

ALTERNATIVE USE OF DISTILLERY STILLAGE

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Granules of dehydrated stillage have relatively high calorific value and low ash content, can be used as biofuel. Dry granulated distillery stillage is a valuable protein feed, environmentally friendly alternative biofuel with high calorific value.

Key words: stillage, processing, humidity, fraction, temperature, granule.

Introduction. Up to date, the alcohol industry has developed quite complicated ecological situation of utilization of primary production wastes-grain stillage. During the year, 82 distilling plants of Ukraine in the process of alcohol production get about 4.5 mln. tons of stillage, which has no market demand, and it is necessary to utilize it by other means. In most cases, it is served to the fields of filtration, thus bringing great damage to the environment [1-6].

Problem. Thus, the plant capacity of 6,000 m³ / day of alcohol per day of crude stillage output is 660...720 m³. It contains 7.5 ... 8.5% of solids, 26 ... 30% of which is protein, which in 2 ... 3 days after receiving the stillage and releasing it on the field of filtration, begins to decompose and evolve dangerous toxic substances. But, taking into account the physical and chemical composition of crude stillage, it can be referred to the valuable protein feed for animals. Nevertheless, nowadays grain stillage is used very inefficiently. In some cases it is fed to animals, but in view of the short shelf life and strong reduction in livestock, such use of distillery stillage is not effective because it allows to utilize only a small part of it. Other stillage is must be sent to the fields of filtration.

Analysis of recent researches and publications. Since the mid 60s of last century and to this day the most effective way of distillery stillage recycling in overseas factories it is drying, followed by granulation. This can significantly improve the environmental situation around the plant, and increase the effectiveness of alcohol production, the revenue from the sale of dry granulated stillage allows to cover 30 ... 40% of production costs and reduce the cost of alcohol by 20 ... 30%. The given experience of West-European producers of alcohol, and it is recommended in our factories to convert stillage in a dry state to improve the efficiency of its use. Dry stillage is more suitable for long-term storage, in addition, it can be used in manufacturing animal feed. This product is a dry granular stillage is known worldwide as DDGS (Distillers Dried Grains with Solubles). This product is a valuable protein feed and is highly regarded in the global market. Implementation of DDGS production at the distillery will make it possible not only to improve the environmental situation and avoid sanctions of Sanitary, Epidemiological and environmental control but also receive additional revenue from the sale of feed products [1-6].

The purpose of research: The development of technology for distillery stillage processing converting stillage into the dry state in order to improve the efficiency of its use.

Results of researches. The technological scheme of recycling. The technological process of obtaining DDGS product is the concentration of grain stillage, drying and granulating the obtained concentrate. After alcohol separation from the stillage, stillage enters the collector of crude stillage (Fig. 1) from where is pumped into the collector under centrifuges. From there, gravity fed to the stillage decanter centrifuge (1), where the separation of undissolved stillage solids (grain stillage contains 7.5 ... 8.5% of SI, including 2,3 ... 2,5% - in solution) from the liquid fraction. Further liquid is sent to evaporation into triple-effect evaporators (2), where the concentration of SB raises to 35 ... 40%. The obtained earlier pellet with humidity 60 ... 65% is mixed with the evaporated concentrate and sent to drying (3), where the excess of moisture content is removed and SV has 87 ... 90%. Then dry stillage using a cyclone shutter (4) is fed into the drying hopper (5) under the pelleting presses (6), which is fed proportionally into the mixer conditioner of granulator, where it gets necessary open steam processing. Prepared raw material enters the extrusion chamber, where takes the form of cylindrical pellets. The obtained granules should be cooled down, in countercurrent cooler (7) with movable slot bottom. The temperature of the granules after cooling is 5 ... 10 ° C above environmental temperature.

