DEVELOPMENT OF EQUIPMENT FOR THE STORAGE OF SOYBEANS WITH ACTIVE VENTILATION

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Abstract: *The article gives an overview of the creation of technology and equipment for pneumatic drying and storage of soy without attracting external sources of energy, and as storage capacity, use cheap freight containers, which will reduce the energy costs of the process and the material consumption of equipment.*

KEYWORDS: *SOY STORAGE AND PROCESSING, DRYING, PNEUMATIC CONVEYING, MODULAR CONTAINER EQUIPMENT, AIR FLOW, AIR CYCLONE, GAS-AIR MIXTURE, RECIRCULATING GRAIN, GRAIN MOISTURE CONDUCTIVITY.*

1. Introduction

The idea of the labor is to create technology and equipment for active ventilation and storage soy of without attracting external energy sources, and use cheap load containers as storage capacity, which will let to reduce the energy costs of the process and the material consumption of equipment. To solve this problem, a technology is proposed that provides storage of grain in modernized cargo containers of 20, 30, 40 tons installed vertically.

The aim of the labor is to scientifically substantiate and develop container-modular equipment for recycling drying of soy in the course of long-term storage of soy, adapted directly to the conditions of agricultural producers, which is modularly designed to create a modular series of separate parts on demand.

In this case, soybean is loaded and unloaded by pneumatic conveyor, which eliminates leakage and loss of soybean. When stored by the same conveyor, the soy-air mass moves in a closed circle, thereby actively ventilating the mass. This continues until the desired humidity is reached. Drive by electric motor or from tractor power take-off shaft (PTO), which is convenient for remote farms. At the same time, the energy intensity of the drying process and soybean storage is reduced.

2. Prerequisites and facilities for solving the problem

Soy is a unique plant, a miracle of the wild. Now soy is the leading culture of world agriculture, the pinnacle of perfection and universality in the whole plant world. Soy is central place to solve the protein problem and is very profitable.The prospects of both production and consumption are related to the population of the earth, which has a growing tendency. Without the use of soy products, the nutrition structure in many regions will be unbalanced and insufficient. Soy seeds contain 38-42% protein, 18-23 fat, 25-30% carbohydrates, as well as enzymes, vitamins, minerals. Due to the rich and various chemical composition, soy does not know its own equal in terms of production growth rates, it has long been widely used as a universal food, fodder and oilseed culture. It has no analogues in the arsenal of plant resources in terms of productivity and quality composition. Soy oil contains 58% of the structure of vegetable oils (rapeseed, cottonseed, sunflower, palm, etc.). Total world production of soy is about 130 million tons, where the main producers being the USA, China, Argentina, Brazil, the EU countries, accounting for more than 85% of the world market. The share of Argentina, Brazil and the United States in world exports is about 87%. [1,2].

According to the Ministry of Agriculture of the Republic of Kazakhstan in 2016, about 220 thousand tons of soy were produced, of which about 20 thousand tons was exported. The main region of soy production in Kazakhstan is the Almaty region, where the cultivation area is 150,000 ha. In the future, it is planned to implement the investment cluster program "Mozhoko-2020", envisaging an increase in sawing to 400,000 hectares and producing up to 1 million tons of soy a year. At the same time, further growth in soy production is constrained by the lack of a stable alternative market for specific products. In 2016, Kazakhstan sold 10.8 thousand tons to Sweden, 1.4 thousand tons to Kyrgyzstan, 1.6 thousand tons to Tajikistan, and 6.1 thousand tons to Uzbekistan. A total of about 19.9 thousand tons of 220 thousand produced. Because of this, soy producers are forced to sell to Chinese buyers for a price two times lower than the world price. In the future, China is willing to acquire Kazakhstan soy in unlimited quantities, as they now have a large demand for soy and soy products, which promises to our farmers the optimism on the issue of the future prospects of production of the product [3].

