

ISSN 2181-8622

Manufacturing technology problems



Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX  COPERNICUS
INTERNATIONAL

**Volume 8
Issue 4
2023**



SLIB.UZ
Scientific library of Uzbekistan

NamMTI ILMIY-TEXNIKA JURNALI

Tahrir hay'ati a'zolari:

Paxtani dastlabki ishlash, to'qimachilik va yengil sanoat

1. Axmadxodjayev X.T., t.f.d., prof. - NamMTI
2. Muradov R.M., t.f.d., prof. - NamMTI
3. Jumaniyozov Q., t.f.d., prof. - "Paxtasanoat ilmiy markazi" OAJ
4. Eshmatov A.B., t.f.d., prof. - Tojikiston Milliy Texnologiyalar Universiteti
5. Xoliqov Q., t.f.d., prof. - NamMTI
6. Ergashev J.S., t.f.d., dots - NamMTI
7. Obidov A.A., t.f.d., dots. - NamMTI

Qishloq xo'jaligi mahsulotlarini yetishtirish, saqlash, qayta ishlash va oziq-ovqat texnologiyalari

1. Toshev A., t.f.d., prof., akad. - Janubiy Ural davlat universiteti, Rossiya
2. Banu Yücel., q.x.f.d., prof. - Ege Universiteti, Turkiya
3. Alimov U., t.f.d. - O'zR FA UNKI
4. Xudayberdiyev A.A., t.f.d., prof. - NamMTI
5. Sherquziyev D.Sh., t.f.d., prof. - NamMTI
6. Merganov A., q.x.f.d., prof. - NamMTI
7. Mamatov Sh., t.f.d., prof. - Webster Universiteti

Kimyo va kimyoviy texnologiyalar

1. Namazov Sh.S., t.f.d., prof., akad. - O'zR FA UNKI
2. Botirov E.X., k.f.d., prof. - O'zR FA O'MKI
3. Akbarov H.I., k.f.d., prof. - O'zMU
4. Boymirzayev A., k.f.d., prof. - NamMTI
5. Nurmonov S.E., t.f.d., prof. - O'zMU
6. Salihanova D.S., t.f.d., prof. - O'zR FA UNKI
7. Kattayev N.T., k.f.d., prof. - O'zMU

Mexanika va mashinasozlik

1. Zaynobiddinov S., f.m.f.d., prof., akad. - ADU
2. Mardonov B., f.m.f.d., prof. - TTYSI
3. Usmanov P., f.m.f.d., dots. - NamMTI
4. Matkarimov P.J., t.f.d., prof. - NamMTI
5. Sharibayev N., f.m.f.d., prof. - NamMTI
6. Erkaboyev U.I., f.m.f.d., dots. - NamMTI
7. Musoyev S.S., t.f.n., prof. - BuxMTI

Ta'limda ilg'or pedagogik texnologiyalar

1. Goncharenko I.I., f.m.f.d., prof. - BMTU, Belorussiya
2. Hüseyin Kamal, t.f.d., prof. - Ege Universiteti, Turkiya
3. Ergashev Sh.T., t.f.n., dots. - NamMQI
4. Musayev J.P., p.f.d., prof. - IRV
5. Xoshimova D., f.f.d., prof. - NamMTI
6. Maxkamov A.M., t.f.d. - NamMTI

Iqtisodiyot

1. Maniki Tiagi, i.f.d. - KIET, Xindiston
2. Malcolm Ng Cher Herh., t.f.d. - INTI IUC, Malaysia
3. Soliyev A., i.f.d., prof. - NamMTI
4. Saidboyev Sh., i.f.d., prof. - NamMTI
5. Matkarimov K., i.f.n., prof. - NamMTI
6. Kadirova X.T., i.f.d., dots. - NamMTI
7. Bustonov M.M., i.f.d., dots. - NamMTI

Muharrirlar guruhi

S. Yusupov, O. Kazakov, B. Xolmirzayev, A. Mirzaev,
A. Tursunov, O. R. Qodirov (mas'ul muharrir)

KINETICS OF DRYING PROCESS OF TOMATO FRUIT

RASULOV SHUHRAT

Senior Lecturer of Bukhara Engineering-Technological Institute
E-mail.: shuxratrasulov1308@gmail.com, Phone.: (+99899) 704 75-10

DJURAEV KHAIRULLO

Associate professor of Bukhara Engineering-Technological Institute
E-mail.: djuraev_xf@mail.ru, phone.: (+99891) 444 84-90

USMANOV AKHTAM

Associate Professor of Bukhara Engineering-Technological Institute
E-mail.: usmonov@mail.ru, phone.: (+99897) 282 90-95

KHALIKOV MUKHRIDDIN

Postgraduate student of Navoi State Pedagogical Institute
Phone.: (+99897) 785 21-77, e-mail: muxri0770@gmail.com

Abstract:

Objective. The scientific research shows studies on the analysis of the kinetic laws of the drying process of tomato fruit were carried out. Non-traditional methods of heat treatment are proposed, based on low-temperature drying regimes aimed at preserving the biologically active substances contained in the tomato fruit. The molecular movement of liquid droplets in the product and the laws of movement of moisture towards the surface in the appropriate wavelength range of infrared light were studied on the basis of experiments.

