account the specifics of the production of granules only and does not take into account the problem of transportation of fuel briquettes and it is local, operates in a certain area of transportation.

The above study does not solve the problem of hazardous factors and risks of explosive production of solid biofuels from plant biomass in a complex and systematic manner.

Statement of the task and its resolution. The purpose of this paper is the comprehensive assessment of dangerous and hazardous factors in the production of fuel briquettes from plant biomass and the development of measures to reduce their impact on fire and explosion hazard of production.

Organic dust is one of the most significant of the harmful and dangerous production factors. The main source of dust formation is extrusion, peeling and crushing processes. During these processes, highly dispersed dust (0.8-5 microns) is released into air, which, in addition to organic particles, contains metallic and mineral particles.

The dust content in the air can reach the highest value when chopping and sawing without a ventilation system (32-163 mg/m^3).

Table 1. The content of dust in the air of the working area during mechanical treatment, depending on the type of raw materials

Processed raw materials	Dust content, mg/m^3
Sunflower husk	800-1000
Sawdust	500-754
Barley straw	176-238

The processing of organic materials undergoes mechanical, physical & chemical changes in their structure, and the air of the working area contains a complex mixture of vapors, gases and aerosols. The flying products formed during thermal decomposition (thermal destruction) of a number of organic substances are fire-explosive, toxic and can cause changes in the central nervous and vascular systems, hematopoietic and internal organs, as well as skin and trophic disorders. Prolonged inhalation of dust in the production environment can lead to the development of dust diseases of the bronchi and lungs - pneumoconiosis, chronic dust bronchitis. The inhalation of dust and gases is extremely dangerous which leads to the disease of beryllium.

The data on the content of dust in the air of the working area during mechanical treatment, depending on the type of raw materials are given in table 1.

During the production of fuel briquettes from plant biomass, an emergency occurs due to the hot surface of the dryer, the crusher, the extruder and the penetrating device. The surface of the extruder head is especially dangerous and fuel briquettes, after extrusion, can smolder and are fire and explosive dangerous. The temperature of the working parts of the extruder and briquettes after extrusion, depending on the type of raw materials is given in Table 2.

Table 2. The temperature of the working parts of the extruder and briquettes after extrusion, depending on the type of raw materials

Type of raw materials	Treatment temperature, ° C
Wood residues	320 350
Sunflower husk	250—290

Also, burns occur if the moisture content of raw materials exceeds 8 %, due to the fact that during extrusion a steam cork is formed, the raw material flies out of the extruder head and injures workers.

The calculation of excess pressure of the explosion for combustible dust has been made in accordance with DSTU B V.1.1-36:2016, using the following formula:

$$\Delta P = \frac{m \cdot H_T \cdot P_0 \cdot z}{V_{CB} \cdot \rho_B \cdot C_p \cdot T_0} \cdot \frac{1}{k_H}, \tag{1}$$

where z is the proportion of the participation of the burned dust in the explosion, in the absence of experimental data on the value of z, it is allowed to take z=0,5; H_T is the heat of combustion, $Дж \cdot кг^{-1}$; ρ_E is air density before explosion at an initial temperature T_o, kg/m^3; C_p is heat capacity of air, *J/kg DO*; T_0 is initial temperature of air, *K*.

The key factor here is the use of the method [4] for obtaining solid fuel from plant raw materials and additives, which has allowed to transfer the danger of production from category B (fire-hazardous) to category V (fire hazard), reducing the excess pressure of combustible dust from 6 kPa to 0.25 kPa, which has been calculated by the formula (1).

It is proposed to replace conventional cyclones with cyclones with additionally created pressure, which arise from the modernization of existing cyclones, in the construction of which electric motor, shaft and blades are added. It should have a productivity of at least 1500 м^3/min. The cyclone with additionally created pressure is shown in Fig. 1. The difference between this cyclone and modern cyclones and dust collectors is the presence of a rotary rotor in the cyclone.

The rotor's working parts provide increased efficiency of separating the dust from the air due to the additional use of inertia forces based on the reflection of the rotary planes.

The rotating rotor, in addition to the function of providing additional inertia forces with ultrafine particles of dust, performs another function, i.e. a centrifugal pump for the selection of clean air from the cyclone body. The drive of the rotor in the form of an electric motor with a power of 3 kW is located at the top of the cyclone and is a sole integral structure.

Not all enterprises producing fuel briquettes have a cooler. For rapid analysis of fuel briquettes, a sample must be obtained. For this purpose, it is suggested to use heat-resistant mites that have the shape, such as a profile of briquette, hexagon or quadrangle, as well as a handle from a heat-resistant material.

In the extrusion and cooling area, it is proposed to install an extractor to remove air from the working area containing smoke and dust, which should be cleaned through installed fabric filters, scrubbers or electric filters.

Conclusions. The analysis of hazards and the assessment of the risks of explosive biofuel production from plant biomass is required to modernize measures to reduce the risk of hazards, effects on the human body and the environment, which can lead to emergencies.

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