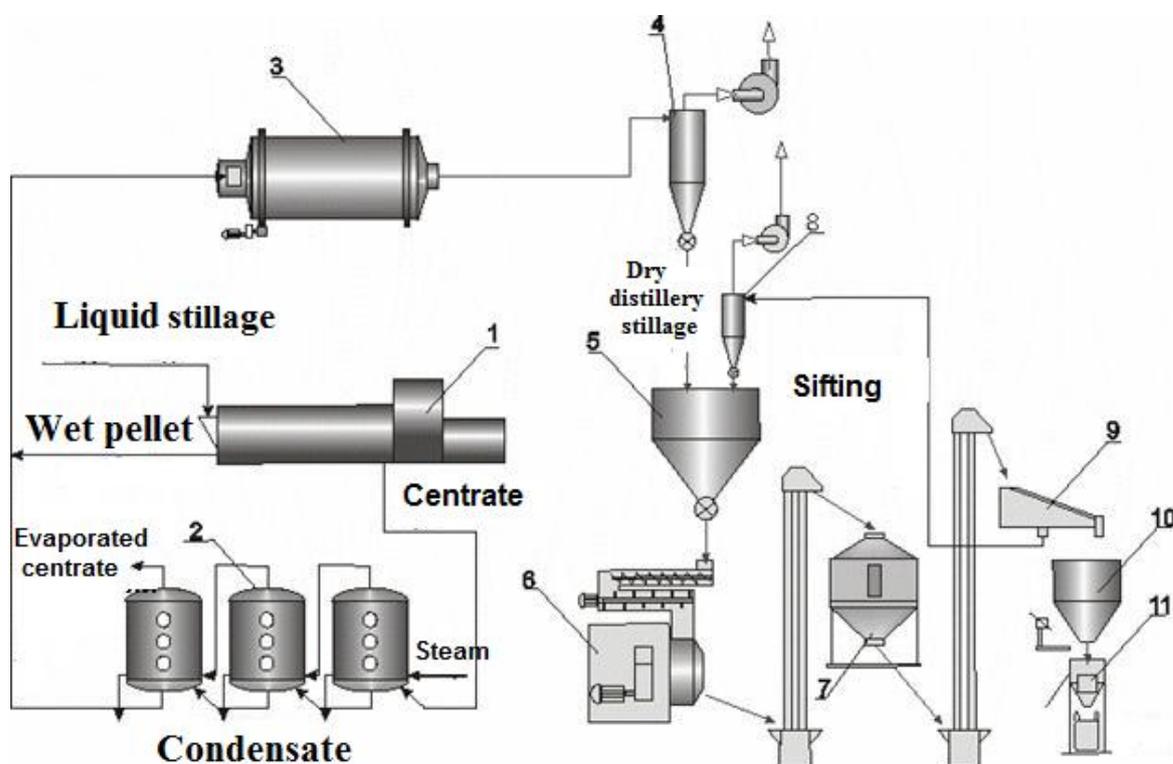


Fig. 1. Technological scheme of recycling.

When transporting pellets for cooling, as well as at pressing the crumbs that affect the quality and appearance of the product are formed. Fines need to be sifted out

on the vibrating sieves (9) and turn the pressing cycle using aspiration system (8). Finished pellets best packed in bags or big bags (using gravimetric dispenser (10) and stitching machine (11)), but it can be stored and shipped in bulk. Dried stillage is a valuable substance and can be used as feed or fuel. But this product has several disadvantages, because of which its use would not be effective. First, it has a low bulk density, which increases the cost of transportation and the end user will get it at too high price [7,8,9,10]. Second, dry stillage half consists of dust-like fractions, which complicates its use greatly: a loss of automatic feeding into the furnace boiler in one case, and there is a denial of the animals to accept it in food in another. To reduce these disadvantages, it is recommended to granulate dry stillage, thus summing up the final product under international standards. Using granulation can reduce the specific volume of 3.5 ... 4 times, increasing the bulk density of 600 ... 650 kg/m³. This will reduce transport costs by several times and transporting granulated stillage for long distances will not affect much on the cost of the product. Besides granulated stillage storage takes much less space in warehouses than not granulated, therefore, increases the capacity of the warehouses. On the other hand, the granules more convenient to use than the powdered product, for the reasons described above. It is also important that due to granulating shelf life of dry stillage increases from one month to six [7,8,9,10]. In addition, the dry granulated stillage used as feed for animals can be administered with other components in its composition, such as various vitamins and supplements, and get ready made complete feed and thus increase the value of the finished product. There are two ways to use granuled stillage of DDGS standard. First, due to the high content of protein and other nutrients (fats, fiber, some carbohydrates) is a valuable dry feed for farm animals. It was found out that it is reasonable to add dried stillage to the diet of cattle, which contains all the nutrients of the liquid stillage, feeding value of which is higher by 30% due to higher digestibility of protein [7,8,9,10].