Methods. On the basis of full-factorial experiments, the threshold values of the parameters affecting the drying process of tomato fruit were determined. In the initial stage of the period of heating and constant drying speed of the product, pulse treatment in the wavelength range of $0.7\div 1.1\ \mu\text{m}$ of infrared light, and in the period of decreasing moisture content of the product, use of continuous drying method in the wavelength range of infrared light of $2.4\div 2.8\ \mu\text{m}$ based on A drying device designed for processing tomato fruit based on pulse mode and continuous drying at low temperature has been developed.

Results. By using the non-traditional drying method, the results representing the drying curves of tomato fruit with a thickness of 8, 10, 15 mm and the drying process speed curves were obtained. The results show that 34-35% of the moisture content of the 8 mm thick tomato, 25-26% of the 10 mm thick tomato fruit, and 14-15% of the 15 mm thick tomato fruit content were experimentally confirmed.

Keywords: drying, equilibrium humidity, desorption, heat capacity density, wavelength, equilibrium humidity.

Introduction. In the world, a number of scientific research works are being carried out on the creation of techniques and technologies for drying agricultural products, production of canned ready-made products [2,3,6,16]. Development of drying devices and regimes that allow preserving BAS (biologically active substances) in the product by using modern methods of energy impact in the drying system, researching the kinetic laws of the drying process for the entire volume of the product, as well as developing scientific research aimed at accelerating

metabolic processes are current issues. Based on these tasks, the issue of experimental research of the kinetic laws of the drying process of tomatoes grown in the open fields and greenhouses of our Republic is expressed in this article.

Methods. On the basis of theoretical and experimental studies, the analysis of the kinetic laws of the tomato fruit drying process was carried out [8,9,12]. A drying device designed for low-temperature drying of tomato varieties grown in the open air was developed, and based on the relevant equations, the change in the

amount of moisture released from the tomato fruit per unit of time was determined [10]. The drying process of tomato fruit varieties "Alamingo", "Sultan", "Moderna" and "Tashkent" was carried out, and the change of moisture in the samples with the size $\delta=8$ mm, $\delta=10$ mm and $\delta=15$ mm was experimentally studied (1,2,3 Tables). In

the theory of drying, the moisture content of the product is usually calculated in relation to the mass of the completely dry product, which remains intact during the drying process, which in turn provides great convenience for calculations. Accordingly, the total mass of the tomato fruit is: [1,7,11,17].

$$G = G_{wet} + G_{adm} \quad (1)$$

where: G_{wet} - the amount of water in the raw material, kg,

The moisture content of the tomato fruit in relation to the total mass:

$$W = \frac{G_{wet}}{G} \cdot 100 \quad (2)$$

The amount of absolute dry matter in tomato fruit is determined by the following equation:

$$G_{adm} = G_b / (1 + w_b^d) \quad (3)$$

where: G_b is the initial mass of the product, kg; w_b^d - initial moisture content of the product, %.

From this equation, the moisture content of the product, kg.moisture/kg.dry. substance:

$$(W^d = G_b - G_{adm}) / G_{adm} \quad (4)$$

Results. In the study of drying kinetics, the drying process of tomato fruit with initial moisture content of 94÷95%, dry matter content of 5.0÷5.3 % and mass ($m=1384$ gr, Table 1; $m=1367$ gr, Table 2; $m=1052$ gr, Table 3) was carried out. τ was increased, and a change in product moisture level was detected every 30 minutes (Fig. 1).

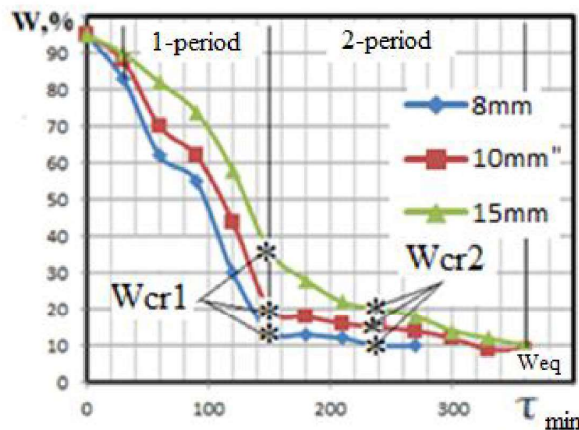


Figure 1. Drying curve

The results of the drying process of tomatoes of three different thicknesses show that during 15-20 minutes, i.e., during the heating of the product, a partial change in the moisture content of the product was observed, the moisture content of the 8 mm thick tomato fruit increased from 95 percent to 86 percent, and the moisture content of the 10 mm thick sample increased to 88

percent. the moisture content of the sample with a thickness of 15 mm decreased to 91%. In the period of constant drying rate (period I), the acceleration of the rate of decrease of moisture content according to the straight line law was observed, and the period of decrease of moisture according to this law w_{cr1}^c continued until the first critical moisture point of the drying rate [20].

