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Physical Principles of Dry Vegetables Fruit Products under the Influence of Infrared

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ABSTRACT: This article analyzes the physical nature of drying vegetable -fruit products under the influence of infrared radiation , the mechanisms of interaction of infrared radiation with the products. It is shown selecting effective paths ceramic infrared radiation sources.

KEYWORDS: electromagnetic wave, infrared wave spectra, drying, heat exchange, ceramics, thermal radiation, convection, the motion of atoms and molecules, the radiation range.

I. INTRODUCTION

As is known, in the Republic of Uzbekistan ovoschoplodovye products matures in the short flying time, three to four months of the year. To ensure the needs of the population for these products throughout the year, there is a storage problem. Traditionally, this problem can be solved in two ways; First, the product is stored in the refrigerator, it requires huge holodylnye area and great energy. Second, the products initially osushivaetsya, then stored in special places. The second method is more efficient than the first, but the process of drying the products is different. Before and currently drying products carried on the areas under the rays of sunlight. This process is done in two ways; under the direct rays of sunlight in open areas, or drying of the products is carried out under the eaves, that is, in a shady area of the canopy. In contrast to the first, in the second case the drained products have high quality, preserving the natural biological primary structural parameters, ie, It is environmentally friendly. However, here as in the first case for large drying space drying required.

II. TEXT DETECTION

In recent years, to accomplish this task, dryers are used, so-called ovens. In these devices ovoschoplodovye osushivaetsya products under the influence of infrared radiation. Operation is that the products for drying is subjected to an intense irradiation of infrared radiation. To do this, stir the food in a special case, where the radiation source is installed. For the production of source is a quartz tube, inside which posted electric spiral from the outside of the tube are applied to a layer of special ceramics. When a current is passed through a spiral tube is heated, and the ceramic layer emits infrared rays. The collection of articles [1], the economic and technical characteristics of the dryers of various designs manufactured in the country and abroad. And in the monograph [2], describes the effect of infrared radiation on biological organisms, medical applications, and the basics of drying ovoshoplodovyh products. In these studies focuses on the improvement and optimization of the technical characteristics dryers. But the physical mechanisms of interaction of radiation with the products and the spectral characteristics of the radiation is not discussed. The purpose of this article is to analyze the spectral characteristics of the source and absorbing infrared radiation environments, as well as mechanisms for the process of drying ovoschoplodovyh products. You can put a primitive question why when irradiated with infrared rays wet bodies drainage occurs, ie, It evaporates. In the academic literature on the physics of the process is due to evaporation from the viewpoint of molecular - kinetic theory.

According to this theory, when heated liquids or gases molecules get heat energy. In the molecules initially excited by the internal rotational and vibrational motion, and then increases the energy of translational motion. The molecules get enough required kinetic energy of the surface tension of the fluid overcoming the forces leave. Such a process in wet bodies, lead to their drainage. For drying wet bodies require a continuous heat transfer. In nature, there are three types of heat, conduction, convection and radiation through electromagnetic [3]. In the first case the heat transfer medium fills the required space between the heat source and the heating body. In the latter case, great masses of gas and liquid is carried in the space and cause it to heat exchange. In the third case, the energy is transferred in form of electromagnetic radiation, and is not required medium for transfer of heat. Infrared radiation is a carrier of thermal energy in the literature and are often referred to as infrared thermal radiation.

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In the absorption of infrared radiation bodies in the molecules forming the body, the internal excited rotational, vibrational and translational motion of the molecule as a whole. If the molecule is in an excited state, the molecule within the complex movement occurs and this leads to a change in the overall dipole moment of the molecule and is observed in the infrared radiation range. The spectral composition of the radiation depends on the internal structure and the symmetry of the molecule. The drying process is associated with the evaporation of water molecules from the surface of the product for this reason, first analyze water absorption and emission spectra. A molecule of water (H_2O) is a triatomic molecules and vibration theory has three vibration (vibration) and three rotational (rotary) movement. Figure 1 shows schematic representations of six independent movement of the water molecule [4]. In a first approximation, these movements can be described as a model of the three harmonic oscillators and rotators. Their energy is determined by the following formulas.

$$E_{осц} = \hbar\omega_0(n+\frac{1}{2}), E_{ром} = \frac{\hbar^2 J(J+1)}{2I}. \qquad (1)$$

Here, n, J-quantum numbers. I-moment of inertia of the oscillator frequency of $\omega_0 = \sqrt{k/m}$ -private. 6 These movements form of vibration and rotational energy spectrum of the molecule as a whole.

$$E(n) = E_{эл}(n_0) + E_{теб}(n_1, n_2, n_3) + E_{айл}(J_1, J_2, J_3),$$
$$(n_0, n_1, n_2, n_3, J_1, J_2, J_3 = 1,2,3,....). \qquad (2)$$

From formula (2) that the molecule has an energy spectrum over a wide range. If the molecule moves from one state to another, it changes leads to the emission or absorption of electromagnetic radiation, whose frequency is determined by the formula

$$\hbar\omega = E^{(1)} - E^{(2)} = (E^{(1)}_{эл} - E^{(2)}_{эл}) + (E^{(1)}_{теб} - E^{(2)}_{теб}) + (E^{(1)}_{айл} - E^{(2)}_{айл}) =$$
$$(\Delta E_{эл} + \Delta E_{теб} + \Delta E_{айл}) = \hbar(\omega_{эл} + \omega_{теб} + \omega_{айл}), \qquad (3)$$

Experimental and theoretical calculations show that the energy spectrum defined by the formula (3) corresponds to the infrared range. The table shows the results of a numerical calculation of the formula (3) and experimental measurements of the absorption spectra of water vapor molecules [4].