Besides, in Kazakhstan there is an opportunity to supply not only primary products (soy), but processed soy products (meal, vegetable oil and other related.), so there are already three soy-processing factories: JSC Vita-Soya productivity 150 thousand tons per year, LLP Plant on processing of soy Extra-24 thousand tons per year, LLP Sary Bulak-24 thousand tons per year. Unfortunately, they can not reach the planned capacity due to the lack of a stable source of raw materials throughout the year, which implies its storage and preparation under appropriate conditions, since soy with high protein and fat content, as well as increased seed hygroscopic, with unfavorable conditions quickly deteriorates (presence of organic impurities, high humidity). Even dry soy seeds are self-warmed by impurities.

According to the Ministry of Agriculture of the Republic of Kazakhstan, about 2 million tons of grain are stored and processed directly by product producers, i.e. various agricultural formations. At the same time, up to 50% of the volume of this raw material is irrevocable losses. Great danger to the grain is fungi, bacteria, harmful impurity and pathogenic microorganisms carried by pests of cereals - insects, rodents, birds. Toxins formed during the molding process, damaged by insects and mold grains, dirt and odors from pests of grain cause a decrease in its feed value, and animals refuse to eat such grain. Processing and transportation of moldy and damaged grain negatively affect the labor safety and the health of workers. The defeat of the grain by fungi is possible in the field, and during storage. Fighting mycotoxins is a worldwide problem, as in the structure of grain losses, mycotoxins account for 25%. The overwhelming majority of domestic agricultural producers, even in "good" times, did not consider the possibility of building their own elevators. The cost of erecting galvanized silos for storage of grain is estimated at about 150 - 250 dollars per ton. That is, in the equipment for an elevator with a capacity of 20 thousand tons alone it is necessary to invest about 3 to 5 million dollars. And also need to pay for design work, building. The minimum payback period of the elevator is 4-5 years, and this is provided that the agrarian will store on it not only its own grain [4,5,6].

In many areas of the country's climatic conditions predetermine cleaning a large part of the harvest of grain, oilseeds and other crops with high humidity, in which their long-term preservation can not be ensured.

Reduced soy humidity to 12% and bringing crude and wet grain to a stable storage state - the main purpose of drying.

In general, drying is understood as the process of dehydration of materials. This complex process consists of the transfer of heat by heated soy air, the transfer of humidity inside the grain to its

surface, its evaporation in the peripheral layers of each grain, the movement of steam from the peripheral layers of the grain to the surface and into inter granular space, removing it from the mass of the grain. At the same time, a number of physical and biochemical processes that affect soy quality are passing through soya. When drying, the role of air is not limited to the functions of the heat deliverer and humidity absorber. Oxygen of air takes part in biochemical processes in the embryo and endosperm, which increase with increasing temperature. At the same time, the processes of physiological ripening of soy are intensified, which is of great importance for improving its quality. Timely and correctly drying increases the stability of soy during storage, improves its grain and food dignity. Drying accelerates the post-harvest ripening of soy, smoothing the grain mass in terms of maturity and humidity, improves the appearance of soy. Drying has a positive effect on output and quality of soy processing products. Drying acts depressingly on pests and soy micro flora, allows in some cases to improve the technological properties of defective grains (damaged by a bug-tortoise, frostbite, sprouted, etc.) Thus, drying allows to bring soy into a stable state for storage and improve its quality.

In the Institute of AIP and NT KazNAU received a patent for invention No. 31913. Method and device for drying the grain .The essence of the invention lies in the fact that the grain is loaded, dried, cured, dried, cooled and unloaded, characterized in that the permissible moisture level at drying and before drying is limited by the value: **ΔUд ≤ Kimu. Usp, where Kim.d.** - Massive exchangeable permissible number of Kirpichev; n is calculated by: **n = (Uн- Uк) - ΔUд / ΔUд, where Uн, Uк, ΔUд** - initial, final moisture content and permissible moisture content, kg ow / kg dry. mat. . A device for drying grain containing, above the drying bunker, drying chamber, cooling, fan, furnace, loading and unloading way, characterized in that the capacity of the drying chambers is determined from**: Gd = G-nGot / ηп / ηд + n, t,** where G, G is the capacity of the dryer and the vending chamber, t; **ηп, ηд** - the fraction of heat entering the evaporation of moisture during drying and drying, h; n is the number of restraints, in addition, the number of chambers before drying is equal to the number of vending chambers [7].