Table 1

| Dry tooth time hour | Size (mm) | Dry dental process product in change in lot mass shi, (grams) | Dry matter in the product, %/ gr | Break up the amount of moisture that leaks outri,% | Moisture change of shi, % | Dry tooth is fastgi % / min | Product moisture storage of (kg.moisture / kg.dry matter) |
|---------------------|-----------|---|----------------------------------|--|---------------------------|-----------------------------|---|
| 0 | 8 | 1384 | 5.0 ÷ 5.3 / 69.2 ÷ 73.3 | 5 | 95 | | 0.97 |
| 30 | 8 | 407 | 5.0+5.3 / 69.2+73.3 | 17 | 83 | 32.5 | 0.85 |
| 60 | 8 | 182 | 5.0+5.3 / 69.2+73.3 | 38 | 62 | 3.75 | 0.65 |
| 90 | 8 | 153 | 5.0+5.3 / 69.2+73.3 | 45 | 55 | 0.32 | 0.56 |
| 120 | 8 | 98 | 5.0+5.3 / 69.2+73.3 | 70 | 30 | 0.45 | 0.30 |
| 150 | 8 | 80 | 5.0+5.3 / 69.2+73.3 | 86 | 14 | 0.12 | 0.141 |
| 180 | 8 | 79 | 5.0+5.3 / 69.2+73.3 | 87 | 13 | 0.0055 | 0.130 |
| 210 | 8 | 78 | 5.0+5.3 / 69.2+73.3 | 88 | 12 | 0.0047 | 0.120 |
| 240 | 8 | 77 | 5.0+5.3 / 69.2+73.3 | 90 | 10 | 0.0041 | 0.10 |
| 270 | 8 | 76 | 5.0+5.3 / 69.2+73.3 | 92 | 8 | 0.0037 | 0.081 |

Table 2

| Dry tooth time hour | Size (mm) | Dry dental process product in change in lot mass shi, (grams) | Dry matter in the product, %/ gr | Break up the amount of moisture that leaks outri,% | Moisture change of shi, % | Dry tooth is fastgi % / min | Product moisture storage of (kg.moisture / kg.dry matter) |
|---------------------|-----------|---|----------------------------------|--|---------------------------|-----------------------------|---|
| 0 | 10 | 1367 | 5.0+5.3 / 69.2+73.3 | | 95 | | 0.95 |
| 30 | 10 | 576 | 5.0+5.3 / 69.2+73.3 | 12 | 88 | 26.3 | 0.92 |
| 60 | 10 | 230 | 5.0+5.3 / 69.2+73.3 | 30 | 70 | 5.76 | 0.76 |
| 90 | 10 | 182 | 5.0+5.3 / 69.2+73.3 | 38 | 62 | 0.53 | 0.65 |
| 120 | 10 | 123 | 5.0+5.3 / 69.2+73.3 | 52 | 44 | 0.49 | 0.44 |
| 150 | 10 | 86 | 5.0+5.3 / 69.2+73.3 | 80 | 20 | 0.24 | 0.201 |
| 180 | 10 | 84 | 5.0+5.3 / 69.2+73.3 | 82 | 18 | 0.111 | 0.181 |
| 210 | 10 | 82 | 5.0+5.3 / 69.2+73.3 | 84 | 16 | 0.0095 | 0.161 |
| 240 | 10 | 81 | 5.0+5.3 / 69.2+73.3 | 85 | 15 | 0.0041 | 0.147 |
| 270 | 10 | 80 | 5.0+5.3 / 69.2+73.3 | 86 | 14 | 0.0037 | 0.141 |
| 300 | 10 | 79 | 5.0+5.3 / 69.2+73.3 | 88 | 12 | 0.0033 | 0.120 |
| 330 | 10 | 78 | 5.0+5.3 / 69.2+73.3 | 92 | 9 | 0.0030 | 0.090 |

