

ISSN 2181-8622

Manufacturing technology problems



Scientific and Technical Journal Namangan Institute of Engineering and Technology

INDEX  COPERNICUS
I N T E R N A T I O N A L

**Volume 9
Issue 4
2024**



IV

MECHANICS AND ENGINEERING

ANALYSIS OF RESEARCH ON SMALL WIND ENERGY DEVICES

KHUDOYBERDIEV UMID

PhD student of "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers"

National Research University, Tashkent, Uzbekistan

Phone.: (0899) 354-8656, E-mail.: umidkhudiyberdiyev1994@gmail.com

**Corresponding author*

IZZATILLAEV JURABEK

PhD of "Tashkent Institute of Irrigation and Agricultural Mechanization Engineers"

National Research University, Tashkent, Uzbekistan

Phone.: (0897) 720-0136, E-mail.: izzatillaev.jurabek@gmail.com

Abstract: Mankind has been using wind energy for several centuries for various purposes. Today, wind energy is mainly used for electricity generation. Small capacity wind power plants (SCWPPs) are mainly used to supply electricity to small power consumers located in off-grid and remote areas. In recent years, various designs of SCWPPs have been developed, which differ from each other in aerodynamic properties, coefficient of useful work, design and a number of parameters. To date, many designs of horizontal and vertical axis SCWPPs have been created. This paper presents the analysis and results of research conducted on small wind power plants.

Keywords: SCWPPs, wind turbine, horizontal axis wind turbines, vertical axis wind turbines, boundary element moment (BEM), Darius wind turbine, Savonius wind turbine, computational fluid dynamics(CFD).

Introduction. Mankind has been using wind energy for various purposes for several centuries. The use of wind energy was first realized in ancient Iran in 200 BC, and by the 7th century windmills began to be used in Iran for various purposes. Since the 1930s, windmills have been used in the United States to pump water and generate electricity. In 1951, John Brown Co produced the world's first grid-connected wind turbine[1]. Today, wind turbines are mainly used for power generation. SCWPPs are widely used to provide electricity to small, autonomous consumers located in remote areas or in areas not connected to the centralized power supply. As of 2023, the total capacity of wind power plants installed in the world amounted to 1,047 GW. Wind power currently produces 10% of the world's electricity consumption[2]. However, the share of small wind power in the share of installed wind farms worldwide is relatively small. For example, between 2013 and 2022, the total installed capacity of small wind energy devices worldwide amounted to 783.8 MW. In 2022 alone, 71.6 MW of additional capacity will be installed, with China, Germany, Italy and the US accounting for the bulk of this installed capacity (Figure 1). From 2013 to 2019, the total installed capacity of small wind power plants was 640.24 MW. As can be seen from the graph in Figure 1, there has been an increase in small wind power, with 143.56 MW of additional capacity installed over the three years from 2019 to 2022.

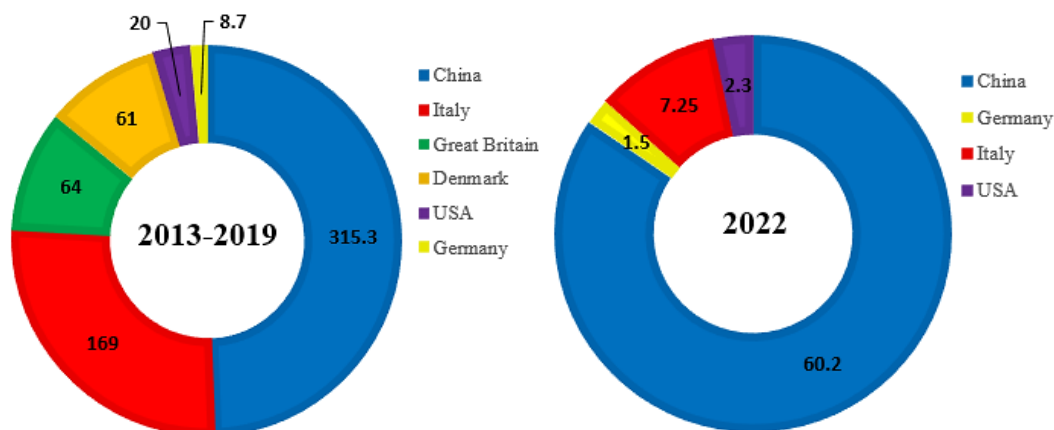


Figure 1. 2013-2022 capacity of installed SCWPPs worldwide [3].

