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APPLICATION OF THE VIBROPNEUMATIC SEPARATOR IN THE CLEANING AND PREPARATION SECTION OF THE CEREALS PROCESSING COMPANY

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Abstract: The development and introduction in the milling industry of new vibrating machines for separating and drying solid particles contributes to the intensification of this difficult technological process. The vibration action allows considerably improving the kinematic parameters – increasing the acceleration and frequency of the working body, reducing the amplitude of the oscillation of the working body compared to existing machines. Cleaning the batch of grains from impurities, sorting their derived products, as well as partially reducing humidity, represent the set of operations, which are carried out with the aim of increasing the quality of the grains in the batch and the derived products. Simultaneously with the removal of impurities, cleaning reduces the volume of products that must be handled, transported and stored, as well as the removal of 1-2% of moisture along the way. In the case of wheat intended for consumption, it is aimed to eliminate impurities as much as possible, which have no food value. The modernized vibropneumatic separator intended for the processing of cereal products, contains a body, mounted on a drum, with a hermetically fixed cover, in which a telescopic connection is placed for cutting the wet product. A working organ is located inside the body, made in the form of a conical sieve with the tip up. The conical sieve is rigidly connected with a vibrating mechanism, and with the bat - by means of elastic elements. Under the action of the vibrating mechanism, the working organ performs a complex spatial movement. Ducts for exhausting the air flow are installed on the circumference of the cover. An inner cone and an outer cone are placed one inside the other under the conical sieve. The device also contains connections for the discharge of the sifted fractions and refuse.

Key words: milling, vibropneumatic separator, vibrating separation machines.

1. INTRODUCTION

The insufficient efficiency and productivity of the machines used can be explained by the non-correlation of the regimes of the mechanical action of the working body and the characteristics of the resistance forces from the solid particles.

The development and introduction in the milling industry of new vibrating machines for separating and drying solid particles contributes to the intensification of this difficult technological process. The vibration action considerably improves the kinematic parameters - the acceleration and frequency of the working body increases, the amplitude of the oscillation of the working body decreases compared to existing machines.

In order to organize and direct the technological process at the milling enterprise successfully, it is necessary to study and research the technological equipment involved in the realization of this process, to know the kinematic, geometric, aerodynamic parameters, etc. Cleaning the batch of grains from impurities, sorting their derived products, as well as partially reducing humidity, represent the set of operations, which are carried out with the aim of increasing the quality of the grains in the batch and the derived products. Simultaneously with the removal of impurities, cleaning reduces the volume of products that must be handled, transported and stored, as well as the removal of 1-2% of moisture along the way. In the case of wheat intended for consumption, the aim is to eliminate impurities, which have no food value.

2. RESEARCH METHODOLOGY

Description of the experimental facility and the principle of operation

Sorting is carried out, after finishing the maximum removal of impurities, with the aim of forming wheat batches as uniform as possible. The technological flow in the cleaning plant includes machines for removing