Table 3

| Dry tooth time hour | Size (mm) | Dry dental procedure nida mahsu change in lot mass, (grams) | Dry matter in the product, %/ gr | Break up the amount of moisture that leaks outri,% | Moisture change of shi, % | Dry tooth is fastgi % / min | Product moisture storage of (kg.moisture / kg.dry matter) |
|---------------------|-----------|---|----------------------------------|--|---------------------------|-----------------------------|---|
| 0 | 15 | 1052 | 5.0+5.3 / 69.2+73.3 | | 95 | | 0.98 |
| 30 | 15 | 692 | 5.0+5.3 / 69.2+73.3 | 10 | 90 | 12 | 0.92 |
| 60 | 15 | 384 | 5.0+5.3 / 69.2+73.3 | 18 | 82 | 5.13 | 0.82 |

| | | | | | | | |
|-----|----|-----|---------------------|----|----|---------|-------|
| 90 | 15 | 266 | 5.0÷5.3 / 69.2÷73.3 | 26 | 74 | 1.31 | 0.152 |
| 120 | 15 | 164 | 5.0÷5.3 / 69.2÷73.3 | 42 | 58 | 0.85 | 0.64 |
| 150 | 15 | 108 | 5.0÷5.3 / 69.2÷73.3 | 64 | 36 | 0.373 | 0.360 |
| 180 | 15 | 96 | 5.0÷5.3 / 69.2÷73.3 | 72 | 28 | 0.0666 | 0.281 |
| 210 | 15 | 88 | 5.0÷5.3 / 69.2÷73.3 | 78 | 22 | 0.0380 | 0.220 |
| 240 | 15 | 86 | 5.0÷5.3 / 69.2÷73.3 | 80 | 20 | 0.00833 | 0.201 |
| 270 | 15 | 84 | 5.0÷5.3 / 69.2÷73.3 | 82 | 18 | 0.0074 | 0.180 |
| 300 | 15 | 82 | 5.0÷5.3 / 69.2÷73.3 | 86 | 14 | 0.0066 | 0.148 |
| 330 | 15 | 80 | 5.0÷5.3 / 69.2÷73.3 | 88 | 12 | 0.0060 | 0.120 |
| 360 | 15 | 78 | 5.0÷5.3 / 69.2÷73.3 | 90 | 10 | 0.0055 | 0.100 |

The curves obtained during the period of decreasing speed of drying (period II) take two different forms in a certain character and explain the second critical speed ω_{cr2}^c . At the end of the second period, the product moisture asymptotically approaches the equilibrium moisture limit. Therefore, the equilibrium moisture limit in the drying cycle explains that the evaporation of moisture from the product composition is completely stopped.

During the drying process, the threshold values of the equilibrium humidity were analyzed, and $10 \leq \varphi \leq 90\%$ the desorption process was studied at the relative humidity of air and the corresponding temperature $25^\circ\text{C} \leq t \leq 62^\circ\text{C}$. The obtained results show that the desorption isotherm of tomato fruit has a certain characteristic point at the above-mentioned limits of temperature and relative humidity of the air, among which the following quantities were determined according to the moisture content of the product in three sections of the drying kinetics [8,9,10,14]:

- monomolecular adsorption within the range of $0 \div 17\%$ of relative air humidity;

- polymolecular adsorption from 15% to 30% relative air humidity;

- change of humidity in microcapillaries at the limit of 30% relative air humidity and above.

of the equilibrium function, $y = f(W_{eq}, t, \varphi)$ the equilibrium moisture of the tomato fruit has the following form,

$$W_{eq} = K_1(t) + K_2(t) \left[\lg\left(\frac{1}{1-\varphi}\right) \right]^{1/2} \quad (5)$$

Based on the results of the drying process speed curve (Fig. 2), the values of the drying process coefficients K_1 and K_2 were determined for the 2 sections of the desorption process, $K_1 = 7,9 + 0.43t$; $K_2 = 1.8 \cdot t^{0.169}$. The obtained results confirm that $8 \div 12\%$ it is desirable to dry tomato fruit around [8,13].

The analysis of the curve of the drying process speed shows that during constant drying speed (I) w_{cr1} , 34-35% of the content of the tomato fruit with a thickness of 8 mm, 25-26% of the content of the tomato fruit with a thickness of 10 mm, and from the content of the tomato fruit with a thickness of 15 mm 14-15% moisture is released. In the period of decreasing drying rate (II), w_{cr2} the equilibrium moisture content of the tomato fruit with a thickness of 8 mm is 9%, the equilibrium moisture content of the sample with a thickness of 10 mm is 11%, and the equilibrium moisture content of the sample with a thickness of 15 mm is 12-13%. In this II period, the evaporation of moisture from the composition of the product slows down, the temperature of the product partially rises, and the w_M evaporation of moisture becomes zero when the moisture content of the product reaches the equilibrium state [19].

