

ISSN 2181-8622

Manufacturing technology problems



Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX  COPERNICUS
INTERNATIONAL

**Volume 11
Issue 1
2026**



NamMTI ILMIY-TEXNIKA JURNALI TAHRIR HAY'ATI A'ZOLARI

Bosh muharrir: f-m.f.d., prof. O.O. Mamatkarimov

Bosh muharrir o'rinbosari: k.f.d., prof. O.K. Ergashev

TEXNIKA FANLARI (PAXTA, TO'QIMACHILIK VA YENGIL SANOAT)

- | | | |
|------------------------------|---|--|
| 1. Prof. Dr. Metin ÇOLAK | – | Ege Universiteti, Turkiya |
| 2. Prof. Dr. Suneel KATERIYA | – | Javoharlal Nehru Universiteti, Hindiston |
| 3. Prof. Dr. Muradov RUSTAM | – | Namangan To'qimachilik Sanoat Instituti |
| 4. Prof. Dr. Obidov AVAZBEK | – | Namangan Muhandislik-Texnologiya Instituti |
| 5. Prof. Dr. Maxkamov ANVAR | – | Namangan Muhandislik-Texnologiya Instituti |
| 6. Prof. Dr. Azizov SHUXRAT | – | Namangan Muhandislik-Texnologiya Instituti |
| 7. Dr. Qorabayev SHERZOD | – | Namangan Muhandislik-Texnologiya Instituti |

TEXNIKA FANLARI (QISHLOQ XO'JALIGI VA OZIQ-OVQAT TEXNOLOGIYALARI)

- | | | |
|------------------------------------|---|--|
| 1. Prof. Dr. Sakina BINTU ABDULLAH | – | Malaya Universiteti, Malayziya |
| 2. Prof. Dr. Abdalova GULISTAN | – | Taraz davlat universiteti, Qozog'iston |
| 3. Prof. Dr. Xudayberdiyev ABSALOM | – | Namangan muhandislik-texnologiya instituti |
| 4. Prof. Dr. Merganov AVAZXON | – | Namangan muhandislik-texnologiya instituti |
| 5. Prof. Dr. Sherquziyev DONIYOR | – | Namangan muhandislik-texnologiya instituti |
| 6. Prof. Dr. Qanoatov XAYRULLO | – | Namangan muhandislik-texnologiya instituti |
| 7. Prof. Dr. Mamatov SHERZOD | – | Toshkent shahridagi Vebster Universiteti |

TEXNIKA FANLARI (MEXANIKA VA MASHINASOZLIK)

- | | | |
|--|---|--|
| 1. Dr. Jaclyn SHARP | – | Pittsburg Universiteti, AQSH |
| 2. Prof. Dr. Aleksey KAZINSKY | – | Saratov davlat texnologiya universiteti, Rossiya |
| 3. Akad. Prof. Zaynobbiddinov SIROJIDDIN | – | Andijon Davlat Universiteti |
| 4. Prof. Dr. Usmanov PAZLITDIN | – | Namangan muhandislik-texnologiya instituti |
| 5. Prof. Dr. Matkarimov PAXRIDDIN | – | Namangan muhandislik-texnologiya instituti |
| 6. Prof. Dr. Sharibayev NOSIRJON | – | Namangan muhandislik-texnologiya instituti |
| 7. Prof. Dr. Erkaboyev ULUG'BEK | – | Namangan muhandislik-texnologiya instituti |

KIMYO FANLARI (KIMYO VA KIMYOVIY TEXNOLOGIYALAR)

- | | | |
|----------------------------------|---|---|
| 1. Prof. Dr. Abel SANTOS | – | Porto Universiteti, Portugaliya |
| 2. Prof. Dr. Junli YANG | – | Lanzhou kimyoviy fizika instituti, Xitoy |
| 3. Akad. Prof. Namazov ShaFOAT | – | O'zR FA Umumiy va Noorganik Kimyo instituti |
| 4. Prof. Dr. Botirov ERKIN | – | O'zR FA O'simlik Moddalar Kimyosi Instituti |
| 5. Prof. Dr. Akbarov HAMDAM | – | O'zbekiston Milliy Universiteti |
| 6. Prof. Dr. Nurmanov SUVANKUL | – | O'zbekiston Milliy Universiteti |
| 7. Prof. Dr. Salihanova DILNOZA | – | O'zR FA Umumiy va Noorganik Kimyo instituti |
| 8. Prof. Dr. Kattayev NURIDDIN | – | O'zbekiston Milliy Universiteti |
| 9. Prof. Dr. Sulstonov PO'LATJON | – | Geologiya fanlari universiteti |