free impurities from the wheat mass, machines for removing existing impurities on the grain surface, moistening, washing machines, hot conditioning machines, transport machines and installations, ventilation machines and installations.
Sorting machines are intended to obtain uniform products and to clean the product of impurities after the shredding operation.
The sorting operation is carried out according to various considerations, namely: size difference, aerodynamic properties, shape difference, specific gravity and magnetic properties.
In production conditions, as well as in the case of research, when putting the vibro-pneumatic separator into operation, it is mandatory to run-in empty, then with load, checking the tightness of all the pipes leading to the exhaust dispensers, as well as those connecting the separator of cyclone. Control of the dispenser locks and their drive motors is carried out. The productivity of the separator is checked by taking samples from each dispenser. Separator maintenance consists in checking the tightness of all assemblies, if areas of wear appear, they are immediately repaired.
The group of researchers, working in the laboratory of the Department of Physical Sciences and Engineering, decided to modernize the vibro-pneumatic separator, namely to develop a combined installation in the form of a dryer-separator in a vibrofluidized layer, in which several technological operations can be carried out , namely carrying out the process of separating foreign impurities from the batch of grains and the heat treatment of the latter, respectively also the process of drying the grains in the batch and separating the impurities.
The device for the vibro-pneumatic separation of cereal products is known, which contains a body, mounted on a drum, with a hermetically fixed cover, in which a telescopic connection is placed for cutting the wet product. A working organ is located inside the body, made in the form of a conical sieve with the tip up. The conical sieve is rigidly connected with a vibrating mechanism, and with the bat - by means of elastic elements. Under the action of the vibrating mechanism, the working organ performs a complex spatial movement. Pipes (or a pipe) are installed on the circumference of the cover to exhaust the air flow. An inner cone and an outer cone are placed one inside the other under the conical sieve. The device also contains connections for the evacuation of the sifted fractions and refuse [1].
The disadvantage of this device is that the installation of four or more connections on the cover surface for exhausting the air flow makes it difficult to select and adjust the speed and air consumption.
A fluidized bed dryer is also known, which contains a drum, a receiving hopper for the wet product, a drying chamber with a lid, a sieve with a vibrating mechanism. The air flow is injected with the help of two high-pressure pumps, is heated in steam heaters and in parallel flows, and through pipes is injected under the screen. On the surface of the cover there is a pipe for the evacuation of the used heat agent, a connection for the evacuation of the dry product, the used heat agent through the pipe system is directed to the system for cleaning the air from dust particles and with a pump it is evacuated to the environment [2].
The disadvantages of this solution consist in increasing the resistance of the thermal agent flow and reducing the transport of moisture from the surface of the particles of the wet product, as a result of which there is a decrease in technological efficiency, the exclusion of the possibility of pneumatic separation and fractionation of dry particles into fractions according to granularity.
One of the basic factors influencing the separation and drying efficiency is the value of the specific load on the screen surface, which depends on the physical-mechanical properties of the product being processed. The lack of constructive elements designed to change the value of the specific load on the sieve surface excludes the possibility of achieving the optimal efficiency of drying and separating the particles depending on the initial physical-mechanical properties of the product.
The problem that was addressed to be solved consists in realizing a common process of drying and separating the powdery products in a vibrofluidized layer.
The dryer-separator in vibrofluidized layer removes the disadvantages mentioned above in that it contains a body, mounted on a drum, with a hermetically fixed cover, in which is placed a telescopic connection for cutting the wet product, equipped with a sleeve. In the body is placed a working organ in the form of a conical sieve with the tip down, united with a vibrating mechanism, installed on twelve elastic elements and equipped with a device for changing the angle of inclination of the sieve within the limits of 2...20°. A perforated plate is mounted above the wet product discharge point. In the body, under the conical sieve, an inner cone with perforations and an outer one with connections for the evacuation of the sifted fractions and refuse, are placed one inside the other. The device also contains a thermal agent convection system consisting of an air pump, connected to a heater and a pipe for injecting the thermal agent under the conical sieve, connected to the outer cone, a pipe for the evacuation and cleaning of the used thermal agent, mounted in the upper part of the cover, equipped with corrugated plates and a flap and united with a cyclone for cleaning the thermal agent used of heavy and light particles, with an air pump and with a cyclone filter for removing microscopic dust particles. The diameter of the pipe for the evacuation and cleaning of the thermal agent used is equal to 2/3 of the

