Analysis Of The Relationship Between Heat Balance And Drying Speeds Of A Solar-Air Collector.

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ABSTRACT:

In this article, you can see the heat balance of the solar-air collector, which serves to dry the fruit, the relationship between the drying speed and the drive speed used in the device, as well as the analysis of the material balance of the dried product. In addition, the dependence of the size of the product to be dried on the drying rate was analyzed and a diagram was constructed. lgan.

Key words:collector, solar-air collector, heat balance, heat capacity, fruit drying, natural drying, artificial drying, drying speed, driving, driving speed, angular speed, linear speed, automation.

1. INTRODUCTION

There are two types of drying methods: "natural" and "artificial". Special drying equipment is used for artificial drying. Natural drying is carried out in the open air and the process takes a long time. The drying process is often performed as a final and in some technological processes as an intermediate stage. As a traditional example of drying, the process of drying agricultural products involves a separate industry. Agricultural products, like other raw materials, may have different forms of moisture. [1] In particular, moisture in chemical, physicochemical and physico-mechanical forms occurs in practice. [2] The shape of the moisture determines the mechanism of the drying process, and the stronger the bond between the product and the moisture, the more difficult the drying process. When the product dries, its contact with moisture is broken. [3]

Material and heat balances of drying.

To create a material balance, we set the following indicators: G_1-the initial amount of wet product coming to dry, kg / h; G_2-amount of dried product, kg / h; u_0, u_k – initial and final moisture content of the product,%; W-during the drying process. [4] The material balance of the drying is written as follows:

a) For a complete product

$$G_1 = G_2 + W \qquad (1.1)$$

b) Absolute dry matter

$$G_1 \frac{100-u_0}{100} = G_2 \frac{100-u_k}{100} \qquad (1.2)$$

Typically, the purpose of material balance is to determine the amount of moisture W removed as a result of drying:[5]

$W = G_1 - G_2$ (1.3)

Substituting the given ratio (1.2) into equation (1.3), we obtain the following.

$W = G_2 \frac{u_0 - u_k}{100 - u_0}$ (1.4)

If the amount of moisture W is definite, the amount of dried product G_2can be determined by equation (1.4).

Consider the following to establish the heat balance of drying. The initial temperature of the product to be driedT_1,^{0}C The amount of material used for drying is equal to G_1. Heat capacity of the product at temperature T_2 $c_m$andheat capacity of waterc_s, Joul/(kg*^{0}C) During the drying process, moisture W evaporates and G_2 is removed from the product to be dried.[6]

Absolute dry air L, kg / h is supplied to the dryer. The air in front of the solar air collector is the enthalpy of absolute dry air I_0Joul/kg will have. The heated air is then fed to the inlet of the dryer. As a result, the enthalpy of air increases to the value of the enthalpy of dry air I1. During the drying process, heat is absorbed as a result of heat transfer to the product, the moisture in the product evaporates and the enthalpy of air changes due to heat loss to the environment. Then, the enthalpy of air used to exit the dryer is equal to the enthalpy of dry air I_2, Joule / kg. we define the amount of heat transferred to the solar air collector as Q_k. As a result, taking into account the heat Q_p lost to the environment from the drying side, we obtain: [7]

$LI_0 + G_2 c_m T_1 + W c_b T_1 + Q_k = LI_2 + G_2 c_m T_2 + Q_p$ (1.5)

From the last equation it is possible to determine the total heat consumption Q_k for drying:

$Q_k = L(I_2 - I_0) + G_2 c_m (T_2 - T_1) - W c_b T_1 + Q_p$ (1.6)

Divide both parts of the last equation (3.6) by W and get the expression for the total heat consumption per 1 kg of evaporated moisture.:

$q_k = l(I_2 - I_0) + q_m - c_v T_1 + q_p,$ (1.7)

$l = \frac{L}{W},\ q_p = \frac{Q}{W},$

$q_m = \frac{G_2 c_m (T_2 - T_1)}{W}$ (1.8)

Here: $l = \frac{L}{W}$ −Specific consumption of heat carrier, 1 / h;$q = \frac{Q}{W}$ −Specific heat consumption, Joul/kg.[8]

Analysis of product size dependence on drying speed.

Sliced apples were used as an experimental product. The apple is round, 4 mm thick and 3 cm, 4 cm, 5 cm, 6 cm and 7 cm in diameter. [9]

We will make a theoretical analysis of the data obtained from the research.

The velocity w of the hot air is constant and w = 0.3 m / s. The drying rate is determined by the following equation.