Density of heat capacity for the drying process of tomato fruit – g ; the limits of influence of wavelength – λ and air speed were determined, and the duration of the drying process was calculated for the non-stationary regime V_{air} . When processing the results, a multifactorial experimental plan was drawn up and appropriate calculations were made using the derivative square method [4,5,10]. Based

on the full factorial experiment, equations representing the value of constant drying rate N for the first period of the kinetics of the drying process, the value of the drying

coefficient K for the second period of drying, and the critical moisture change were obtained W_{cr} [15]:

$$N = 0.38 \exp(0.18g + 0.163 v_{air} + 0.072 t_{air} + 0.18\lambda)$$

$$K = 0.137 \cdot 10^{-2} \cdot \exp(0.601 \cdot g + \frac{2.3v_{air}}{18.65+7.36 \cdot v_{air}} + 0.074 t_x + 0.178\lambda)$$

$$W_{cr} = 468.77 \cdot \exp(-0.0179 \cdot v_{air} + 0.0079 t_{air} + 0.029\lambda)$$

N , K and W_{cr} correlation coefficients represent the adequacy of the tomato fruit drying process.

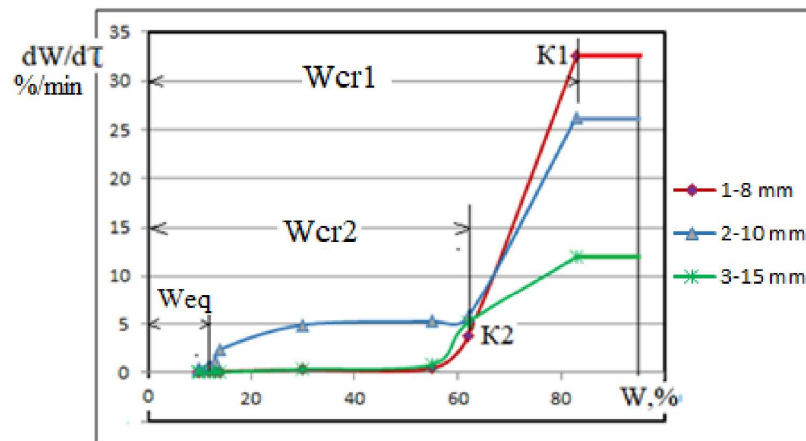


Figure 2. Drying process speed curve

Figure 2. Drying process speed curve

Parameters influencing the drying process (g , v , t , λ) within the following limits ($0 \leq g \leq 0,95 \text{ kW/m}^2$; $1.5 \leq v_{air} \leq 2,2 \text{ m/s}$; $58^\circ\text{C} \leq t_{air} \leq 62^\circ\text{C}$; $0.7 \leq \lambda \leq 2,8 \text{ mkm}$) the deviation error of the performed calculations is 5%. The process slows down as a result of the initial direction of the drying process, i.e. through heat-moisture-conduction, liquid droplets in the product are directed toward the center. In the second period, the temperature gradient in the product decreases, and the movement of liquid drops begins to move in the opposite direction, that is, from the center to the evaporation zone (surface). As the temperature increases per unit of time, the release of moisture in the product accelerates. As a result, in the first period of the drying process, the drying speed increases by 3.5 ÷ 4 times, and the value of the drying coefficient 2,0 ÷ 2,5 increases by times.

During the period of constant drying rate of the drying process, the critical moisture content of the product 1,5 ÷ 1,8 was observed to decrease by 1.5 times, the rate of drying process was observed to increase by 1.5 times, and during the period of decreasing drying rate, it was observed to increase by 1.2 times.

A drying device was developed for processing tomato fruit based on pulse mode and drying at low temperature in the wavelength range of 0.7 ÷ 1.1 and 2.4 ÷ 2.8 μm of infrared light. In the drying device, it was possible to control and adjust the change of parameters such as product humidity, temperature, relative humidity of the air in the drying chamber by units of time, and to implement the technological process based on the automatic control system [9,11,18].

Discussions. The theoretical and practical experiments conducted on the

drying process show that the efficiency level of the production of dried fruits and vegetables is evaluated by the energy efficiency of the device, the quality index of the finished product, and the shelf life. The most important factor affecting these indicators is the process of heat treatment of this product, and it is appropriate to develop an optimal design of the drying device on this basis. Traditional drying methods for the production of dried agricultural products are no longer suitable for low-productivity industries due to their high energy costs. Because a number of drying equipment is designed to work on the basis of liquid and gaseous fuels. Due to the rapid increase in the world price of such energy resources, the cost of the produced products is sharply high and does not cover the expenses. From this point of view, the application of optimal options of heat exposure based on the non-traditional heat treatment method and accelerating the movement of moisture in the product to the surface - in a step-by-

step, pulse mode, creates the basis for obtaining targeted results [12].

