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Drying Process of Seeded Cotton

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Abstract

In a market economy, great importance is attached to preserving the original quality indicators of fiber, seeds, fluff and other products in order to ensure the competitiveness of products produced at cotton gins along with other industries on the world market. , which, in turn, represents the moisture content of raw materials stored at cotton ginneries and supplied to production. If it is high, it is necessary to dry it in a timely manner, maintain the required standard humidity and carry out the cleaning and treatment process. It is clear that the cotton gin enterprise is taking on an important task.

4-4.5 million per year. when processing tons of seed cotton, the volume of cotton harvested by machine increases; as a result of unfavorable weather conditions during the months of operation of a cotton enterprise, the humidity and contamination of cotton raw materials increases, which in turn requires acceleration of drying and cleaning of cotton.

Key words: Barometric pressure of moist air, absolute air humidity, moisture capacity, relative humidity dew temperature of the air, heat preservation, heat capacity, air density.

Introduction

Cotton seeds belong to the category of materials with low thermal conductivity. Wet seed cotton consists of the following components: fiber, seed husk, seed kernel.

The chemical composition of the seed kernel consists of fat and protein. In addition to these, mixtures of carbon, crystals, colloids and pentanes are included. The seed core is colloidal in nature, and its structure is a capillary vaporous substance. Capillary-porous materials include cotton fiber and seed husks. The bark consists mainly of woody cells, its thickness is 0.3-0.4 mm. The seed core itself consists of proteins, carbohydrates and other substances in a colloidal dispersed state. Colloid is a capillary-porous material as an object for processing cotton seeds.

The fact that the structure of raw cotton components has different morphological indicators indicates different moisture content. The seed cotton component has a moisture content consistent with its physical properties. The moisture content of the seeds (husk and kernel) exceeds the moisture content of the fiber.

The mechanism of movement and displacement of moisture depends on the degree of its interaction with the components of seed cotton.

The fiber mainly has surface-mechanically bound moisture, which emanates slightly from the surface in the form of free surface liquid.

In most cases, the core contains physico-chemically bound moisture, which can move within the material both as liquid and as vapor. Evaporation of this moisture occurs gradually and depends on a number of factors. In addition, seed cotton is a type of material that has low heat and moisture permeability, and its quality deteriorates at high temperatures. Thus, from the point of view of the drying process, the binding of moisture to the fibers and bark is relatively weak and is easily broken.

The core is limited to the separation of liquid with a strong bond and physicochemical bond with the fiber, and the core must be heated at the highest possible temperature without affecting its quality characteristics.

When moisture is separated from the components of seed cotton, an irreversible physical and mechanical process occurs in which colloidal physical and biochemical changes occur.

Therefore, it is necessary to ensure the technological properties of drying seed cotton.

Many researchers take into account that the temperature of industrial seeds should not exceed 75°C; exceeding it leads to the destruction of the protein substance of the kernel. The fiber should not be heated above a heating temperature of 100-105°C. From the point of view of the drying process, seed cotton is a complex material, since the seed contains about 70% moisture and has little heat and mass exchange. On the surface they are covered with a heat-sensitive fibrous mass, their quality is a criterion for the process.

During drying, the change in moisture occurs faster in the fiber, since it is partially blocked from the air by a layer of fiber, and it moves much more slowly towards the seed kernel, which is covered with a shell and does not come into direct contact with air.

Scientific research has established that the relative humidity of one fiber does not exceed 30% compared to the total moisture content of seed cotton.

Due to the low moisture content and large surface area of the fiber, it dries faster than seed. Therefore, skillful drying results in complete moisture and uneven shine of the seed, and in this case, the drying of seed cotton is carried out using the moisture from the fiber until moisture is retained. The negative situation caused by this situation, that is, during the subsequent process of fertilizing, the dried fiber may break and the wet seeds may rot, which affects the quality indicator of the product.

Shows the distribution of moisture between the components of seed cotton stored in the scientific center of the cotton industry (%)

Seed cotton	Fiber	Kernel	bark
10	6,9	8,1	17,1
15	10,4	14,1	23,2
20	13,8	20,5	28,9
30	20,5	34,7	38,3

Thus, an important condition for the operation of dryers made from raw cotton components is the condition.

The screened cotton does not enter the dryer evenly. Determination of the equilibrium moisture content of a unit volume of material under the influence of the same physical conditions of the drying agent in the design of the dryer, which ensures rapid movement of the blades when the seed cotton moves, that is, the separation of moisture from its components occurs smoothly. In other conditions, the drying process is self-wetting (uneven), in which seed cotton with the same initial moisture content is loaded into the dryer.