$v = \frac{\Delta m}{St}\left[\frac{g}{sm^2 \cdot min}\right]$ (2.1)

Here; $\Delta m = \frac{m_0 - m_i}{m_0} * 100\%andm_0$ −the initial mass of the apple sample, g; m_i −mass of apple sample after drying, g; S −surface of the product to be dried,$S = \frac{\pi d^2}{4}$cm^2.T = 1 minute for drying experiments.

a) The diameter of the apple sample 3 cm, m_0=2,2 g and m_i=1 g when:

$$S = \frac{\pi d^2}{4} = \frac{3{,}14 \cdot 3^2}{4} = 7{,}1\ cm^2$$

$$\Delta m = \frac{2{,}2 - 1}{2{,}2} * 100\% = 54{,}54$$

For this case, the drying rate is as follows:

$$v = \frac{54{,}54}{7{,}1 \cdot 1} = 7{,}68 \quad \left[\frac{\%}{cm^2 \cdot min}\right]$$

b) The diameter of the apple sample 4 cm, m_0=2,3 g and m_i=1,3 g when:

$$S = \frac{\pi d^2}{4} = \frac{3{,}14 \cdot 4^2}{4} = 12{,}56\ cm^2$$

$$\Delta m = \frac{2{,}5 - 1{,}3}{2{,}5} * 100\% = 48$$

For this case, the drying rate is as follows:

$$v = \frac{48}{12{,}56 \cdot 1} = 3{,}82 \quad \left[\frac{\%}{cm^2 \cdot min}\right]$$

c) The diameter of the apple sample 5 cm, m_0=2,7 g and m_i=1,4 g when:

$$S = \frac{\pi d^2}{4} = \frac{3{,}14 \cdot 5^2}{4} = 19{,}6\ cm^2$$

$$\Delta m = \frac{2{,}7 - 1{,}4}{2{,}7} * 100\% = 48{,}14$$

For this case, the drying rate is as follows:

$$v = \frac{48{,}14}{19{,}6 \cdot 1} = 2{,}45 \quad \left[\frac{\%}{cm^2 \cdot min}\right]$$

d) Diameter of apple sample 6 cm, m_0=2,8 g and m_i=1,3 g when:

$$S = \frac{\pi d^2}{4} = \frac{3{,}14 \cdot 6^2}{4} = 28{,}3\ cm^2$$

$$\Delta m = \frac{2{,}8 - 1{,}4}{2{,}8} * 100\% = 50$$

For this case, the drying rate is as follows:

$$v = \frac{50}{28{,}3 \cdot 1} = 1{,}76 \quad \left[\frac{d}{cm^2 \cdot min}\right]$$

e) The diameter of the apple sample 7 cm, m_0=3,1 g and m_i=1,6 g when:

$$S = \frac{\pi d^2}{4} = \frac{3{,}14 \cdot 7^2}{4} = 38{,}5\ cm^2$$

$$\Delta m = \frac{3{,}1 - 1{,}6}{3{,}1} * 100\% = 48{,}38$$

For this case, the drying rate is as follows:

$$v = \frac{48{,}38}{38{,}5 \cdot 1} = 1{,}25 \quad \left[\frac{\%}{cm^2 \cdot min}\right]$$

Based on the results obtained, the following diagram was constructed.

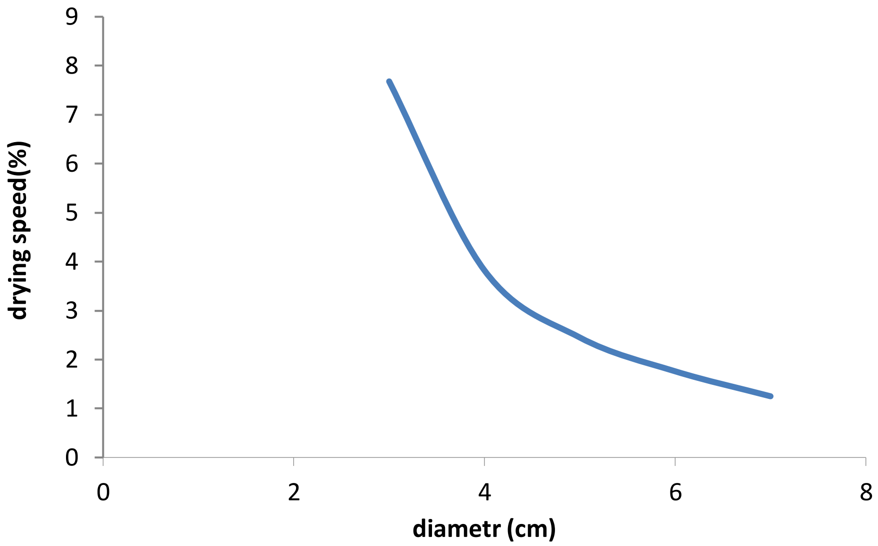

Figure 1. Graph of the surface area of the product depending on the drying rate.

Drive applied by the construction speed of the product to be driedtezliginianiqlash.

In this section, we will talk about the application of the drive and the results, the device is dried by moving the drying of the fruit on the conveyors. As a result, the following achievements are achieved:[10]

1-Double drying of the product,
2-Reduction of drying time,
3-The liquid (moisture) released as a result of drying the product should not interfere with each other,
4-Reduction of energy consumption,
5-Use of non-conventional energy sources,
6-Possibility to automate driving speed depending on solar radiation,
7-Achieving the quality of the dried product.