The table shows that the short-wave ($\lambda_i \approx$ 6-0.55 mic), corresponding to the vibrational motion, and the long-wavelength part ($\lambda_i \approx$ 278-6 mic), to the rotary motion. Also, the short-wave part of the spectrum corresponds to the long-wave part of the optical range. It is not difficult to understand that for this reason, under the influence of solar radiation, there is an intense evaporation of water. According to theoretical calculations by the formula (3) in a range of water must observed ruled individual spectral lines, corresponding to the values λ_i (or ω_i). In the experimental measurements in place there is always some strip lines $\lambda\omega_i(\Delta\omega_i)$, which corresponds to the natural broadening of the width of the lines. This shows that the intra molecular motion of molecules is complex. For clarity, the graph of experimental absorption spectrum actuation portion of water vapor in the range of 4-35 microns [4]. For wavelengths of 5,2 mic and 6 mic, 6,25 mic, 6,75 mic in the table on the graph corresponds to only one resonance line in the range of 5-8 mic ($\Delta\lambda \approx$ 3mic). The peak of the resonance corresponds to a wavelength of λ_i = 6,1 mic, shown in the table. The following experimental peaks correspond roughly to λ_i =17mic, λ_i = 21 mic, λ_i = 33mic associated with three different types of rotational motion of the molecules, as shown in the figure.

The ovens for drying ovoshoplodovyh offered products, the infrared radiation source is a ceramic compound specially produced for this purpose. In [1], as the source of radiation is a ceramic material proposed so-called "mullahs" emitting radiation up to 25 mic. In other devices, it offers ceramic materials based on quartz emits radiation to 3-5 mic, but in the majority of the works of the spectral characteristics of the source of radiation is not discussed. From above resulted analysis it can be concluded that used for drying special ceramic material must have a wide range of emission within the spectral range of water absorption. Those material should emit radiation of different frequencies coating weight of the absorption spectrum of water molecules. This leads to an improvement in the economic efficiency of the device. The question arises, what qualities distinguished drying ovoshoplodovyh products than drying by solar radiation. The climatic conditions of our country for drying ovoshoplodovyh under solar radiation enough. It is known that in the solar radiation spectrum besides the infrared ray and have ultraviolet optical radiation and partially rays with

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energies higher [5]. Optical and ultraviolet rays are produced in the optical transitions of external electrons, electron shells of atoms. This radiation has higher energy than infrared rays, when they get into a hydrocarbon, the molecular structure of foods destroys their chains. And this leads to a change in biological structure ovoschoplodovyh product. In other words, when drying products completely or partially lose initial, natural quality. The infrared radiation acts mainly water molecules and their interaction with hydrocarbon molecules, the first drying stage can be ignored. So, how their energy is not sufficient for the active destruction of hydrocarbons. As we mentioned earlier in this article, for the above mentioned reason, the drained products in the solar shade have higher natural qualities. But this method of drying time longer than drying in open areas. This can be called the drying temperature drying, as in this case, a thermal evaporation of water from the product, and drying time depend on the temperature of the shadow area.