From the data presented in Figure 1, it can be seen that the installation and utilization of small wind power plants has increased in recent years. This situation is explained by the fact that small wind power plants are used to supply electricity to small energy consumers located far from the central power supply.

Materials and methods. Scientists such as Kutta, Zhukovsky, Prandtl, Betz, Darrius and Savonius have made incomparable contributions to the development of wind energy devices. In recent years, the aerodynamic characteristics of horizontal and vertical axis wind energy devices have been studied as a result of research conducted by researchers. have been improved and the efficiency has been increased. The studies conducted have been carried out using various methods, including turbine element torque, lift line theory and other similar aerodynamic methods.

Table 1 below summarizes the research conducted in the field of horizontal axis wind energy devices, the research of used turbine element moment (BEM), computational fluid dynamics (CFD) methods and experimental studies. The BEM method is widely used in the analysis of blades of horizontal axis wind energy devices. The essence of the method is that the turbine is broken into small parts, forces and moments in each part are calculated separately, and then their total result is calculated. The method of computational fluid dynamics allows to model the aerodynamics of wind turbines and forces acting on them with high accuracy using such programs as Ansys, QBlade, XFOil.

Table 1: Study of low-power horizontal axis wind turbines.

Researcher	Research method	Brief description
Refan M., Hangan H [4]	Experimental/ Theoretical (BEM)	It is found that the results of experimental tests of a low-power wind power device in a "wind tunnel" and the results obtained by the BEM method are close to each other.
Dosing M., Madsen H.A., Bak C. [5]	Theoretical (BEM)	Using the BEM method, the wind turbine airfoil moment was increased by 5%.

Krogstad P.A., Lund J.A. [6]	Experimental/ Theoretical (BEM)	The study analyzed that with the value of "tip speed ratio" 6, the value of power factor is 0.448, and the results of lift force and power factor in the simulation process are close to the experimental research.
Esfahanian V. et al. [7]	CFD/BEM	The wind flow around the rotor and its aerodynamic efficiency were evaluated by the CFD method, and the flow around the rotor was calculated
Song Q. et al. [8]	Theoretical (BEM)	In the research, the power factor was calculated to be high at the "tip speed ratio" values of 5 and 6
Bai C.J. et al. [9]	Theoretical (BEM)	The turbine lift force and torque of a horizontal axis wind turbine with a power of 10 kW were calculated based on the modified stand model of BEM
Najar F.A et al. [10]	CFD/BEM	Using different methods, it was determined that the lifting power of the S 809 wind turbine is the highest at angles between 6° and 14°. An angle of 14° is accepted as the optimal angle for this wind turbine.

One of the main disadvantages of horizontal axis wind turbines is that they do not produce enough power at low wind speeds and are wind direction dependent. Vertical axis wind turbines operate at low wind speeds and produce electricity, and their operation is independent of wind direction. The presence of these aspects has generated interest in vertical axis wind turbines in recent years, resulting in their new designs by various scientists and increasing the useful efficiency of existing ones. In general, vertical axis wind turbines are structurally divided into two types (Darius and Savonius).