diameter of the conical sieve. On 1/3 of the central surface of the conical sieve, holes of sizes smaller than the average sizes of the product particles are made, and on 2/3 of the remaining surface of the conical sieve, holes of sizes equal to or larger than the average sizes of the product particles are made. The sleeve is equipped with a level fixator for adjusting the distance between it and the surface of the conical sieve.
The process of drying and separating in a vibrofluidized layer, removes the disadvantages mentioned above in that it includes the injection of the flow of heated thermal agent under the conical sieve with a speed lower than or equal to the falling speed of the product subject to drying, heating the wet product cut off on the conical sieve and the vibration of the sieve with the separation of the sifted fraction from the refuse fraction of the dry product, the evacuation of the used thermal agent and its cleaning.
The result of the work consists in obtaining the common process of drying and separating the pulverulent products in a vibrofluidized layer.
The information presented in the work is explained by the drawings in fig. 1 and 2, which represent: the construction diagram of the dryer-separator in a vibrofluidized layer and the technological diagram of the drying and separation process in a vibrofluidized layer.
The dryer-separator contains a drum 1, on which a body 2 is mounted with a hermetically fixed cover 3. Inside the body 2 is placed a telescopic connection 5 for cutting the wet product, equipped with a sleeve 17. In the body 2 is placed a working organ in the form of a conical sieve 6 with the tip down, which is connected to a vibrating mechanism 13. The conical sieve 6 is installed on twelve elastic elements 10 and is equipped with a device 11 for changing the angle of inclination of the sieve within 2...20°. A perforated plate 8 is mounted inside the cover 3, above the point of cutting off the wet product. In the body 2, under the conical sieve 6, an inner cone 15 with perforations and an outer cone 16 with connections 24, 25 are placed inside each other for the evacuation fractions sifted and refused, accordingly. The sleeve 17 is equipped with a level fixator 18 for adjusting the distance between the sleeve 17 and the surface of the conical sieve 6. The dryer-separator also contains a convection system of the thermal agent 4 consisting of an air pump 19, connected to a heater 20 and a pipe for injecting the thermal agent under the conical sieve 6, connected to the outer cone 16, a pipe for the evacuation and cleaning of the used thermal agent, mounted in the upper part of the cover 3, equipped with embossed plates 7 and a flap 9, and connected with a cyclone 22 for cleaning the thermal agent used of heavy and light particles, with an air pump 21 and with a filter-cyclone 23 for removing microscopic dust particles. The diameter of the pipe at the top of the cover 3 for the evacuation and cleaning of the used thermal agent is equal to 2/3 of the diameter of the conical sieve 6. On 1/3 of the central surface of the conical sieve 6, holes of smaller sizes than the average dimensions of of the product particles, and on 2/3 of the remaining surface of the conical sieve 6, holes of sizes equal to or larger than the average sizes of the product particles are made.
The dryer-separator with vibrofluidized bed works in the following way.
The wet product moves through the adjustable telescopic connection 5 and through the sleeve 17 on the surface of the conical sieve 6. The construction of the telescopic connection 5 ensures its vertical movement. With the help of the level fasteners 18, the adjustment of the distance between the sleeve 17 and the surface of the conical sieve 6 is ensured, which also contributes to the output of the product on its surface. The process of drying and separating in a vibrofluidized layer includes the injection with the air pump 19 of the flow of heated thermal agent under the conical sieve 6 with a speed lower than or equal to the falling speed of the product subjected to drying, heating the wet product cut off on the conical sieve 6 and the vibration of the sieve with the separation of the sifted fraction and the refusal of the dry product, the evacuation of the used thermal agent and its cleaning.
The process allows, with optimal precision, to predetermine the product cut volume and the thickness of the initial product layer on the surface of the conical sieve 6. The heat agent flow passes through the holes of the conical sieve 6, through the vibrofluidized layer of the wet product, through the perforated plate 8, through the plates embossed 7, moving through the convection system of the thermal agent 4 towards the cyclone 22 and the cyclone-filter 23. In the cyclone 22 the used thermal agent is cleaned of heavy and light particles, and in the cyclone-filter 23 the microscopic dust particles are removed, then the thermal agent is discharged into the environment.

