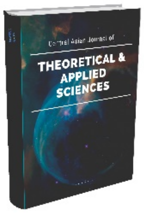

CENTRAL ASIAN JOURNAL OF THEORETICAL AND APPLIED SCIENCES

Volume: 02 Issue: 12 | Dec 2021 ISSN: 2660-5317

Improving the Efficiency of Flat Solar Collectors in Heat Supply Systems

Yusuf Karimovich Rashidov
Tashkent Institute of Architecture and Civil Engineering, Navoi, Tashkent, Uzbekistan

Ma'murjon Muxtorovich Ismailov, Salimjon Azamdjanovich Rahmankulov
Fergana Polytechnic Institute, Fergana, Uzbekistan

Received 25th Oct 2021, Accepted 27th Nov 2021, Online 16th Dec 2021

Annotation: *The article deals with the optimization of circuit solutions and operational parameters in order to increase the efficiency of solar heat supply systems equipped with flat solar collectors.*

Keywords: *solar collectors, solar water heating device, comparable costs, heat production, operating efficiency.*

Introduction

The main and most expensive element of the solar heat supply system (SST) is the solar collector (SC). Therefore, the task of increasing its thermal efficiency and optimizing the weight and size characteristics and parameters of thermal engineering perfection is in the constant field of vision of many researchers. [1-3]

In 2018, the total area of installed SCs as part of various solar installations in the world amounted to 686 million m^2 [4-6]. At the same time, from 2000 to 2018, the total area of installed SCs in the world increased by 7.6 times [1], of which more than 71 % are tubular vacuum collectors SCs [7,8], most of which use double-layer tubes of Chinese production [9]. The remaining 29% is accounted for by flat solar collectors (FSC), which are widely used in European countries.

It should be noted that the rate of SC application is currently decreasing, and the production of SC in the world is constantly falling [10]. The European SC market is also stagnant: the volume of collector commissioning has been declining for more than 10 years. Since 2009, the main task of the European heliotechnical science has been to find ways to reduce the cost of flat SC and SST in general [11].

During the last 15 years, the weight and size characteristics and parameters of the thermal engineering perfection of flat SCs have practically not changed [12]. They are quite well developed in the world practice, and have reached parameters close to their limit values [13]. In other words, a significant increase in the efficiency of the use of solar thermal energy in the SST due to the improvement of the weight and size characteristics and thermal parameters of individual FSC structures in the foreseeable future is not necessary.

Therefore, it seems promising to increase the efficiency of using existing flat solar collectors in heat supply systems by optimizing their operating parameters.

Copyright (c) 2021 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

In contrast to traditional fuel and electric heat generators [14], the efficiency of the PSC depends very much on the average temperature of the absorbing heat exchange panel [15], which usually has a sheet-tube design (Fig. 1). For example, in the first approximation, it can be assumed that an increase in the operating heating temperature for each degree in a flat solar collector leads to a decrease in its efficiency by 1-2% [16]. Therefore, the same SC, under the same climatic conditions, with different operating parameters in the SST, can generate heat with different thermal efficiency.

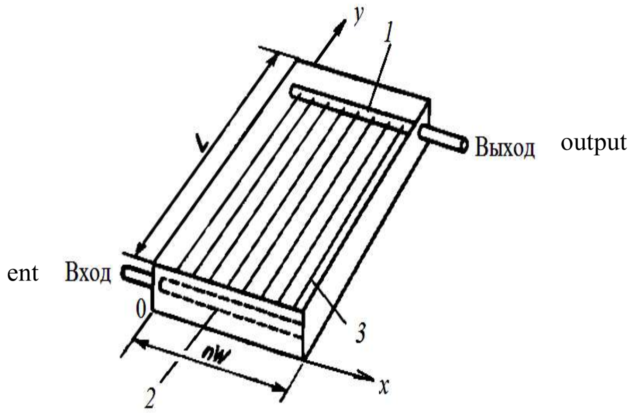

Figure. 1. Flat solar collector of the sheet-tube type

Determining the average temperature of the absorbing heat exchange panel is quite a difficult task [4], since this requires a detailed study of the temperature distribution in the collector plane along the x and y axes (Fig.2, a). Under the influence of the heat transmitted to the liquid, it heats up, and a temperature gradient occurs in it in the direction of flow (along the y axis). Since the overall temperature level at any part of the reservoir is determined by the level of the local temperature of the liquid, the spatial picture of the temperature field will look similar to that shown in Fig. 2, b. The temperature distributions in the x-axis direction at any y value and in the y-axis direction at any x value are shown in Fig. 2, c and d.

Thus, to increase the efficiency of flat solar collectors in heat supply systems by optimizing their operating parameters, it is necessary to analyze the influence of these parameters on the panel temperature distribution in two mutually perpendicular directions: along and across the direction of liquid flow.