TA'LIMDA ILG'OR PEDAGOGIK TEXNOLOGIYALAR

- | | | |
|--------------------------------|---|--|
| 1. Prof. Dr. Paul TIKALSKY | – | Oklahoma Davlat Universiti, AQSH |
| 2. Dr. David Leffler | – | Liberty Universiteti, AQSH |
| 3. Prof. Dr. Wen-Jian ZHANG | – | Zhejiang Universiteti, China |
| 4. Prof. Ergashev SHARIBBOY | – | Namangan Muhandislik-Qurilish Instituti |
| 5. Prof. Dr. Musayev JAHONGIR | – | OFIV |
| 6. Prof. Dr. Eshbayeva ULBOSIN | – | Namangan Muhandislik-Texnologiya Instituti |
| 7. Prof. Dr. Xoshimova DILDORA | – | Namangan Muhandislik-Texnologiya Instituti |

IQTISODIYOT FANLARI

- | | | |
|----------------------------------|---|--|
| 1. Dr. Biral MERCAN | – | Necmettin Erbakan Universiteti, Turkiya |
| 2. Dr. Orsolya KATONA | – | Miskolc Universiteti, Vengriya |
| 3. Prof. Dr. Soliyev AHMADJON | – | Namangan Muhandislik-Texnologiya Instituti |
| 4. Prof. Dr. Saidboyev SHERMIRZA | – | Namangan Muhandislik-Texnologiya Instituti |
| 5. Prof. Matkarimov KAMOLIDDIN | – | Namangan Muhandislik-Texnologiya Instituti |
| 6. Dr. Bustonov MANSUR | – | Namangan Muhandislik-Texnologiya Instituti |
| 7. Dr. Rashidov RAKHMATILLA | – | Namangan Muhandislik-Texnologiya Instituti |

Muharrirlar guruhi

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



THE IMPORTANCE OF USING REVERSE OSMOSIS IN TOMATO PASTE PRODUCTION

IKROMOV FARRUXBEK

PhD student, Namangan State Technical University, Namangan, Uzbekistan
Phone.: (0893) 576-1192, E-mail.: farruhbekikromov1992@gmail.com

IKROMOVA YULDUZXON

PhD student, Namangan State Technical University, Namangan, Uzbekistan
Phone.: (0899) 977-3080, E-mail.: yulduzusmanova0901@gmail.com
**Corresponding author*

XAMDAMOV ANVAR

Associate Professor, Namangan State Technical University, Namangan, Uzbekistan
Phone.: (0893) 946-0956, E-mail.: anvarkhamdamov@rambler.ru

Abstract: This article compares the efficiency of the traditional thermal evaporation method and the modern reverse osmosis (RO) process in the production of tomato paste. The study examines the advantages of reverse osmosis technology in maintaining product quality and its cost-effectiveness in reducing energy consumption. The results show that the reverse osmosis process minimizes damage to heat-sensitive components and requires significantly less energy than traditional methods. The article also highlights the prospects for using a hybrid method that combines reverse osmosis and vacuum evaporation to achieve high-quality concentrates.

Keywords: Tomato paste, reverse osmosis, membrane processes, concentration, energy saving, evaporation, tomato juice, nutritional value.

Introduction. Tomatoes are one of the most important agricultural products, used both in their natural ripe state and as processed products, as well as as an additive to food products. The requirements for the quality and varieties of tomatoes used for the production of tomatoes, juices, purees and pastes as an additive to food products are significantly different from the requirements for tomatoes used for consumption. Technically ripe tomato products are more important than marketable varieties in terms of shape and appearance, in terms of indicators such as sugar, acidity and organo-mineral substances. The content of sugar and dry matter in technically ripe tomato products depends on the conditions of their ripening and also on the conditions of product processing.