Conclusion. The conclusion is that in the initial stage of the drying process (50-60 minutes of the period of heating and drying speed of the product) in order to accelerate the molecular movement of liquid droplets in the product, to generate the required heat for the release of moisture, the wave of infrared $\lambda = 0,7 \div 1,1 \text{ mkm}$ light based on the implementation of processing based on the pulse mode in the length range. Then, in the period of decreasing drying speed (II), as well as the continuous $\lambda = 2,4 \div 2,8 \text{ mkm}$ drying process in the wavelength range of infrared light up to the equilibrium moisture limit of tomato fruit, created the basis for obtaining a positive result. The advantage of continuous drying in the infrared wavelength range is that liquid droplets located in the center of the product have maximum absorption at this wavelength, which accelerates the movement of moisture to the surface $\lambda = 2,4 \div 2,8 \text{ mkm}$.

References

1. Гинзбург А.С. Основы теории и техники сушки пищевых производств. –М.: Пищевая промышленность, 1973.-528 с.
- 2.Семенов Г.В. Сушка сырья: мясо, рыба, овощи, фрукты, молоко /Г.В. Семенов, Г.И.Касьянов. - Ростов н/Д: Издательский центр "МарТ", 2012. - 112 с.
- 3.Атаназевич В.И. Сушка пищевых продуктов /В.И. Атаназевич. - М.: ДеЛи, 2010. - 295 с.
- 4.Грачев Ю.П., Плаксин Ю.М. Математические методы планирования экспериментов. - М.: ДеЛи принт. 2005. –296 с.
- 5.Алтухов, И. В. Экспериментальная ИК-установка для сушки плодов и овощей / И. В. Алтухов, В. Д. Очиров, В. А. Федотов // Вестник ИрГСХА. – 2017. – № 81/2. – С. 90–96.
- 6.Афонькина, В. А. Инфракрасная сушка термолабильного растительного сырья на примере зеленых культур: дис. ... канд. техн. наук : 05.20.02 / Афонькина Валентина Александровна. – Челябинск, 2014. – 158 с
- 7.Гинзбург А.С., Савина И.М. Массовлагообменные характеристики пищевых продуктов.-М.: Легкая и пищевая промышленность. 1982.-280 с.
- 8.Джураев.Х.Ф., Артиков А.А., Додаев К.О., Хикматов Д.Н., Сафаров О.Ф., Мехмонов И.И. Интенсификация процесса тепло- и массообмена при комплексной переработке сельхозпродуктов.// Ж. Хранение и переработка сельхозсырья.-2003.№11.-С47.
9. Shukhrat Rasulov, Askar Artikov, Kamiljan Abidov and Khayrullo Djuraev. Development of the installation and experimental research of the patterns of change in influencing factors in the process of tomato drying // IV International conference on

applied physics, information technologies and engineering APITECH-IV 2022 participated in the IV International Conference on Applied Physics, Information Technologies and Engineering (Apitech-IV 2022) on October 6-8, 2022 |Bukhara, Uzbekistan. Journal of Physics: Conference Series. 1-8 p.

10. Shukhrat Rasulov, Khayrullo Djuraev, Kamildjan Abidov, Akhtam Usmanov and Amirulla Fayziev. Experimental research of the low-temperature drying process of tomato // IV International conference on applied physics, information technologies and engineering APITECH-IV 2022 participated in the IV International Conference on Applied Physics, Information Technologies and Engineering (Apitech-IV 2022) on October 6-8, 2022 |Bukhara, Uzbekistan. Journal of Physics: Conference Series. 1-7p.

11. Uvayzov S.K., Rasulov Sh.X., Mizomov M.S., Fayziyev A.X. Mathematical description of the process of heat and mass exchange during drying // Xorazm ma'mun akademiyasi axborotnomasi –8-1/2023 XIVA-2023 147-153 b.

12. Расулов Ш.Х., Джураев Х.Ф., Увайзов С.К., Мизомов М.С., Файзиев А.Х. Разработка оптимального механизма перемещения тепло-и массоперенос в процессе сушки // Научно-технический журнал Ферганского политехнического института 2023. Том 27. №5. С 118-125.

13. Джураев Х.Ф., Расулов Ш.Х., Абидов К.З., Усмонов А. Энергосберегающая технология сушки томатного сырья универсум.com УНИВЕРСУМ ТЕХНИЧЕСКИЕ НАУКИ № 9 (102) сентябрь 2022г. Част 3 Москва 2022. 15-18 с.

14. Rasulov Sh.X., Djuraev Kh.F., Adizova M.R. Fundamentals of Kinetiks of Tomato Drying Process // Eurasian Research Bulletin In volume 6 of March, 2022 IMPACT FACTOR: 8.105 p 26-30 Genius Journals Publishing, Group, Brussels Belgium.