The aim of the study is to identify the features of improving the efficiency of flat solar collectors in heat supply systems by optimizing their operating parameters that affect the average temperature of the absorbing heat exchange panel.

Consider and analyze the operating parameters that affect the value of the average temperature of the absorbing heat exchange panel along the direction of the liquid flow (along the y axis) and the thermal efficiency of flat solar collectors in heat supply systems.

The flow rate of the heat carrier through the SC is one of the main operating parameters that affect its efficiency and operational readiness of the solar hot water supply system (HWSS).

Copyright (c) 2021 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

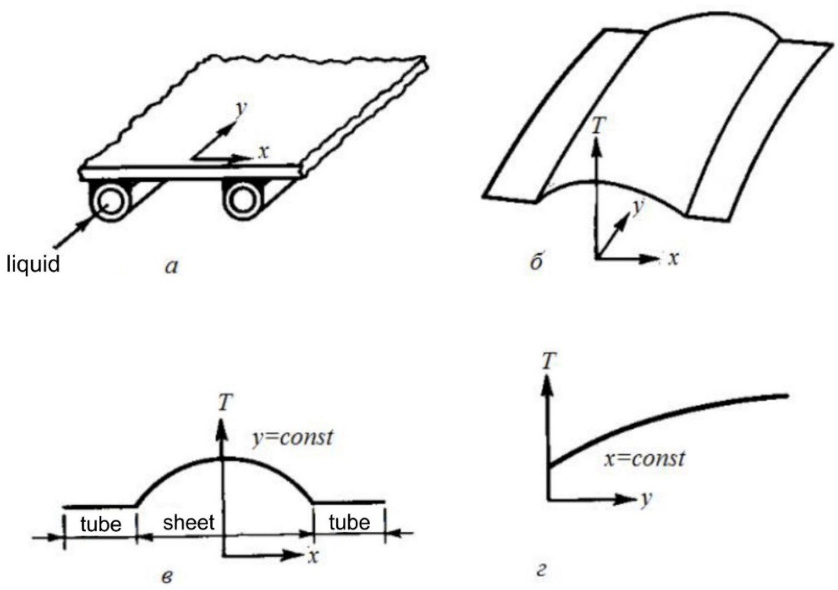

Figure. 2. Temperature distribution of the absorbing heat exchange panel of a flat solar collector of the sheet-tube type [4]:

It is known that until 1980, in the HWSS pumping systems, the coolant flow rate was selected at the level of 54 kg/(m2 ∙ h) [16]. In recent years, installations with a significantly lower specific flow rate have been used, providing better temperature stratification of water in the storage tank and high operational readiness of the system, which after 1 to 1.5 hours allows you to supply hot water to the consumer with the required temperature. For example, in Sweden, typical unit costs range from 7.2 to 21.6 kg / (m2 ∙ h) [4].

A significant advantage of installations with a low specific consumption, as noted in [5], is a reduction in the power of the circulation pump and the diameter of the pipelines, which also leads to a reduction in capital and operating costs. At the same time, the potential gain in the share of solar energy coverage for a solar installation with a perfectly stratified tank and with a small specific water flow through the SC, in the range from 7.2 to 25.2 kg/(m2 ∙ s), compared with a fully mixed tank and a large specific water flow through the solar collector of the order of 36-72 kg/(m2•s), can reach 1/3 [4].

Increasing the share of load coverage in such an installation is possible from 0.48 to 0.66. However, it should be noted that in practice, such a significant gain has not yet been achieved due to the complexity of implementing good temperature stratification in the tank. However, the positive effect was confirmed experimentally, for example, in [6].

The change in the specific flow rate of the coolant through the SC operating on the battery tank is associated with factors that have the opposite effect on the daily efficiency of the HWSS systems. If the increase in the specific flow rate of the coolant through the SC and the associated decrease in the temperature difference on it, on the one hand, leads to an intensification of heat removal from it, on the other hand, this contributes to a constant increase in the temperature of the water feeding the SC during the day. This leads to an increase in the average temperature of the SC in the daily section of the HWSS system operation.[17-19]

A decrease in the specific flow rate of the coolant through the SC and the associated increase in the temperature difference on it, on the one hand, leads to a decrease in the intensity of heat removal from it,

Copyright (c) 2021 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

but on the other hand, it provides SC with water with a constantly low initial temperature. This ensures that the average temperature of the SC absorber is constant in the daily operation of the HWSS systems.

It follows that the evaluation of the efficiency of HWSS systems with flat solar collectors should be carried out according to their daily heat output, taking into account the multiplicity of heating of the coolant in the SC [17].