However, along with this, we propose a method of active soy ventilation. In this case, the material itself moves in the air stream. As a result, cooling and drying of the unmerged material is achieved in order to prevent or eliminate self-heating during mass harvesting, equalize the temperature and humidity of the material during storage, eliminate clumping and form local rotting zones, etc.

Along with this, the re-equipped containers are currently used in urban and temporary architecture, for realizing business ideas and creating residential and workplaces. Of the containers build houses, hotels, shops, build shopping centers and even office buildings. The advantages of container construction are obvious - it's cheap, fast, practical and durable. All these positive characteristics of buildings built on the basis of sea containers, could not fail to appreciate the workers of agriculture, agrofirms and private farmers who have found their application of such a universal design, as a metal container block.

Today standard 20-foot and 40-foot containers are actively used as granaries, as well as universal warehouses for agricultural products. Practice has shown that a minimal re-equipment of the container in accordance with the required conditions allows for a long time to preserve the quality and weight of any type of grain.

Analysis of the mechanism of dehydration of the material during convective drying shows that the temperature of the drying agent can be significantly increased to 70 ° C during brief heating of the material. The limit is the temperature at which the evaporation temperature (the temperature of the wet thermometer of the psychrometer) will be equal to or close to the allowable temperature of the grain heating. Experiments show that, at a high temperature of the drying agent, soy warm up to 55 ° C to an acceptable temperature, and the evaporation of moisture from its surface takes place within a few seconds (about 10 s). Above 55 ° C, the supply of heat to soy above 55 ° C leads to injury to the embryo of the grain [8].

In this connection, we are proposed the most sparing, less energy-consuming method of storage and drying of soy, acceptable for the conditions of direct commodity producers.

3.The solution of the problem under consideration

As a result of preliminary research it was established that for the drying and storage of soy it is most effective and economically expedient to use active ventilation of the material while the material itself is moving in the air stream. As a result, cooling and drying of the material is achieved. As a result, the soy in the tank is stirred, preventing and eliminating self-warming, equalizing the temperature and humidity of the material during storage, excluding caking and the formation of local decay zones, etc.

At the same time, the modernized agricultural containers, agricultural company and private farmers, who have found their application of such a universal design as a metal container block, could not but evaluate the converted containers.

With this in mind, the advantages outlined above can have a greater effect when combined using them.

We offer a new version of container-modular equipment for drying and storage of grain in farms (Fig. 1).

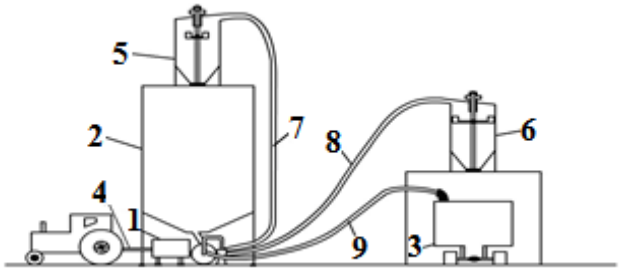

Figure 1*- Container-module equipment for drying grain. 1-pneumatic conveyor, 2-equipped container, 3-vehicle for grain storage, 4-VOM tractor, 5,6-cyclone, 7,8,9-hoses for grain loading and unloading*

The equipment operates as follows. The process consists of three cycles: loading, venting and unloading.

Loading (Fig. 2) is carried out by means of a pneumatic conveyor (1) from the vehicle (3) through the suction conduit (9), then hoses (7) into the hopper (2), where the grain is stored.