The first vertical axis wind turbine of the Darrius type was invented by Georges Darrius in 1931. Among vertical axis wind turbines, the efficiency factor is high, and the principle of its operation is based on the lifting force of the air flow [11]. To date, various designs have been created based on Darrius's design, which differ fundamentally from each other in terms of structural structure, aerodynamic properties, and efficiency [12]. As a result of experimental research conducted by scientists on the Darrius wind turbine in different years, its designs were created. In particular, Alexander Gorlov invented a spiral-shaped wind turbine, which is a modified version of the Darrius turbine. The advantage of this vertical axis wind turbine over other wind energy devices is the high starting torque, low noise level, and small load on the turbine [13]. V. Krivosov and V.P. As a result of the research conducted by Krivospitsky on the Darrius type vertical axis wind turbine, a construction of a vertical axis wind turbine with 4 turbines was developed. The start-up speed of the wind turbine was 2.4-2.6 m/s, the efficiency was 34-36%. As a result of experimental research conducted by Raymond Musgrove on Darrius type wind turbines, a new type of vertical axis wind turbine design with increased start-up parameters and useful work coefficient was created. The number of blades of this wind turbine was 6, the wind speed at start-up was 1.6-2 m/s, and the efficiency was 39-40% [14]. A.G. As a result of research conducted by Ajay et al., a new X-rotor-shaped

vertical axis wind energy device with improved aerodynamic parameters was developed [15]. Figure 1 below shows vertical axis wind turbines created as a result of research.

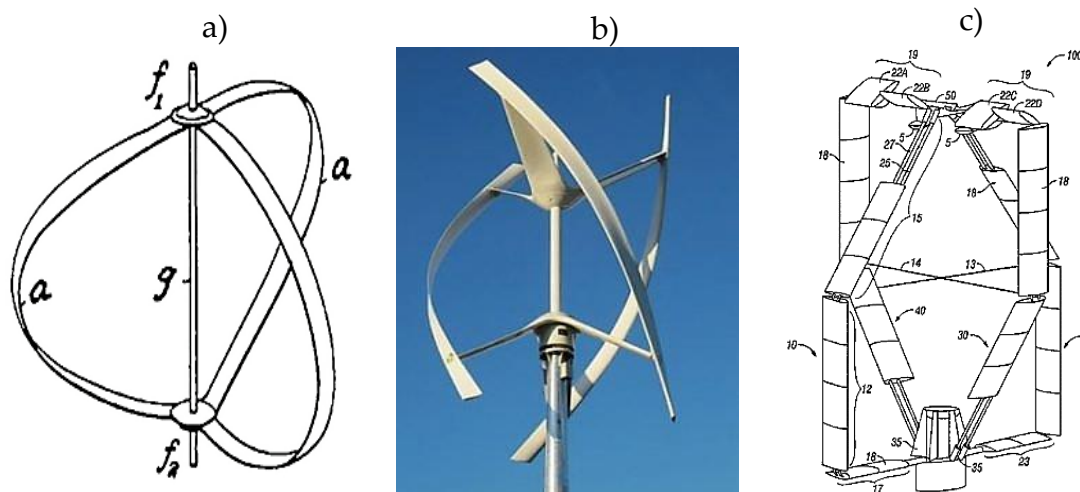


Figure 2. Darrius-type vertical-axis small-power wind turbines:

a) Darrius vertical wind turbine b) Gorlov vertical wind turbine c) Korivsov-Kripotsky wind turbine t.

In addition to the research conducted on the constructions of Darrius type wind turbines, in order to improve their aerodynamic parameters, scientists such as S. Armstrong, J. Miao, M. Randall, M. Takao also conducted scientific research on the aerodynamic profile. Table 2 below provides the details of the study conducted.

Table 2. Experimental studies on the aerodynamic profile of Darrius type wind turbines.