15. Artikov A., Djuraev Kh.F., Masharipova Z.A., B.N. Razhabov. Systems thinking, analysis and finding optimal solutions on examples of engineering technology. (Bukhara: Durdona Publishing House), 2020. P.184.

16. Левинский, В.Н. Обоснование технологии и параметров установки инфракрасной сушки высоковлажного сырья на примере томата.: дис. ... канд. т. - х. наук: 05.20.02 / Левинский Василий Николаевич. – Троицк, 2021. – 24 с.

17. Завалий А.А. Разработка и тепловое моделирование устройств инфракрасной сушки термолабильных материалов // А. А. Завалий, Ю. Ф. Снежкин – Симферополь: Ариал, 2016. - 263 с

18. Джураев Х.Ф. Научные основы инфракрасно-конвективной сушки плодов сельскохозяйственных культур. Ташкент: Фан, 2005. – 107 с.

19. Джураев Х.Ф., Артиков А.А., Чориев А.Ж. О распределении влаги при сушке пластинчатых, коллоидно – капиллярно – пористых изделий на примере тонко нарезанной дыни // Ж. «Хранение и переработка сельхозсырья», М.: 2002. №7 -С.13-14.

20. Джураев Х.Ф. Закономерность переноса влаги в процессе сушки плодовых культур // Ж. «Вестник ТашГТУ». 2004. № 1 – С. 174-178.

C O N T E N T S

| PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY | |
|--|-----------|
| N.Usmanova, M.Abdukarimova, Sh.Mahsudov | |
| Information modules for automation of the process of forming the structure of industrial collection of women's clothing..... | 3 |
| O.Turdiyeva, A.Khojiyev | |
| Research analysis of transformation new assortment development..... | 10 |
| M.Rasulova, Sh.Mamasoliyeva, G.Norboyeva | |
| Evaluation of heat conductivity of special clothing..... | 15 |
| D.Rayimberdiyeva, N.Nabidjanova, N.Ismailov | |
| Mathematical model of the influence of a gymnast's strength on clothing fabric..... | 22 |
| G.Gulyaeva | |
| Modeling of strength reliability and transformation of a knitted loop at the limit state of the structure..... | 26 |
| H.Diyorov | |
| Experimental determination of the cleaning efficiency of the fiber in the pipe.. | 31 |
| S.Khashimov, R.Muradov | |
| Problems in cleaning cotton-seed and their solution..... | 35 |
| GROWING, STORAGE, PROCESSING AND AGRICULTURAL PRODUCTS AND FOOD TECHNOLOGIES | |
| N.Kurbanov, S.Bozorov | |
| Development prospects of the oil production industry in the republic of Uzbekistan and foreign countries..... | 41 |
| Sh.Rasulov, Kh.Djuraev, A.Usmanov, M.Khalikov | |
| Kinetics of drying process of tomato fruit..... | 45 |
| M.Sobirova, J.Farmonov | |
| Oil extraction studies from flax seeds..... | 52 |
| M.Meliboyev, G.Makhmudova, N.Muydinova | |
| Importance of potato powder extraction technology in production and industry..... | 56 |
| CHEMICAL TECHNOLOGIES | |
| E.Panoev, Kh.Dustov, J.Jamolov | |
| Research of corrosion and foaming processes in gas absorption purification and technology of their protection in inhibitors..... | 61 |
| U.Odamov, M.Komilov | |
| Assessment of the degradation process of solar photovoltaic plants in the climatic conditions of Uzbekistan..... | 69 |
| R.Dusanov, Kh.Turaev, P.Tojiev, D.Nabiev, KH.Eshankulov | |
| Physical-mechanical properties of composite materials based on vermiculite, bazalt, wollostanite, and polyethylene P-Y 342 and polyamide PA-6..... | 77 |
| Z.Voqqosov, M.Ikromova | |
| Bentonite and phosphorite production of organomineral fertilizers based on raw materials and nitrogen-fixing microorganisms ((CD:B:NFM=100:5:(0-4)), (CD:B:PF:NFM=100:5:5:(0-4)))..... | 81 |
| D.Abdirashidov, Kh.Turaev, P.Tajiyev | |