G.V. Bannikov recommends a formula for determining the smoothness of the drying process “P”.

$$P = \frac{W_b}{0,7 * W} \qquad \text{or} \qquad P = \frac{W_я}{0,46 * W^{1,275}}$$

In that

Smooth R-drying process.

Humidity of Vya- and VV-fiber and seeds before drying, %

0.7* W, 0.46* W1.275-Moisture content of fiber and seeds after drying, %

Cotton seed moisture W

The drying process is best calculated at P=1.

The process of obtaining fiber with high spinning characteristics is said to be when it retains its natural characteristics during primary processing, namely during the drying process. The quality characteristics of the fabric depend on the structural characteristics of the fiber. Therefore, the study of physical and mechanical properties (breaking stress, elongation, length, thickness, humidity and level of contamination is not enough to assess the influence of the equipment operating mode on the properties of the fiber during raw cotton processing.

The problem of improving the quality of raw cotton requires a revision of the entire processing technology, a re-evaluation of its parameters, such as spoilage, fluffiness, curling, and fabric strength.

When we analyze the thermophysics of the seed core, more heat is released from the seed core compared to other components of the seed cotton. The temperature of seed cotton can be increased by using a low temperature agent. The structure of the seed coats is similar to the structure of cotton, and their thickness is 0.25-0.5 mm. Chemical composition of the bark: 40-45% cellulose, 20-25% lignin, 20-25% pectosan, 3% protein and other compounds.

The thermophysical properties of the seed coat are close to the thermophysical properties of the seed core. The thermal conductivity of the seed coat is 30% lower than that of the seed core, and the coefficient of moisture conductivity is 20% lower. The seed of 1 piece of cotton contains 7-15 thousand fibers.

The thermophysical characteristics of raw cotton components are given in the table below.

Table 1.1

№	Name of indicators	Unit	Fiber	Sheath	Core
1.	Moisture	%	7,1	11,6	6,7
2.	The smallest weight	$\frac{KJ}{kc}$	1,52	0,38	1,62
3.	Heat capacity	$\frac{KJ}{kc}$	1,8	1,67	1,55
4.	Heat transfer coefficient	$\frac{Vt}{m^0c}$	0,06	0,24	0,35
5.	Moisture permeability coefficient		0,90	1,3	0,075

The distance between the fibers is equal to 2-3 fiber diameters, and the fiber length is from 25 mm to 45 mm, depending on the type of cotton. Its thickness ranges from 15 microns to 25 microns. From Table 1.1 it can be seen that the thermal conductivity coefficient of cotton fiber is 0.06 W/m^{2}s, which is 4 times less than that of seed fiber. This indicator complicates the heat transfer process in the core. The seed cotton is crushed in the drying drum. In such cases, there is a lot of space between the fibers. This space is occupied by the drying agent. Steam mixed with air has low thermal conductivity, but high thermal insulation properties.

Drying of fibers occurs faster than drying of seeds. Therefore, during the drying process of seed cotton, the evaporation of moisture contained in the fiber and seeds occurs unevenly. The main disadvantage of drying technology: in the process of drying seed cotton, the quality of the fiber deteriorates, since drying occurs unevenly, that is, the fiber heats up, but the seed does not heat up to normal.

Drying is the main production process of raw cotton processing, which consists in preserving the natural properties of the fiber, obtaining high-quality raw cotton and ensuring efficient operation of the equipment.

The quality of manufactured products depends on the preparation of raw cotton for storage, storage conditions and preparation for processing in factories. From this point of view, the main operation of the primary cotton processing technological process is the drying of seed cotton, especially machine-harvested seed cotton.

According to the regulations for the primary processing of seed cotton, the drying function is carried out in the drying and cleaning departments of cotton preparation centers in the cleaning departments of cotton gin plants. These workshops are equipped with a complex of technological machines and mechanisms, including drying drums.

In recent years, counterflow dryers SBS (in which the drying agent and drying material move in opposite directions) and direct-flow dryers of the 2SB-10, SBO brand (in which the drying agent and drying material move in opposite directions) have been used in the cotton ginning industry. and the movement of the drying agent) were used to dry seed cotton moving in the same direction).

In counterflow dryers, the temperature of the drying agent continuously acting on the seed cotton is constantly increasing. In this case, the fiber is exposed to temperature before the husk and core of the seed, resulting in cases of overheating of the fiber. In such dryers, the drying speed of seed cotton components is slightly lower than in direct-flow dryers. In addition, direct-flow drum dryers have a number of other advantages.

Currently, the drying and cleaning shops of cotton gin plants are equipped with 2SB-10 and SBO drum dryers.