Author	Aerodynamic profile Rotor	Rotor diameter (m)	Pitch angle	Power factor (Cp)
S.Armstrong	NACA 0013	2.5	+2.5° and -1.5°	0.32
	NACA 0015		-3.5° and -5.5°	
J.Miao	NACA 0015	0.9	0°, -10° and 10°	0.55
M.Randall	NACA 0018	5	From -7 to +3°	0.39
M. Takao	NACA 0018	0.6	-	0.205

The NACA 0015 airfoil for an H-type vertical wind turbine was tested in a "wind tunnel" in a research study by S. Armstrong et al. As a result of the tests and experiments, it was determined that the value of the power coefficient is up to 0.55 [16]. In the scientific research conducted by J. Miao and others, increasing the value of their power coefficient by improving the starting moment in SCWPPs was analyzed [17]. In an experiment conducted at Sandia National Laboratories on a vertical wind turbine with a turbine diameter of 5 m, the value of the power factor at $\lambda=5$ was determined to be equal to 0.39 [18]. M. Takao and others conducted research on the NACA0018 aerodynamic profile with a rotor diameter of 1.8 m in the "wind tunnel" and as a result, the power coefficient

for this profile was determined to be 0.205 [19]. In addition to the experimental studies on the aerodynamic profile, numerical modeling methods were also used. In particular, several researchers have analyzed various aerodynamic profile parameters using the method of computational fluid dynamics and created their 2D and 3D models. Table 3 below describes some of the studies conducted using the computational fluid dynamics method.

Table 3. Studies on aerodynamic profiles.

Author	Model	Aerodynamic profile
Wekesa et al.	2D	NACA0022
Mohamed et al.	2D	NACA0021, S-1046
Chowdhury et al.	3D	NASA0018
Howell et al.	2D	NACA0022

The aerodynamic profile parameters of the NACA0022 were analyzed using the computational fluid dynamics method in a research study by Wekesa et al. As a result of the analysis, a 2D model of the wind turbine was created using digital modeling, and the power coefficient for this turbine was 0.13-0.3 [20]. Under the leadership of Mohamed, conducting research on 20 different aerodynamic profiles, a 2D model of NACA0021 and S-1046 aerodynamic profiles was created using computer modeling, and these models were analyzed by the method of computational fluid dynamics. As a result of the study, the power coefficient of the S-1046 airfoil was increased by approximately 26.83% and the power coefficient of the NACA0021 airfoil was increased by approximately 10.87% [21]. In the study conducted by Chowdhury, numerical modeling and experimental results were compared. Analysis has shown that the results obtained from numerical modeling and experimental studies are almost identical [22]. Howell et al did research on the NACA0022 airfoil. As a result of the research, it was found that the values of the turning angle cause a sharp change in the value of the rotor moment at a small level [23]. The Savonius turbine was invented by Sigurd Johannes Savonius, and its principle of operation is based on the resistance force of the air flow.



Figure 3. Savonius wind turbine [24]

The efficiency of this wind turbine is small compared to Darrius turbines, and its energy production efficiency is 20% [14]. But it is widely used due to the high starting torque at low wind speeds. As a result of experimental and theoretical research conducted in different years, Savonius turbine constructions of various types have been created. Table 4 below provides a brief analysis of Savonius turbine research.

Table 4. Analysis of research on Savonius wind turbines.

Author	Research method	Research description
Plourde et al.	Experimental	The efficiency of Savonius turbines when their top and bottom parts were closed was analyzed.
Wakui et al.	Numerical	Generators used in Savonius wind turbines were analyzed.
Kamoji et al.	Experimental	Compared to the traditional Savonius wind turbine, research has been conducted on the spiral-shaped Savonius wind turbine
Sheldahal et al.	Experimental	The influence of the number of wind turbines on the efficiency of the wind turbine has been studied
Mohamed et al.	Numerical	Efficiency was determined in the research carried out by the k-e model. Also, the results of numerical modeling and experimental studies were compared

In a research study by Plourde, the efficiency of Savonius turbines with their tops and bottoms closed was analyzed [25]. Wakui et al. conducted research on generators used in Savonius type vertical axis wind generators. As a result of the research, it was determined that the generator used in wind turbines should match the consumer parameters [26]. Kamoji was carried out on a spiral-shaped Savonius wind turbine, and as a result of the research, despite the small value of the wind speed, the value of the power coefficient was 0.174[27]. Sheldahal et al evaluated the effect of the number of wind turbines on the Savonius turbine efficiency. Constructions with two, three and four turbines for the wind turbine were tested. As a result of the experiments, it was estimated that a two-turbine wind power plant is more efficient than a three- and four-turbine one [28]. Using the k-e model, Mohamed et al found that the theoretical efficiency of a Savonius wind turbine is 0.3. The results of numerical modeling and experimental studies were compared, and the values were found to be close to each other [29].