If we look at the circuit diagram of the device;

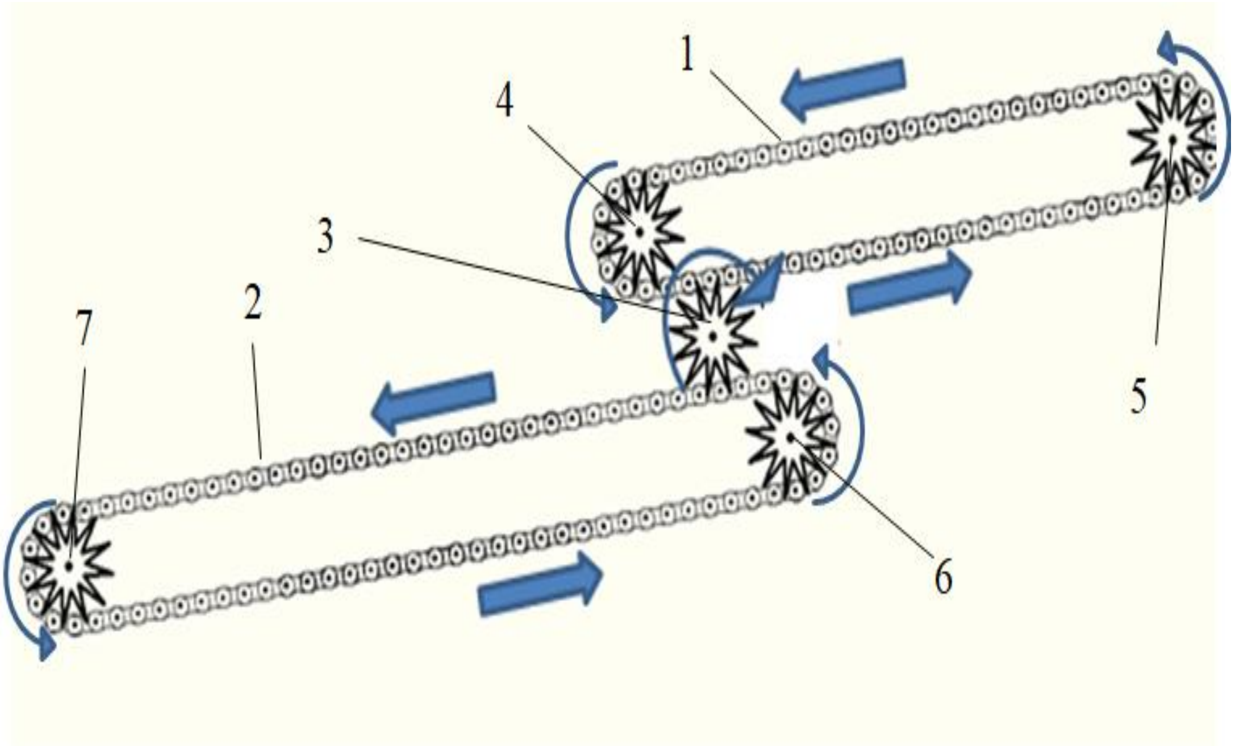

Figure 2.Schematic view of conveyor movement.

1st first conveyor, 2nd second conveyor, 3rd drive wheel, 4-5-6-7 guide wheel.

If we put a clockwise direction on the 3rd drive wheel, the rest will also rotate in the indicated direction. As a result, the conveyor moves in the direction we want it to go. [11]
Depending on the level of solar radiation and air humidity in the device, as well as the different components of different products, it is possible to know the time of construction of the product at the level of established standards. Let us denote this time by t. If the total length of the product conveyor is l, then its (conveyor) speed, taking into account the fact that the product to be dried dries from the first conveyor to the end of the second conveyor at a certain level

$v = \frac{l}{t}$ (3.1)

will be.
The angular velocity of the drive can be determined by the velocity v of this detected conveyor. In this case, velocity v is the linear velocity of the drive. The formula for finding the linear velocity [12]

$v = \omega \cdot R$ (3.2)

angular velocity through

$\omega = v/R$ (3.3)

can be determined. Where R is the radius of the guide wheel (3).

2. CONCLUSION

The solar-air collector provides some convenience when upgraded with drive and automation equipment. For example, in cases where the unit of energy from the sun is low, it is possible to automate the drying process by increasing the drying time by automatically slowing down the driving speed or by accelerating the drying speed when the solar radiation increases.

Many agricultural products are grown in Uzbekistan. The processing of these products can make a significant contribution to economic development. One of the methods of this (processing and storage) is definitely drying. This requires the use of energy-saving devices, innovative technologies, automated mechatronics and robotics equipment in the drying of agricultural products, as well as scientific research and experiments to solve problems.
Therefore, as mentioned above, as the advantages of the research work done;

- Double drying of the product,
- Reduction of drying time,
- The liquid (moisture) released as a result of drying the product does not interfere with each other,
- Reduction of energy consumption,
- Use of non-conventional energy sources,
- Possibility to automate driving speed depending on solar radiation,
- Achieving the quality of the dried product.
- and so on.

In summary, this study examined the dependence of the drying process on the heat balance, material balance, and the drying rate of the product being dried. In addition, the calculation of the angular velocity of the drive applied by the drying speed of the product was studied.

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