Methods: In the process of concentrating tomato juice, it is also possible to use filters that operate without thermal treatment, such as reverse osmosis, microfiltration and ultrafiltration. Filtration processes are distinguished by their energy efficiency compared to evaporation processes, and no heat agent is used in the filtration process. Since the process is carried out at low temperatures in the filtration process, it is possible to preserve the products that are not resistant to high temperatures in the product, while maintaining its natural characteristics such as color, smell, consistency and taste.

Filtration is the process of separating liquids based on the size of the product molecules. In the food industry, filtration is often used to separate fruit juices and alcoholic beverages, and it also allows microorganisms to be removed from the product being concentrated. This, in turn, reduces the factors that contribute to product spoilage.

Ultrafiltration separates molecules smaller than those obtained by microfiltration, ranging from 0.1 to 100 nm. Filtration is used in the production of juices and alcoholic beverages, as well as in the separation of whey from dairy products. Reverse osmosis is an important filtration process for effectively separating the smallest molecules, and is commonly used to purify drinking water and seawater. Microfiltration, ultrafiltration, and reverse osmosis are widely used in various industries, but they have only recently begun to be used in the food industry for concentration and separation of products.

The osmosis filtration process is used to concentrate heat-sensitive products and is more widely used in the production of medical products. In the production of food products, the filtration process was initially proposed in the wine industry for the separation and concentration of clear grape juice and was later put into practice. In the current food industry, the filtration-concentration process is used for specific products and is not fully explored, limited by its capabilities. This research work includes the study of the possibilities of using filtration (reverse osmosis) processes in the production of tomato paste, increasing the concentration of tomato juice, and the development of appropriate production strategies. Alternative low-temperature concentration processes, such as microfiltration, ultrafiltration, reverse osmosis, and isothermal membrane distillation, require less energy than heat exchange processes, but can also be concentrated without causing drastic changes in the color, taste, and odor characteristics of the final concentrates. The advantages of using a membrane process for tomato juice concentration include: low labor costs, operating costs (no column required since no evaporation process occurs), recovery, increased product yield, reduced energy requirements, and minimal waste generation.

When using the evaporation process in the production of tomato paste, the process is carried out in the following sequence: tomatoes are brought from the fields and sent directly to production or storage warehouses. The product is washed, sorted and cleaned using washing belts. The washed, clean tomato fruits are mechanically processed and blanched. The blanched tomatoes are crushed and the juice is separated from the pulp and seeds in 2 stages. The separated tomato juice is concentrated in a three-stage circulating evaporator. The tomato paste leaving the evaporator is pasteurized in a tube-type heat exchanger in a tube-type heat exchanger, and the cooling process is also carried out in the same type of heat exchanger. The tomato paste that has undergone these processes is sent for packaging (Figure 1).

Fruits and vegetables contain a high amount of water, and humidity and temperature are important indicators for the development of microorganisms, which limit the storage conditions of fruits and vegetables. This increases transportation and storage costs. Therefore, fruits and vegetables are often stored by cooling and drying. Evaporation does not help to completely remove the moisture in fruits and vegetables. Drying, on the other hand, partially or completely removes moisture.

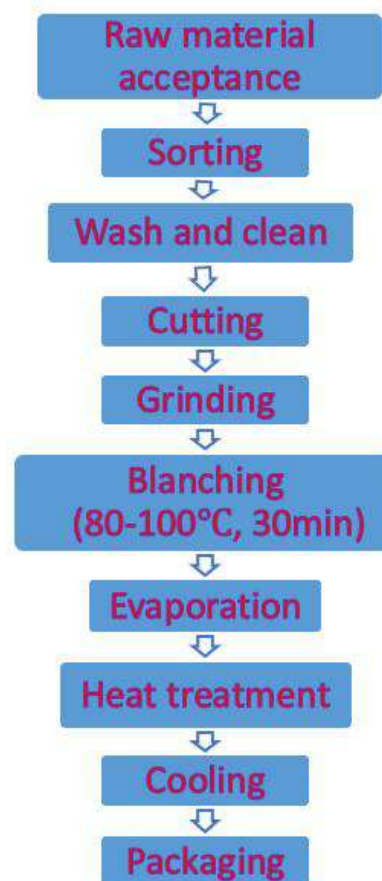


Figure 1. Technological scheme for the production of tomato paste

Results: The technological parameters and economic costs of increasing the concentration of tomato juice using multi-stage evaporators have been studied by many researchers.