Conclusion. Studies conducted on horizontal and vertical axis small capacity wind turbines show that, despite their different aerodynamic profiles and designs, the efficiency of power generation depends on the wind energy and its parameters. Therefore, depending on the wind speed, it is advisable to select a wind turbine of suitable design. For example, horizontal wind turbines require high wind speeds. At the same time, there is a possibility of using this type of wind turbines in the production of large capacities. Compared to horizontal axis wind turbines, the main advantage of vertical axis wind turbines is the high starting torque at low wind speeds. Due to this feature, it can be used to supply electricity to consumers in areas with low wind speeds.

However, the use of vertical white wind turbines of the Darrius and Savonius types in the production of large volumes of electricity causes a number of technical difficulties. In particular, the increase in the size of the device, the need for a large starting torque, a large mechanical load on the support, etc.

References

- [1] Abhishikta T., Ratna K.V., Dipankur K.S., Indraja V., V.H.Krishna A review on small scale wind turbine, Renewable and Sustainable Energy Reviews, 56 (2016) 1351-1371
- [2] WWEA Annual Report 2023 Record Year for Windpower in 2023
- [3] Alice O., et.al. Distributed Wind Market Report: 2023 Edition, Pacific Northwest National Laboratory, funded by the Wind Energy Technologies Office, Office of Energy Efficiency and Renewable Energy of the U.S. Department of Energy under Contract DE-AC05-76RL01830
- [4] Refan, M.; Hangan, H.: Aerodynamic performance of a small horizontal axis wind turbine. ASME J. Sol. Energy Eng. 134(2), 021013 (2012). <https://doi.org/10.1115/1.4005751>
- [5] Døssing, M.; Madsen, H.A.; Bak, C.: Aerodynamic optimization of wind turbine rotors using a blade element momentum method with corrections for wake rotation and expansion. Wind Energy 15, 563–574 (2012). <https://doi.org/10.1002/we.487>
- [6] Krogstad, P.Å.; Lund, J.A.: An experimental and numerical study of the performance of a model turbine. Wind Energy 15, 443–457 (2012). <https://doi.org/10.1002/we.482>
- [7] Esfahanian, V.; Pour, A.S.; Harsini, I.; Haghani, A.; Pasandeh, R.; Shahbazi, A.; Ahmadi, G.: Numerical analysis of flow field around NREL Phase II wind turbine by a hybrid CFD/BEM method. J. Wind Eng. Ind. Aerodyn. 120, 29–36 (2013). <https://doi.org/10.1016/j.jweia.2013.06.006>
- [8] Song, Q.; Lubitz, W.D.: BEM simulation and performance analysis of a small wind turbine rotor. Wind Eng. 37(4), 381–399 (2013). <https://doi.org/10.1260/0309-524X.37.4.381>
- [9] Bai, C.J.; Hsiao, F.B.; Li, M.H.; Huang, G.Y.; Chen, Y.J.: Design of 10 kW horizontal-axis wind turbine (HAWT) blade and aerodynamic investigation using numerical simulation. Procedia Eng. 67, 279–287 (2013). <https://doi.org/10.1016/j.proeng.2013.12.027>
- [10] Najar, F.A.; Harmain, G.A.: Blade design and performance analysis of wind turbine. Int. J. ChemTech Res. 5(2), 1054–1061 (2013)
- [11] M.M. Aslam Bhutta va boshqalar, Vertical axis wind turbine – A review of various configurations and design techniques, Renewable and Sustainable Energy Reviews 16(2012) 1926-1939
- [12] Brian Hand, Andrew Cashman, A review on the historical development of the lift-type vertical axis wind turbine: From onshore to offshore floating application,