III. EXPERIMENTAL RESULTS

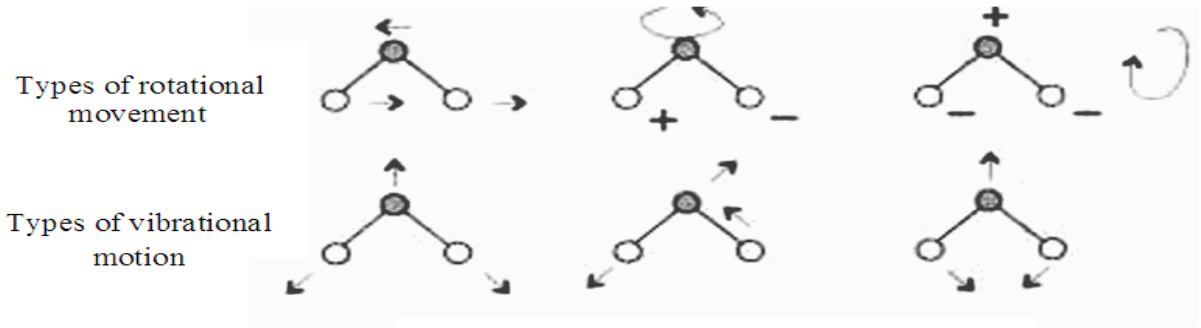

Fig. Types of movement of water molecules

Rotational spectra (rotational) movements							
λ(exp)	$\lambda_1(theor)$	$\lambda_2(theor)$	$\lambda_3(theor)$	λ(exp)	$\lambda_1(theor)$	$\lambda_2(theor)$	$\lambda_3(theor)$
267(mic)	278	208	-	35.7	39.0	36,8	-
175.6	182	-	-		37..0	34,8	35,0
167	-	-	175	32	32.7	32	-
132	139	137	-	30.6	30.9	29,7	-
116.8	111.2	-	-	29.0	29.3	-	-
108.9	-	104	-	28.9	27.8	27,7	-
105.8	-	-	-	26.6	26.6	26,0	29,2
90.9	91.7	-	87,5	25.0	25.3	24,5	-
83	-	83	-	23,0	-	23,1	25,0
79.3	79.4	-	-	22.9	-	-	-
78	-	-	-	21.6	-	21,9	-
74.5	-	-	-	20.5	-	20,8	21,9
72.2	-	-	-	19.7	-	-	-
69.9	68.3	69,3	-	19.2	-	-	19,4
63.7	-	-	-	17.5	-	-	-
65.8	61.7	-	-	15.7	-	-	17,5
57	-	59,4	58,1	14.3	-	-	15,9
52.6	55.6	52,0	-	13.4	-	-	14,6
50	50.1	-	-	12.4	-	-	13,5
49	-	-	-	11.6	-	-	12,4
44.1	45.6	46,2	43,8	10.9	-	-	11,7
40.0	42.2	41,6	-				10,9

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The spectra of normal (vibration) fluctuations							
$\lambda(\exp)$	$\lambda_1(theor)$	$\lambda_2(theor)$	$\lambda_3(theor)$	$\lambda(\exp)$	$\lambda_1(theor)$	$\lambda_2(theor)$	$\lambda_3(theor)$
6.1	-	-	-	0.98	1.02	0.97	0.98
4.7	-	-	-	0.85	0.88	-	0.85
2.29	3.05	-	-	0.75	0.77	0.73	0.75
1.98	2.03	-	1.96	0.63	0.68	-	-
1.46	1.52	1.45	1.48	-	-	-	-
1.18	1.22	-	1.17	0.55	0.55	0.58	-

Fig.2. Rotational spectra (rotational) movements and The spectra of normal (vibration) fluctuations

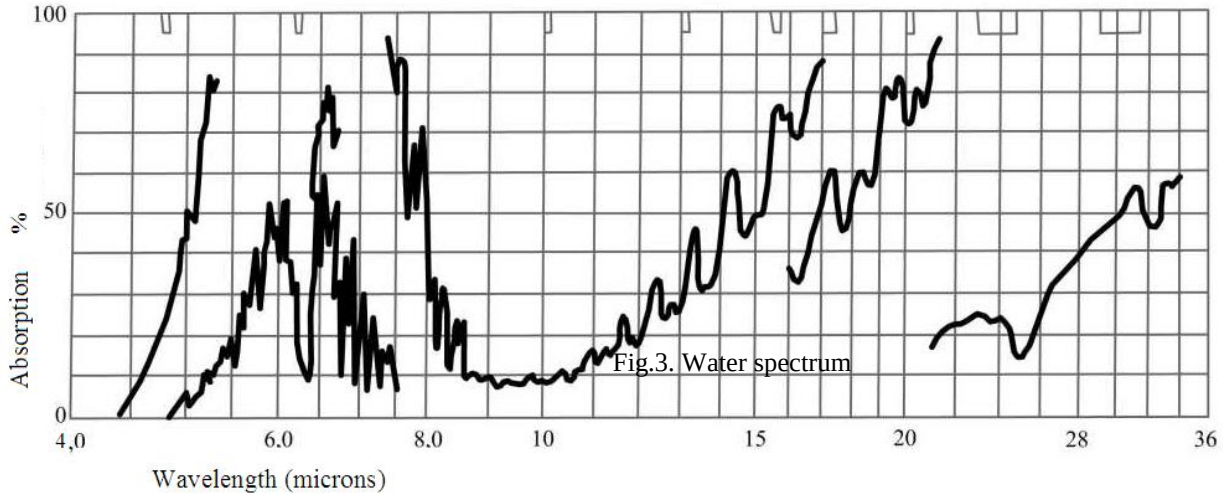

Fig.3. Water spectrum

VI. CONCLUSION

It should be noted that the optical beams and also ultraviolet involved during evaporation of water molecules. Thus there is a Raman scattering radiation hydrocarbon molecules. In such processes, the energy of the primary radiation changed slightly, and the contribution of the infrared radiation is produced as a result of the Stokes process is much less than in the optical range. Recently, before the product manufacturers ovoshoplodovyh task, when drying the product as much as possible to maintain their original natural appearance. Despite the surplus energy, drying under the influence of infrared radiation is responding to these requirements, as well as a drying can be performed at any time of the year.

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