In this study, the advantages and disadvantages of the filtration (reverse osmosis) process in the production of tomato paste were studied compared to the three-stage evaporation process, and the following results were obtained. Evaporators require both electrical and thermal energy to increase the concentration of tomato juice. The reverse osmosis process, on the other hand, requires only electrical energy. Since the evaporators are three-stage, it was found that the consumption of electrical energy is twice as high as that of reverse osmosis. While the process duration in the reverse osmosis process is 2-4 hours, in the evaporators the process lasts 6-18 hours, depending on the heat exchange surface (Table 1).

Table 1. Electricity consumption required for the process

PROCESS	Type of energy	Average energy consumption (kW/m ³)	Duration of the procedure	Thermal energy consumption
Reverse osmos	electricity	3.0-6.0 kW/m ³	2-4 hour	Not required
Multistage distillation	thermal-electricity	7.0-12.0 kW/m ³	6-18 hours depending on temperature, surface and volume	2500–2700 kJ/kg

The study compared the economic, technological and organic aspects of evaporation plants with reverse osmosis, and also introduced alternative filtration processes. The cost analysis mainly included capital costs, labor, fuel, steam, cooling water and electricity costs. It was found that reverse osmosis consumes less energy than evaporation and is more suitable for preserving its natural state.

Filtration processes involve the selective separation of components in a liquid or gaseous stream through a semipermeable barrier. Membrane separation is a physical process that involves the retention of a concentrate and the passage of moisture through a membrane. The driving force for the separation is pressure.

Table 2. Technical and economic and comparative analysis of indicators

Indicator	Evaporation (Distillation)	Reverse Osmos (RO)
The main mechanism	<i>Heat (Phase change)</i>	<i>Mechanical pressure (Membrane)</i>
Degree of desalination	<i>Very high (99.9%)</i>	<i>high (95-99%)</i>
Cleaning from microorganisms	<i>Sterile (due to boiling)</i>	<i>Full (due to small membrane pores)</i>
Energy consumption	<i>High</i>	<i>Low/Medium</i>
Volatile organic substances	<i>It may pass</i>	<i>Holds well</i>

During the evaporation process, volatile organic compounds, which indicate the naturalness of the product, can evaporate together with water vapor during the evaporation process. In the reverse osmosis process, the product remains concentrated due to the absence of evaporation and thermal treatment. The microbiological state of the product during the evaporation process is completely sterile (Table 2).

Discussion: Evaporation and reverse osmosis are the two most common technologies for liquid purification. When comparing them, attention is paid to the efficiency of the process, the quality of the final product and the economic aspects.

The results of the study show that the use of the reverse osmosis process in the production of tomato paste is a revolutionary solution not only in economic terms, but also in terms of quality. These results can be analyzed in the following three main areas:

1. Minimization of thermal effects and quality preservation: in traditional evaporation methods, tomato juice is heated. As a result of such heat treatment, thermolabile (heat-sensitive) substances inherent in tomatoes, such as the lycopene pigment and vitamin C, are significantly destroyed. The reverse osmosis process under discussion is carried out at room temperature. This allows you to preserve the natural color and nutritional value of the product by almost 100%. Aromatic volatile substances (essential oils) that evaporate during evaporation are completely retained on the reverse osmosis membrane, which ensures a richer taste of the final product.

2. Energy efficiency and resource conservation: reverse osmosis uses 50-60% less energy than evaporation. The main reason for this is that reverse osmosis does not involve a phase transition (water turning into steam). The heat energy required to evaporate water is very high, which increases production costs. In membrane technology, the main energy is spent only on driving high-pressure pumps. This is important in the current global energy crisis and the transition to a “green economy”.