Table 1. Physical and chemical composition of natural, dried and evaporated stillage.

Type of stillage	NE.,%	Structure of dry matter					
		Nitrogen			protein	white	ash
		general	protein	non-protein			
Natural	7,5.8,5	4,2	3,1	1,1	26,25	19,37	5,7
Evaporated	15...16	4,2	3,2	1,0	26,25	20,00	5,36
Dry	86...90	4,86	3,2	1,66	26,68	24,00	5,38

For organoleptic and physico-chemical parameters DDGS generally meets the requirements set in the table 2. In the search for alternative use of granulated distillery stillage our experts have studied the thermal properties of the product DDGS, obtained in the experimental plant from crude stillage of Kosarskii distillery. Based on the experimental results in the table, we can conclude that the

granules of dry stillage have very high heat of combustion and low ash content, and can be used as fuel. Thus dry granulated distillery stillage is also an environmentally friendly biofuel with high calorific ability comparable to dense types of wood and charcoal. All equipment and technological scheme of DDGS pellets can be divided into 4 areas: area decantation of crude stillage, evaporation of the liquid centrate, drying and granulating of dry stillage [7,8,9,10].

Table 2. Physical and chemical properties of natural, dried and evaporated stillage.

№	Specifications	Characteristics
1	Appearance	Crumbled product or granules
2	Color	From light yellow to brown
3	Scent	Bread yeast-inherent grain raw yeast, without foreign smell
4	Moisture,%, not more For granuled products,%, not more	10,0 11,0
5	Mass fraction of crude protein (in a.s.v.), not less	25,0 (30,0)
6	Mass fraction of protein on Barnshtein (in a.s.v.), not less	18,0
7	Mass fraction of carbohydrates (in a.s.v.), no more	25,0
8	Mass fraction of ash (in a.s.v.), no more	10,0
9	The diameter of the granules, mm, no more	10,0
10	Metallomagnetic impurities: particles up to 2 mm inclusive in 1 kg of product, mg, not more	30,0
11	Total bacterial contamination, thousand cells in 1 g, not more	150
12	Toxicity	not allowed

Separation of stillage into liquid (centrate) and dispersed (wet pellet) phases is carried out using decanter centrifuges produced by «GUINARD» (France), Alfa Laval (Sweden) or RPA. Frunze (Ukraine). Evaporation of liquid centrate to the dry matter content of 40% is carried out on the equipment manufactured by «Alfa Laval (Sweden) or OSC Tambov plant" Komsomolets "(Russia) under the license of TOMSA DESTIL SL (Spain). Drying of wet pellet mixture with concentrated liquid centrate is carried out in rotary-tube dryer manufactured by "Pandorf" (Germany), dryers JHG, VHJ type produced in China or SCM type production of "Nijinskyi Mechanical Plant" (Ukraine). Granulation of dry stillage is performed on a set of equipment produced "Grantekh" / Group of Companies "Crystal" /

(Ukraine). The experts of group of companies "Crystal" has a large experience in the production of granulated products, including the alcohol industry. In particular,

Table 3. **Thermal properties of grain stillage.**

Indexes		Granulated stillage
Humidity	W^p , %	8,285
	W^a , %	8,285
Ash	A^p , %	1,6
	A^c , %	1,74
Volatile substances	V^a , %	73,345
	V^c , %	81,39
Heat of combustion:		
- on the dry matter	kJ / kg	20 158
- higher operating		19 666
- working below		18 286
Conversion coefficient		0,624
Sulfur		0,74

the technology of granulation of distillery stillage is worked out designed equipment line of drying and granulation. In engineering plant the following types of equipment such as press granulators, countercurrent coolers, vibrating separators are manufactured [7,8,9,10].