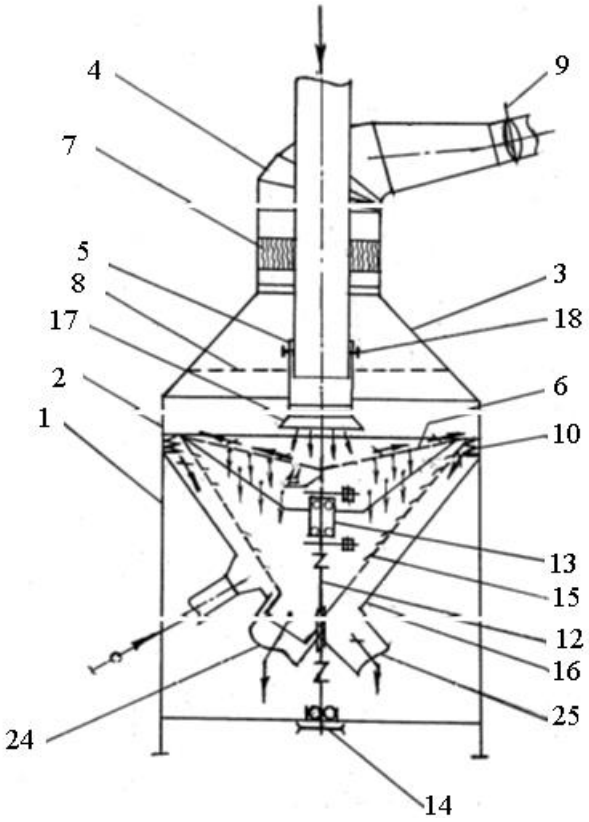

Fig. 1. Constructive scheme of the dryer-separator in vibrofluidized layer

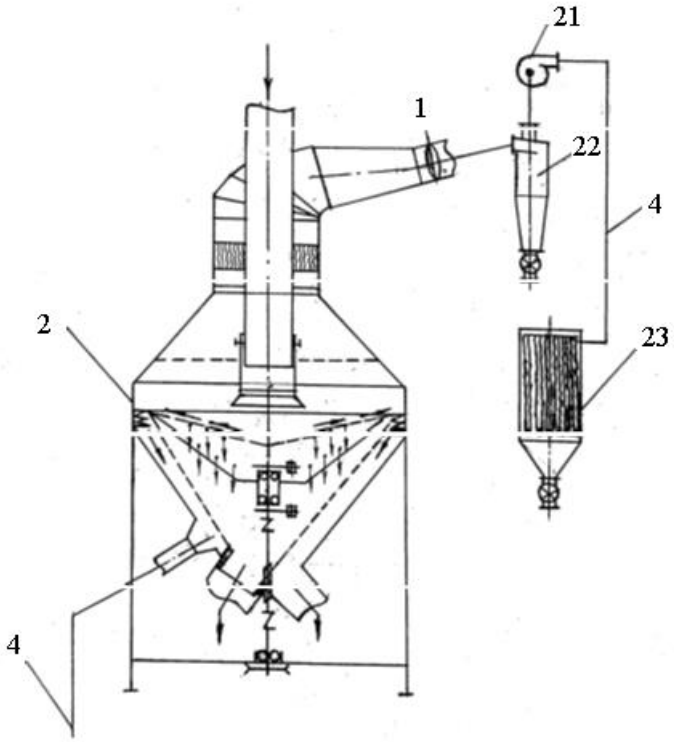

Fig. 2. Technological scheme of the drying and separation process in a vibrofluidized layer

3. RESEARCH RESULTS

The technological process of drying and separating the wet product in the vibrofluidized layer takes place following the movement of the particles of the wet product on the surface of the conical sieve 6 from the center to the periphery, at the exit of the wet product under the influence of the high frequency oscillations of the conical sieve 6 and the agent flow thermal. Based on the complex action of the high-frequency oscillations of the conical sieve 6 and the flow of thermal agent on the wet product subjected to drying, conditions are created

for its loosening, pseudo-fluidization, the reduction of the resistance of the layers of the wet product, the reduction of the coefficients of internal and external friction between the particles, at the same time the thermal agent flow passes more easily through the holes of the conical sieve 6, through the vibrofluidized layers of the wet product, respectively, in such a vibrofluidized layer each wet particle is subjected to drying from all sides by the thermal agent flow.

When the product particles pass through the sieve holes, they fall under the influence of the upward flow of the thermal agent. In turn, the heavy particles of the dry material, and with a relatively high density, move through the layers of particles downward, towards the surface of the conical sieve 6, come into contact with the surface of the sieve, moving from the center of the conical sieve 6 to the periphery and part of them pass through the holes of the sieve, in the form of a sifted product (screened fraction), they end up in the inner cone 15. The particles with a relatively low density move between the layers of particles upwards, towards the upper layers and are located in them, in the form of product (residual fraction) refuse and is evacuated from the sieve. The refuse product is directed into the outer cone 16. To increase the efficiency of drying and separating the particles of the wet product in a fluidized layer, with the help of the special device 11, which is mounted on the top of the conical sieve 6, the angle of inclination of the sieve can be adjusted in relation to horizontal axis within 2...20°. Thus, when installing the angle of the conical sieve equal to 2o (below the horizontal axis), moister particles are obtained from the product, the content of the sifted product (the fraction sieved) is relatively lower, the productivity is higher, and when installing the angle of inclination of the sieve conic greater than 2°, drier particles are obtained and the content of the sifted fraction is higher, the productivity being optimal.

4. CONCLUSIONS

As a result of the research, increasing the angle of inclination up to 20° and more contributes to increasing the quality of dry and sifted particles with a relative decrease in productivity. Respectively, the rational range of inclination of the screen which simultaneously ensures the quality of drying and separation and the optimal productivity is from 2^o to 20^o.

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