3. Technological limitations and hybrid solutions: The reverse osmosis process has its own technical limitation - this is the increase in osmotic pressure. As tomato juice thickens, its osmotic pressure increases and at a certain point the process stops. Standard tomato paste is usually in a thick state.

Based on the above research results, the “Filtration (reverse osmosis)-single-stage evaporation” model was determined as the most optimal.

Conclusion. Studies have shown that the use of the “Filtration (reverse osmosis)-single-stage evaporation” process in the production of tomato paste has several advantages over the circulating three-stage evaporation process, and the low temperature of the process allows for the full preservation of the natural color, aroma and vitamins (especially vitamin C) of tomatoes. Economically, “Filtration (reverse osmosis)-single-stage evaporation” is quite economical compared to the full evaporation method due to its low energy consumption. In order to obtain a high-quality product in the industry, the most optimal solution was considered to be the introduction of a technology that first uses reverse osmosis and then short-term vacuum evaporation.

References

1. N.R.Yusupbekov, H.S.Nurmuhamedov, S.G. Zokirov. Kimyoviy texnologiya asosiy jarayon va qurilmalari. - T.: "Fan va texnologiya", 2015. - 848 b.
2. Dodaev Q.O. «Razrabotka nauchnix osnov intensivatsii teplomas-soobmennix protsessov pererabotki tomatov». Monografiya. T.: Iz-vo «Fan», 2005g. -125
3. Taubman Ye.I. Viparivanie. – M.: Ximiya, 1982. – 328 s.

4. Lipatov N.N. Protsessi i apparati pishevix proizvodstv. – M.: Ekonomika, 1987. – 272 s.
5. Ditnerskiy Yu.I. Obratniy osmos i ultrafiltratsiya. – M.: Ximiya, 1978. – 352 s.
6. Artikov A.A. Oziq-ovqat sanoati jarayonlari va qurilmalari (Darslik). – T.: O'zbekiston faylasuflari milliy jamiyati, 2010. – 616 b.
7. Salimov Z. Kimyoviy texnologiyaning asosiy jarayonlari va qurilmalari. 2 tomli. - Toshkent: O'zbekiston, 1995. T.1. - 237 b.

CONTENTS

TECHNICAL SCIENCES: COTTON, TEXTILE AND LIGHT INDUSTRY

Parpiyeva N., Kayumov J., Parpiyev D., Tukhtasinov D., Rizayev D., Komilov M.	3
Rotational auto-oscillations of ribbed cylinders in a pneumatic pressure supply system	
Mirzaumidov A.	14
Integrated multi-track laser surface hardening of gears and rotating components: thermal field control and residual stress engineering	
Mirzaumidov A., Xabibullayev D.	20
Practical study of determining vibrations of 5LP machine in experimental research	
Kozokov S.	26
Determination of optimal parameters of an advanced device for cleaning cotton from large impurities based on a mathematical model	
Mamakhanova Z.	38
Biomechanical principles of sportswear design for kayak slalom athletes	

TECHNICAL SCIENCES: AGRICULTURE AND FOOD TECHNOLOGIES

Sattarov K., Khazratkulov J.	46
Use of non-traditional raw materials in the production of fish feed	
Akramova G.	52
Grain cold conditioning device and technological solution	
Ravshanov S., Abdullayeva F., Zaynobiddinov M.	59
Investigation of the chemical composition, structure, and functional-technological properties of the secondary product "gluten" from kokand spirit JSC	
Abdurahimov A., Tashmurotov A., Kuzibekov S., Ochilova S., Toshmurotov M.	63
Comprehensive assessment of linear dimensions, physical-mechanical and chemical properties of cotton seeds of foreign and local varieties	
Yakubjanova Y.	69
Milk-based refreshing beverages: classification, nutritional benefits and comparative advantages over other beverage types	
Aliyeva G., Kanoatov X.	73
Study of the efficiency of using cryoprotectors on the rheology of the test	

Abdurazzokova M., Raxmonova X.	
Degradation of pectin and starch in sweet sorghum stem juice using enzymes	83
Ismanova A., Meliboyev M.	
Physico-chemical analysis methods in combined drying of topinambur raw materials	87
Atamirzayeva S.	
Investigation of additives in the composition of meat canned products based on taraxacum officinale Wigg. plant	93
Abdullayeva B.	
Comprehensive assessment of quality and safety indicators of minced meat semi-finished products	100
Ikromov F., Ikromova Y., Xamdamov A.	
The importance of using reverse osmosis in tomato paste production	105