Decanter centrifuge produced by Alfa Laval (France)	Alfa Laval (France) Evaporators
Rotary-tube dryer SCM-150 (Nijinskyi MOH Ukraine)	Press granulator of HT type ("Grantekh", Ukraine). 
The counter flow cooler of HT type ("Grantekh", Ukraine).	Vibrating separator GTP ("Hrantek", Ukraine).

Fig. 2. Technological equipment of recycling process.

Depending on the size of the existing building, which provides accommodation of facilities, production line layout can be vertical (placing equipment on several

floors) or horizontally when basic equipment is on one level. However, at the height of the horizontal layout placement of individual elements can reach 6.7 meters. The vertical layout of equipment for the production of granulated dry stillage of DDGS standard ("Crystal" company project for distillery LLP "Kit Co" m. Shymkent, Kazakhstan). Based on the results of economic calculations in the table, we can conclude that the dry stillage requires considerable production costs and it is a commercial product, for which there is a market. According to experts, the main consumers of feed product DDGS will be representatives of livestock breeders-farms, poultry farms, as well as private and collective farms. One of the most important factors determining the state of the animal husbandry is the supply of highly protein feed.

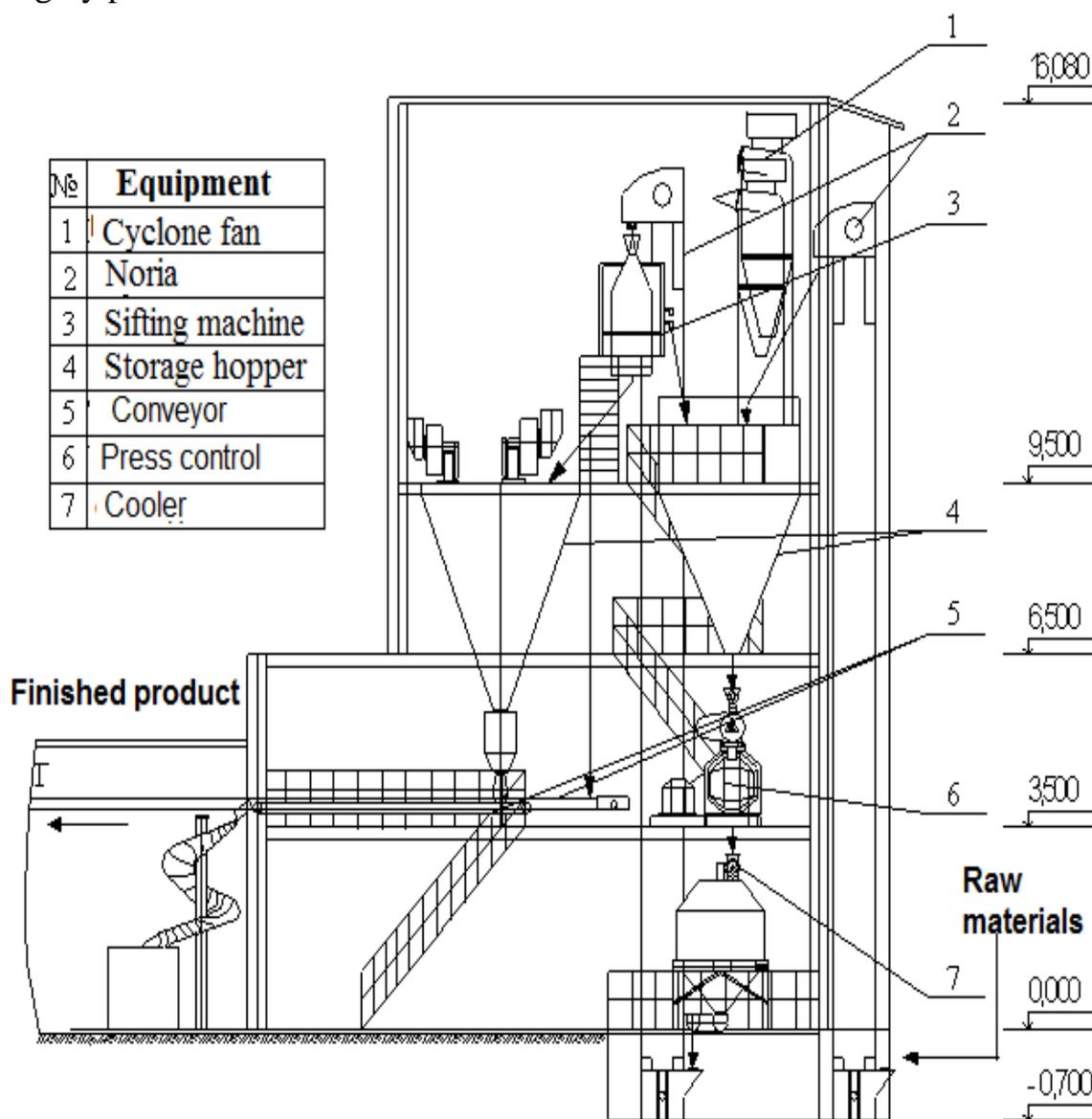


Fig. 3. The horizontal layout of manufacturing equipment for the production of granulated dry stillage of DDGS standard [1,2,3].

In the EU protein feed consumption is about 450 kg per ton of feed grain, in Ukraine, this figure is only 85 kg. Because of the acute shortage of raw protein annual overrun of grain in Ukraine is about 1.5 mln. tons. As a result, each year

livestock and poultry is declining. Implementation of this project is to provide the production of about 15 thousand tonnes of competitive valuable protein feed only at one plant with a daily capacity of 6000 decalitres of alcohol. Currently, the largest consumers of DDGS protein feed is North Africa, Central and Southeast Asia. The market price of 1 ton of dry granulated stillage in these regions is 100 ... 140 USD. Also one of the promising markets of the dry granules may be Western petroleum companies that consume stillage as an alternative biofuel. In the next 5 years DDGS product prospects on market as a biofuel practically unlimited. Based on the thermal characteristics of granules DDGS, prospects estimated cost of 1 ton of product on the market can make biofuels from 120 to 160 USD, depending on the season [7,8,9,10].