Consider and analyze the operating parameters that affect the value of the average temperature of the absorbing heat exchange panel across the direction of liquid flow (along the x-axis) and the thermal efficiency of flat solar collectors in heat supply systems.

In this case, the uniformity of the distribution of the liquid flow through the lifting pipes of the flat SC is of great importance [4]. If the flow distribution is uneven, some sections of the SC containing lifting pipes with a low flow rate may have a temperature much higher than the temperature of the sections with a higher flow rate.

Analytical and experimental studies of this problem were carried out in [8, 9, 10], which evaluated the effect of the uneven distribution of the fluid flow in the ICS system on heat generation at different (small, medium and large) specific flow rates and the schemes of connecting the collectors to each other. In [8], a review of some studies of the uniformity of the flow distribution in the SC is given, and an analytical method for calculating the flow distribution and its experimental verification is also presented.

In [9], the results of analytical and experimental studies of the effect of uneven distribution of the liquid flow through the riser pipes of a beam-absorbing heat-exchange panel SC of a sheet-tube type on heat generation are presented. The experiments were carried out in full-scale conditions on one of the sections of a solar installation designed for hot water supply to the hotel and consisting of 10 parallel branches with 4 series-connected SC in each branch.

The range of changes in the specific flow of liquid through the SC both with the diagonal arrangement of the inlet and outlet pipes (Z-scheme), and with the arrangement of these pipes on one side of the section (P-scheme) was g=5÷30 kg/(m2•h). In the experiments, the water temperature at the outlet of each branch of the SC section was measured, which was a measure of how efficiently energy was diverted from the SC. The difference in temperature between the branches of the SC section is also a measure of the lack of uniformity in the flow distribution, since at the entrance to each branch, cold tap water was supplied with the same temperature, which was also measured. [21-22]

For the Z-scheme at low (g=5.15 kg/(m2•h)) and medium (g=10.6 kg/(m2•h)) specific flow rates, and for the P-scheme only at low (g=4.96 kg/(m2•h)) specific flow rates, an almost uniform flow distribution was observed in the individual branches of the IC section, as can be seen from the slight temperature differences (±2÷3 ^{o}C) at the outlet from the parallel branches. For the Z-scheme at large (g=29.4 kg/(m2•h)), and for the P-scheme at medium (g=20.0 kg/(m2•h)) and large (g=30.4 kg/(m2•h)) specific flow rates, there was a noticeable unevenness in the flow distribution through the extreme 9 and 8 branches of the SC section, in which the temperature differences are already up to ±4÷5 ^{O}C from the average value, and in comparison with the most extreme 10 branch differ by 8÷10 ^{o}C.

In [14], the results of measuring temperatures at low, medium and high specific flow rates for a battery of twelve SC connected in parallel to each other are presented. According to experimental data, the temperature differences between the central part and the extreme sections of the battery at high flow rates reach 22 ^{o}C, and with a decrease in specific flow rates through the SC, similar to experimental data [13], these temperature differences decrease. However, this difference is very significant and therefore has a strong impact on the overall thermal efficiency of the SC battery. Therefore, based on the results of studies in [10], it is recommended to use hydraulic channels of sufficiently large diameter in structures, so

© 2021, CAJOTAS, Central Asian Studies, All Rights Reserved

Copyright (c) 2021 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

that pressure drops mainly occur in lifting pipes. In SC batteries with forced circulation, when the number of lifting pipes exceeds 24, it is recommended to use a series-parallel or parallel-serial connection instead of a parallel connection.

When designing and designing individual collectors and SC batteries with a given unevenness of the flow distribution, it is necessary to know the quantitative relationship between the above design parameters, which is given in [15]. The method of hydraulic calculation of the heat exchange panel of a solar water-heating collector of the sheet-tube type with a given uneven distribution of the liquid flow under conditions of forced circulation is given in [20].

Conclusions

Increasing the thermal efficiency of flat solar collectors in heat supply systems in conditions when their mass and size characteristics and parameters of thermal engineering improvements are already well developed in the world practice, studied and reached values close to the limit values can be achieved by optimizing their operating parameters in two ways:

1) due to a single heating of water in solar collectors with a small specific flow rate in the range from 7.2 to 25.2 kg / (m2 · s) corresponding to low flow rates and a high temperature gradient along the direction of movement of the liquid in the solar collector, which provides an overall increase in the share of covering the thermal load of the consumer from 0.48 to 0.66 due to high temperature stratification of water in the battery tank;

2) by improving the uniformity of the distribution of the coolant flow through the lifting pipes and reducing the temperature gradient perpendicular to the direction of movement of the liquid on average from 4 to 5 °C and a corresponding increase in the efficiency of the solar collector by the same amount.