CHEMICAL SCIENCES

Janaev M., Adilov R., Ergashev O.	
Laws of micelle formation in aqueous solutions of azomethines based on monoethanolamine and acetaldehyde	111
Mukhammadjonov M., Rakhmatkariyeva F., Oyidinov M.	
Hydrothermal synthesis of KA (LTA-type) zeolite from Angren kaolin: structural, morphological, and adsorption characterization	117
Abdukhamidova F., Ibragimova K., Khusenov A., Rakhmanberdiev G.	
Nitro-carboxymethylinulin synthesis	128
Yusupova M., Mamadjonova M., Egamberdiev S., Abduvohidov I.	
Study of the process of aminolysis of secondary polyethyleneterephthalate with monoethanolamine without the participation of a catalyst and analysis of the obtained product	134
Eshonkhodzhaeva O., Mirzarakhmetova D.	
Features of cationic pectin synthesis and properties	140
Urinboeva M., Abdikamalova A., Mamataliev N., Ismadiyorov A.	
Synthesis of surfactants based on fatty acids and their spectral analysis	147
Urinboeva M., Abdikamalova A., Mamataliev N., Ismadiyorov A.	
Adsorption activity of bentonite clays toward dyes	153
Hakimova Kh., Makhkamova D., Turayev Z.	
Extraction of the nickel microelement from industrial secondary products using sulfuric acid	166
Ochilov G., Boymatov I., Ganiyeva N.	
Adsorption properties of modified adsorbents for dyes	176

Shamuratova M., Giyasidinov A., Abdikamalova A., Eshmetov I.	
Bonding of porous structure and soil moisture retention in modification surfactants and polymers	180
Giyasidinov A., Sultonov B., Dedaboyeva M., Aliyev O.	
Optimal amounts and concentrations of calcium nitrate solution in the production of phosphate fertilizers	186
Shermatov A., Sherkuziyev D.	
Optimization of acid decomposition of washed calcined phosphoconcentrate using a mixed secondary sulfuric-extraction phosphoric acid system: chemical and ftir investigation	195
Umirov F., Erkaev A., Kucharov B., Maxmudov R., Baxshilloev N.	
Production of magnesium chloride from magnesium-containing brines by the isothermal method at 25 °C based on the system $2Na^+, Mg^{2+} \parallel SO_4^{2-}, 2Cl^- - H_2O$	202
Urinov A., Aslonov A.	
Development of an effective anti-corrosion polymer composition for oil and gas trunk pipelines on a resource-saving basis	209
Khamidov R., Oydinov M., Abdulkhaev T.	
Crystalline structure and spectroscopic analysis of LIA zeolite	216

TECHNICAL SCIENCES: MECHANICS AND MECHANICAL ENGINEERING

Azamov S.	
Improvement of methods for increasing the energy efficiency indicators of an off-grid solar photovoltaic system	224
Kayumov U., Pardaeva Sh.	
Operational characteristics of centrifugal pumps in the mining industry	231
Mamanazirov J., Mamatkulov Sh.	
Investigating mxene material for evolution reaction in water splitting	240
Obidov A., Khudayberdiyeva D., Mirzaakhmedova D.	
Experimental construction development of the device for cleaning cotton from small impurities	247
Sultanov D., Mamahonov A.	
Assessment of the chemical and mineralogical properties of rocks from the mountainous areas of chortoq district, namangan region, based on xrf and ftir methods	257
Abduvakhidov M., Mirjalolzoda B., Umarov A.	
Bending vibrations of flexible packet-type working bodies of technological machines	271



Abduvakhidov M., Mirjalolzoda B., Umarov A.

Theoretical study of bending vibrations of packet-type working bodies of technological machines with account of internal longitudinal forces **278**

ECONOMICAL SCIENCES

Ergashev A.

The impact of public–private partnership (PPP) mechanisms on enterprise competitiveness in the implementation of green technologies **283**