| | |
|--|------------|
| Studying the structure and properties of polypropylene filled with nitrogen, phosphorus, metal-containing oligomers..... | 90 |
| M.Khoshimkhodjaev, M.Khuramova | |
| Optimization of the method for instrumental neutron activation analysis (inaa) of natural objects..... | 100 |
| F.Rakhmatkariyeva, M.Koxxarov, Kh.Bakhronov | |
| Isotherm of ammonia adsorption in zeolite CaA (M-22)..... | 105 |
| R.Kurbaniyazov, A.Reymov, B.Pirnazarov, Sh.Namazov, O.Badalova, B.Beglov | |
| Rheological properties of ammophosphate pulps obtained using phosphorite powder of the khodjakul deposit..... | 111 |
| F.Eshkurbonov, A.Rakhimov, J.Rakhmonkulov, E.Safarova, A.Ashurova, N.Izzatillayev, M.Bobokulova | |
| Investigation of the chemical-mineralogical composition of bentonite of the khaudag deposit and synthesis of wine fining agents based on its..... | 117 |
| J.Shukurov | |
| Modeling the production of dimethyl ether from natural gas..... | 126 |
| D.Makhkamova, Z.Turaev, M.Dedaboyeva | |
| Study of interaction of components in $ZnSO_4 - NH_4H_2PO_4 - H_2O$ system.... | 137 |
| D.Akhunov | |
| Study of the problems of atmospheric waste water collection and green field irrigation..... | 142 |
| D.Jumaeva, R.Akhrorova, S.Barnoeva, O.Kodirov, U.Raximov | |
| Study of adsorption isotherms of polar and non-polar molecules on silica adsorbents..... | 146 |
| MECHANICS AND ENGINEERING | |
| E.Abdullaev, V.Zakirov | |
| Using parallel service techniques to control system load..... | 154 |
| E.Aliyev, A.Mamaxonov | |
| Development of efficient chain transmission construction based on analysis of constructive characteristics of chain drives of technological machines..... | 161 |
| S.Utaev, A.Turaev | |
| Results of a study of the influence of oil contamination on wear of the working surface of diesel cylinder lines..... | 171 |
| L.Tilloev, Kh.Dustov | |
| Separation of the polymer mass from the waste of the alkaline cleaning process of pyrogas by the extraction method..... | 177 |
| A.Mirzaalimov | |
| Effect of temperature on photoelectric parameters of three-way illuminated solar cells..... | 183 |
| Sh.Mamajanov, A.Qakhharov, Sh.Isaboyev | |
| On training of competitive personnel - on the basis of creating a new generation of teaching literature in the educational process (in the example of mechanical science)..... | 193 |
| K.Ismanova | |
| Mathematical model and analytical solutions of the process of physics-chemical hydrodynamics..... | 197 |
| N.Sharibayev, B.Nasirdinov, G.Rasulova | |

| | |
|---|------------|
| Microcontroller-based mechatronic system with heating and humidity sensor for silkworm eggs incubation..... | 205 |
| M.Rasulmuhamedov, K.Tashmetov, T.Tashmetov | |
| Methods of determining transport flows..... | 210 |
| J.Izzatillaev, U.Khudoyberdiev, X.Mamadiev | |
| Prospects for the application of vertical axis wind turbines in the Jizzakh region..... | 218 |
| Y.Asatillaev, N.Israilov | |
| Problems and possibilities of laser synthesis of metal powders in additive technologies..... | 230 |
| U.Meliboev, D.Atambaev | |
| Determination of acceptable values of the main factors affecting the production of twisted thread..... | 237 |
| N.Adilov | |
| Assessment of the technical condition of the weight checking wagon type 640-VPV-271..... | 242 |
| ADVANCED PEDAGOGICAL TECHNOLOGIES IN EDUCATION | |
| M.Ikromova | |
| Programming as one of the main approaches in the development of children's komputational thinking..... | 247 |
| A.Yuldashev | |
| Developing activities, the academy of public administration under president of the republic of Uzbekistan..... | 253 |
| B.Kholhodjaev, B.Kuralov, K.Daminov | |
| Block diagram and mathematical model of an invariant system..... | 259 |
| B.Mamadaliyeva | |
| Improving students speaking skills in practical lessons..... | 267 |
| G.Rasulova | |
| A lexical-semantic study of terms related to agricultural technology in Uzbek and English languages..... | 273 |
| ECONOMICAL SCIENCES | |
| M.Bustonov | |
| Digital economy and employment..... | 279 |
| M.Bustonov | |
| Econometric analysis of the activities of multi-sectoral farms..... | 285 |
| M.Rahimova | |
| Prospects for the development of small and medium business in Namangan region..... | 292 |
| A.Abdullayev, H.Djamalov | |
| Organizational structure of the internal control service for the fulfillment of tax obligations of enterprises..... | 297 |
| H.Djamalov, A.Abdullayev | |
| Issues of organizing internal control of fulfillment of tax obligations of enterprises..... | 307 |
| Sh.Maripova | |
| Specific features of management in small business enterprises..... | 316 |
| N.Abdieva, R.Abdullayeva, U.Rajabov | |
| The constituent elements and the need for state regulation of small business and private entrepreneurship..... | 324 |