The main working part of the 2SB-10 dryer is the drying chamber, made of a metal drum with a diameter of 3200 mm and a length of 10000 mm. Its frame is made of 2 mm thick steel sheet and mounted on a frame made of angles. Inside the drum along its length there is a system of 12 shovels, which serve to lift raw cotton as the drum rotates and distribute it throughout the drum. To create the best hydrodynamic conditions for convective heat transfer and impart rigidity to the structure, transverse rings with a height of 250 mm are installed per meter. The drum is made of three rows of steel pipes and has a 6000 mm long brake grid across the chamber. Its function is to increase the residence time of raw cotton in the falling zone, where the material is actively exposed to the drying agent. Seed cotton is fed into the drum using a screw conveyor with a diameter of 300 mm and an inclination of 300 to the horizon. This feeding device is inserted into the drum through a trunnion with a diameter of 1190 mm and is fixed to the front turret of the drum. At a drum rotation speed of 10 min-1, the most optimal loading with seed cotton is 30% of the drum volume, i.e. 1200 kg of seed cotton.

The drying agent is also introduced into the drum from where the wet seed cotton enters through the feeding device into the drum. When seed cotton hits the blades, it rises up, and when descending from above, a coolant is passed through them. In this case, the drying agent transfers heat to the wet material, absorbs moisture and is released into the atmosphere through the exhaust pipe. And the seeded cotton leaves the drum after several cycles of raising and lowering, after drying to a certain extent. In this case, the seeded cotton is removed using shovels installed in the last part of the drum.

The drying drum 2SB-10 is distinguished by its simple design, ease of operation and operation without the accumulation of seed cotton.

This drum also has the following disadvantages:

- firstly, the seeded cotton being dried is not evenly distributed along the length and cross-section of the drum, as a result, an empty zone appears that is not filled with seeded cotton, and through this zone, the heat carrier passes through the dryer without meeting the seeded cotton. This leads to a lot of useless heat loss.

- secondly, the heat transfer drum is not evenly distributed along the length and cross section. Its average speed at the entrance to the drum is 7-8 m/s, and in the last meters it drops to 0.1-0.4 m/s.

- thirdly, the design of the drum limits the speed of the heat carrier entering the chamber. In order to prevent seeded cotton from passing quickly through the drum, the speed of the heat carrier is kept within the limit of 0.6-1.5 m/s.

A number of scientists became interested in extracting moisture from seed cotton as well as extracting impurities from it. As a result, as a result of conducting a number of researches and studies, the SBO drying drum was created based on the 2SB-10 drying drum, which separates the moisture and small impurities of seed cotton.

The initial 7.0 m section of the SBO drying drum is the same as that of the 2SB-10 drum, but the last 3.0 m long section consists of a steel mesh surface, surrounded by a shell, and a screw conveyor is placed at the bottom to remove the dirt. At the top of the metal shell, a hot air nozzle is installed, through which the drying agent is introduced into the drum cleaning section.

In order to clean the seeds stuck on the mesh surface, a metallic brush is placed on the inside of the outer shell, which interacts with the mesh surface.

The raw material is removed through the filters after the cleaning section. The used desiccant is released into the atmosphere through the outlet pipe.

However, along with the advantages of the 2SB-10 and SBO drying drums, they also had a number of disadvantages. The main of these shortcomings is the high degree of fiber entanglement in the abovementioned drying drums, which in turn had a negative effect on the quality of the fiber. Studies and experiments have shown that screw feeders and brake bars increase fiber entanglement by 20%.

Analyzing the cotton seed drying process in factories in the USA, it shows that the initial temperature of the drying agent in the seed cotton drying process should be 700C. During the first 1 to 3 seconds of seed cotton drying, the most moisture is evaporated from the seed cotton, so when the temperature of the drying agent is 1800C, the quality of the fiber begins to deteriorate, because most of the moisture in the fiber evaporates.

The convective drying drum is universal, its structure is simple, the material can move freely in it, and the seed is relatively evenly dried.

during the drying process, seeded cotton is dried to the standard with low productivity at high (17%) moisture. The result of the analysis shows that the internal shovels do not evenly distribute the seed cotton in the drying drum size.

Most of the cotton is shed in bunches from the surface of the shovel. The flow of heat cannot pass between the bunches, as a result, the exchange of moisture and heat slows down. The effectiveness of the effect of the drying agent on the material to be dried is higher in the spill zone over the shovels. . If the material is in the drying drum for 6 minutes, then it takes 1.2-1.5 minutes for the seed to be poured over the shovels.

The drying process can be intensified due to the spillage of seed cotton on the shovels and the increase in the drying agent's exposure time to them.

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