Sustainable Energy Technologies and Assessments,
<https://doi.org/10.1016/j.seta.2020.100646>

[13] Gorlov, A. (1998) Development of the Helical Reaction Hydraulic Turbine. Northeastern University, Boston

[14] D.N. Gorelov and V.P. Krivospitsky, Prospects for development of wind turbines with orthogonal rotor, Thermophysics and Aeromechanics, 2008, Vol. 15, No. 1

[15] A.G.Ajay va boshqalar, Aerodynamic model comparison for an X-shaped vertical-axis wind turbine, Wind Energy Science, 453-470, Copernicus Publication, 2024

[16] S.Armstrong, A. Fiedler, S.Tullis, Flow separation on a high Reynolds number, high solidity vertical axis wind turbine with straight and canted blades and canted blades with fences, Renewable Energy 2012, 41:13-22

[17] J.Miau va boshqalar Design and test of a vertical-axis wind turbine with pitch control, Application Mechanical Mater 2012, 225:338-43

[18] M.Randall, Klimas PC, Aerodynamic performance of vertical and horizontal axis wind turbines, Journal Energy, 1981:189-90

[19] M.Takao va boshqalar, A straight-bladed vertical axis wind turbine with a directed guide vane row-effect of guide vane geometry on the performance, Journal Therm.Sci. 2009, 18(1): 54-7

[20] Wekesa DW, Wang C, Wei Y, Kamau JN. A numerical analysis of unsteady inflow wind for site specific vertical axis wind turbine: a case study for. Renewable Energy 2015;86(0):648–61

[21] Mohamed MH. Performance investigation of H-rotor Darrieus turbine with new airfoil shapes. Energy 2012;47(1):522–30

[22] Chowdhury AM, Akimoto H, Hara Y. Comparative CFD analysis of vertical axis wind turbine in upright and tilted configuration. Renew Energy 2016; 85:327–37

[23] Howell R, Qin N, Edwards J, Durrani N. Wind tunnel and numerical study of a small vertical axis wind turbine. Renew Energy 2010;35(2):412–22

[24] Abhishiktha Tummala, Ratna Kishore Velamati, Dipankur Kumar Sinha, V. Indrāja, V. Hari Krishna, A review on small scale wind turbines, Renewable and Sustainable Energy Reviews 56 (2016) 1351–1371

[25] Plourde BD, Abraham JP, Mowry GS, Minkowycz WJ. An experimental investigation of a large, vertical-axis wind turbine: effects of venting and capping. Wind Eng 2011;35(2):213–22.

- [26] Wakui T., Tanzawa Y., Hashizume T., Outa E., Usui A. Optimum method of operating the wind turbine-generator systems matching the wind condition and wind turbine type, World Renewable Energy Congress , 2000
- [27] Kamoji MA, Kedare SB, Prabhu SV. Performance tests on helical Savonius rotors. Renew Energy 2009;34(3):521–9
- [28] Sheldahl RE, Feltz LV, Blackwell BF. Wind tunnel performance data for two-and three-bucket Savonius rotors. J Energy 1978;2(3):160–4
- [29] Mohamed MH., Janiga G., Pap E.,Thevenin D. Optimal blade shape of a modified Savonius turbine using an obstacle shielding the returning blade. Energy Conversation and Management, 2011, 52:236-42