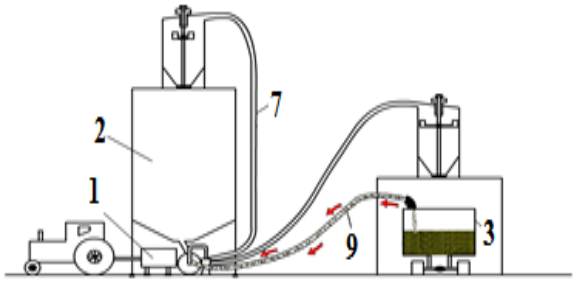

Figure 2*-Scheme of grain loading through a pneumatic conveyor*

The active ventilation of the grain (Fig. 3) is carried out in a closed circle through the pneumatic conveyor (1) -shoot (7) - cyclone (5) into the storage bin (2).

Ventilation is carried out until the humidity is 12%. At the same time, there is a valve on the pneumatic conveyor to transfer the flow of mass into the corresponding hose.

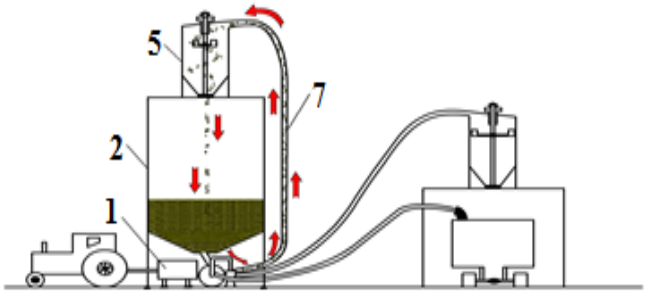

***Figure 3**- Scheme of ventilation of grain flow in a container*

The unloading of grain from the hopper (Fig. 4) comes from the lower part by means of a pneumatic conveyor (1), a hose (8) through a cyclone (6) into a vehicle (3).

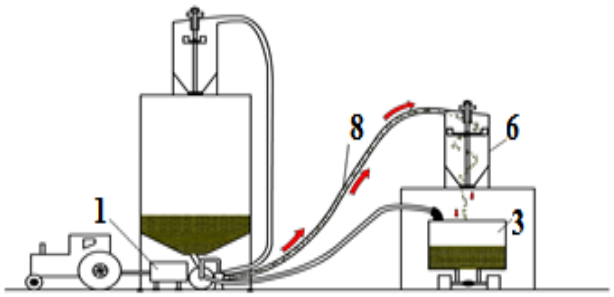

***Figure 4.** - Grain unloading scheme*

Modular equipment of container type are the most advanced devices for rapid cooling, as well as for slow drying of soy and seeds of various crops, intended for the accumulation and temporary conservation of soy, while preserving its sowing and food qualities.
The equipment occupies a relatively small space, provides full mechanization of loading and unloading of grain, it is mounted quite quickly. Thanks to the ability to work in any weather, rapid cooling, full mechanization of loading and unloading soy, vented hoppers are suitable for use in combination with inline grain cleaning and drying lines [9].

4. Conclusion

For post-harvest drying of soy, container-modular equipment for pneumatic drying and storage is offered.
The equipment will occupy a relatively small space, provide full mechanization of grain loading and unloading, install quickly enough, and use containers of 20, 40 tons as capacity for storage, which makes it possible to work in any weather, rapid cooling, full mechanization of loading and unloading soya , ventilated bunkers are suitable for use in combination with grain-line drying lines.
The proposed technology of container-modular air drying and storage equipment will allow drying without the use of expensive energy sources (gas, fuel oil, coal). It is necessary to justify the technological constructive scheme of the proposed variant of soy drying, with the conduct of an analytical study. Development of a technical specification for a laboratory sample of a soy drying plant, followed by manufacturing for laboratory testing.

5. Used literature

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