Conclusions. Dry distillery stillage is more suitable for long-term storage, in addition, it can be used to manufacture animal feed. This product is a dry granular stillage, known as DDGS (Distillers Dried Grain with Solubles). The process to obtain a product DDGS is the concentration of grain stillage, drying and granulating the obtained concentrate. This product is a valuable protein feed and highly regarded in the global market. Implementation of DDGS production at distilleries will make it possible not only to improve the environmental situation and avoid sanctions of sanitary, epidemiological and environmental control but also receive additional revenue from the sale of feed products. Granules of dehydrated stillage have very high heat of combustion and low ash content, and can be used as biofuel. Thus, dry granulated distillery stillage is also environmentally friendly alternative biofuel with high calorific value comparable to dense types of wood and charcoal.

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АЛЬТЕРНАТИВНОЕ ИСПОЛЬЗОВАНИЕ ПОСЛЕСПИРТОВОЙ БАРДЫ

Уминский С. М., Конев С. В

Ключевые слова: барда, переработка, влажность, фракция, температура, гранула.

Резюме

Гранулы из сухой барды имеют достаточно высокую теплоту згорания и низкую зольность, могут быть использованы в качестве биотоплива. Сухая гранулированная послеспиртовая барда является ценным белковым кормом, экологически чистым альтернативным биотопливом с высокой теплотворной способностью.

ALTERNATIVE USE OF DISTILLERY STILLAGE

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Key words: the bard, processing, humidity, fraction, temperature, granule.

Summary

Granules of dehydrated stillage have relatively high calorific value and low ash content, can be used as biofuel. Dry granulated distillery stillage is a valuable protein feed, environmentally friendly alternative biofuel with high calorific value.