CONTENTS

PRIMARY PROCESSING OF COTTON, TEXTILE AND LIGHT INDUSTRY

Korabayev Sh.	3
From street traffic to space: innovations in autonomous vehicles	
Egamov N.	10
Investigation of vertical forced vibration in the longitudinal - vertical plane of a binder that softens the crush between cotton rows	
Khamraeva S., Kadirova D., Davlatov B.	15
Determination of alternative technological factors for the production of functional fabric with a complex structure	
Khamraeva S., Kadirova D., Daminov A.	21
Designing fabrics for a given stretchability	
Kuliyev T., Rozmetov R., Tuychiev T., Sharipov Kh.	28
The effect of the angle of heat agent supply to the drying - cleaning equipment on cotton quality and cleaning efficiency of the equipment	
Abdujabbarov M., Alieva D., Karimov R.	35
Determination of the influence of the length of the tested yarn samples on their mechanical characteristics	
Jurayeva M., Nabidjonova N.	41
Research on physical and mechanical properties of fabric selected for special clothing of preschool children	
Yangiboev R., Allakulov B., Gulmirzayeva S.	45
Studying the alternative technological factors of the loom in the production of textiles based on basalt yarn	
Ganikhanov Kh., Mavlyanov A., Abdusamatov A., Mirzaumidov A.	55
Analysis of the maintechnologicalparameters of the condenser	
Mavlyanov A., Mirzaumidov A.	60
The scientific basis of the lightened shaft	
Elmanov A., Mirzaumidov A.	69
Modeling of laser processingof thin-walled steel gears	
Nurillaeva Kh., Mirzaumidov A.	77
Cotton cleaner with multifaceted grates	
Ganikhanov Kh., Mavlyanov A., Abdusamatov A., Mirzaumidov A.	83
The equation of motion of cotton fiber in the condenser	
Khuramova Kh., Xoshimxojaev M.	89
Progressive method of cotton regeneration	

Abdulkarimova M., Lutfullaev R., Usmanova N., Mahsudov Sh.	94
Evaluation of aestheticity of women's dress models based on deep learning models	

GROWING, STORAGE, PROCESSING AND AGRICULTURAL PRODUCTS AND FOOD TECHNOLOGIES

Zufarov O., Isroilova Sh., Yulchiev A., Serkayev K.	101
Theoretical aspects of obtaining oxidation-stable vegetable oils	
Toshboyeva S., Dadamirzaev M.	110
Filling sauces for canned fish and their layer kinetics	
Atamirzaeva S., Saribaeva D., Kayumova A.	115
Prospects for the use of rose hips in food technology	
Turgunpolatova Sh.	121
Study of the quality of fruit pastela products	
Sultanov S.	126
Analysis of experiments on the process of deodorization of vegetable oil using floating nozzles	
Adashev B.	132
Physical-chemical analysis of oil taken from seeds of safflower	
Ismailov M.	137
Influence of surface layer thickness on hydraulic resistance of the device	
Khurmamatov A., Boyturayev S., Shomansurov F.	142
Detailed analysis of the physicochemical characteristics of distillate fractions	
Madaminova Z., Khamdamov A., Xudayberdiyev A.	154
Preparing peach seed for oil extraction and improving oil extraction through pressing	
Aripova K.	162
Methods of concentration of fruit juices and their analysis	
Djuraev Kh., Urinov Sh.	168
Theoretical and experimental study of the crack formation device in the shell of apricot kernels	

CHEMICAL TECHNOLOGIES

Urinboeva M., Abdikamalova A., Ergashev O., Eshmetov I., Ismadiyarov A.	175
Study of the composition and main characteristics of petroleum oils and their emulsions	
Tursunqulov J., Kutlimurotova N.	182
Application of 1-(2-hydroxy-1-naphthoazo)-2-naphthol-4-sulfo acid in amperometric determination of scandium ion	
Kucharov A.	191

Development of coal enrichment and gas extraction technology for the use of construction materials industrial enterprises	
Abdulkhaev T., Mukhammadjonov M., Mirzarakhimova F.	
Isotherm of benzene adsorption and differential heat of adsorption on AgZSM-5 zeolite	198
Vladimir L., Eshbaeva U., M.Ergashev	
Innovative environmental packaging for separating storage of two components, allowing to extend the lifetime without preservatives	204
Kodirov O., Ergashev O.	
Energetics of adsorption of water molecules to aerosol	212
Yusupov K., Erkabaev F., Ergashev D., Rakhimov U., Numonov M.	
Synthesis of melamine-formaldehyde resins modified with n-butanol	219
Ergashev O., Abdikamalova A., Bakhronov Kh., Askarova D., Xudoyberdiyev N., Mekhmonkhonov M., Xolikov K.	
Thermodynamics of Congo red dye adsorption processes on mineral and carbon adsorbents	228
Ergashev O., Maxmudov I.	
Water vapor adsorption isotherm in zeolites regenerated by microwave thermoxidation method	235
Jumaeva D., Zaripbaev K., Maxmudov F.	
The elements and oxide content of the chemical composition of the feldspar	242
MECHANICS AND ENGINEERING	
Khudoyberdiev U., Izzatillaev J.	
Analysis of research on small wind energy devices	249
Atajonova S.	
Mathematical model of system analysis of technological processes in the form of key principles for effective decision-making	258
Kuchkarbayev R.	
Mathematical modeling of heat transfer through single-layer and multi-layer cylindrical walls in buildings and structures	264
Atambaev D.	
Difference in the length of individual yarn composition of twisted mixed yarn and comparative analysis of single-thread elongation deformations	269
Abdullayev S.	
Modeling the functionalities of an automated system for managing movement in the air	276
Turakulov A.	
Describing computational domains in applications for solving three-dimensional problems of technological processes	285
Mamaxonov A.	

Mathematical model of machine aggregate of tillage equipment process	293
Khudayberdiyev A.	
Technical and economic aspects of processing pyrolysis distillate into motor fuel	304
Abdurahmonov J.	
Research results on the selection of the mesh surface of a lint-cleaning device	311
Vohidov M.	
Development of a program for determining eccentricity by analyzing the magnetic field in the air gap of an asynchronous motor	319
Utaev S., Turaev A.	
Analysis of methods and prospects for application of optical methods for control of working surfaces of cylinder liners of internal combustion engines	327
Boltabayev B.	
Determination of seed damage in the pneumatic transport system by conducting experiments	335
Azizov Sh., Usmanov O.	
Simulation of equation of motion of the new construction gin machine	339
Sharibaev N., Homidov K.	
Theoretical analysis of the coefficient of friction induced by the pressure force of a vertical rope acting from above and below	347
Aliyev B., Shamshidinov M.	
Improvement of the linter machine and development of its working scheme	356
Mukhametshina E.	
Analysis of cotton flow behavior in different pneumatic pipes	362
Yangiboev R., Allakulov B.	
Obtaining and analyzing correlational mathematical models of the sizing process	369
Mirzakarimov M.	
Efficient separation of fibers from saw teeth in the newly designed gin machine	379
Azambayev M.	
Measures to improve the quality of fluff	387
Abdullayev R.	
Scientific innovative development of cotton gining	392
Kholmiraev F.	
Air flow control factors in pneumatic transport device	397
Sharibaev N., Makhmudov A.	
Separation of cotton from airflow in pneumatic transport systems of the cotton industry	404
Sharibaev N., Mirzabaev B.	

Effect of steam temperature on yarn moisture regulation in textile industry **410**

Sultanov S., Salomova M., Mamatkulov O.

Increasing the useful surface of the mesh surface **415**

Muhammedova M.

Kinematics of the foot in a healthy person's foot and ankle injury **421**

ADVANCED PEDAGOGICAL TECHNOLOGIES IN EDUCATION

Abdullayev H.

Algorithm for creating structured diagrams of automatic control systems **429**

Kodirov D., Ikromjonova N.

On delayed technological objects and their characteristics **437**

Uzokov F.

Graphing circles, parabolas, and hyperbolas using second-order linear equations in excel **444**

ECONOMICAL SCIENCES

Zulfikarova D.

Issues of developing women's entrepreneurship **449**

Ergashev U., Djurabaev O.

Methods for assessing the effectiveness of waste recycling business activities in the environmental sector **455**