This work was performed with the support of the Ministry of Innovative Technologies of the Republic of Uzbekistan within the framework of the fundamental grant BN-M-F3-003.

References

1. Weiss W., Spörk – Dür M. “Solar Heat Worldwide. Global Market Development and Trends in 2018. Detailed Market Figures 2017. 2019 edition”.Available: www.iea-shc.org/data/sites/1/publications/Solar-Heat-Worldwide-2019.pdf.
2. Фрид С.Е. Современные солнечные коллекторы: типичные параметры и тенденции их изменения/ С.Е. Фрид, Н.В. Лисицкая// Гелиотехника. – 2018. – №2. – С.27-37.
3. Рашидов Ю.К. Системы солнечного теплоснабжения: мировой опыт и перспективы развития в условиях Узбекистана/ Ю.К.Рашидов// Международная научно-практическая конференция «Экологическая, промышленная и энергетическая безопасность – 2019», Севастополь 23-26 сентября 2019 года, С.1361-1365.
4. Даффи Дж. Основы солнечной теплоэнергетики. Пер. с англ.: Учебно-справочное руководство/ Дж. Даффи, У. Бекман. – Долгопрудный: Издательский дом «Интеллект», 2013. – 888 с.
5. Hollands K.G.T. A Review of Low-Flow. Stratified-Tank Solar Water Heating Systems/ K.G.T. Hollands, M.F. Lightstone // Solar Energy, 1989. – V. 43. – P. 97.
6. Carvalho M.J. An Experimental Comparison of Operating Strategies for Solar Water Systems/ M.J. Carvalho, M. Collares-Pereira, F.M. Cunha, C. Vitorino // Solar Energy, 1988. – V. 41. – P. 33.
7. Рашидов Ю.К. Оценка эффективности систем солнечного горячего водоснабжения с однократным нагревом воды в плоских солнечных коллекторах/ Ю.К. Рашидов//

© 2021, CAJOTAS, Central Asian Studies, All Rights Reserved

Copyright (c) 2021 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

Международная научно-практическая конференция «Экологическая, промышленная и энергетическая безопасность–2018», Севастополь 24-27 сентября 2018 года, С.993-997.

8. Weitbrecht V., Lehmann D., Richter A. Flow Distribution in Solar Collectors with Laminar Flow Conditions/ V. Weitbrecht, D. Lehmann, A. Richter // Solar Energy. V. 73, 2002. – P.433.
9. Смирнов С.И., Константиновский Ю.А., Торшин А.,С. Влияние неравномерности распределения потока жидкости в системах солнечных коллекторов на выработку тепла// Гелиотехника. 1981. №1, с.24-28.
10. Dunkle R.V., Davey E.T. Flow Distribution in Absorber Banks// Paper presented at Melbourne International Solar Energy Society Conference, 1970.
11. Рашидов Ю.К. Повышение равномерности распределения потока жидкости по подъёмным трубам луче поглощающей теплообменной панели солнечного водонагревательного коллектора лист отрубного типа в условиях принудительной циркуляции/ Ю.К. Рашидов, А.У. Вохидов// Гелиотехника. – 2016. – №4. – С.8-14.
12. Рашидов Ю.К. Метод гидравлического расчёта теплообменной панели солнечного водонагревательного коллектора лист отрубного типа с заданной неравномерностью распределения потока жидкости в условиях принудительной циркуляции/ Ю.К. Рашидов, Ж.Т. Орзиматов, К.Ю. Рашидов, Ф. Файзиев// Международная научно-практическая конференция «Экологическая, промышленная и энергетическая безопасность – 2019», Севастополь 23-26 сентября 2019 года, С.1391-1395.
13. Madaliev M. E. U., Rakhmankulov S. A., Tursunaliev M. M. U. Comparison of Finite-Difference Schemes for the Burgers Problem //Middle European Scientific Bulletin. – 2021. – Т. 18. – С. 76-83.
14. Madaliev M. E. U. et al. Modeling of Deformation Processes and Flow of Highly Concentrated Suspensions in Cylindrical Pipelines //Middle European Scientific Bulletin. – 2021. – Т. 18. – С. 128-136.
15. Xamdamaliyevich S. A., Rahmankulov S. A. INVESTIGATION OF HEAT TRANSFER PROCESSES OF SOLAR WATER, AIR CONTACT COLLECTOR //E-Conference Globe. – 2021. – С. 161-165.
16. Kholmurzaev, A. A., & Tokhirov, I. K. (2021). The active participation of students in the formation of the educational process is a key to efficiency. ACADEMICIA: An International Multidisciplinary Research Journal, 11(4), 435-439.
17. Абдукаримов, Б. А., & Тохиров, И. Х. (2019). Research of convective heat transfer in solar air heaters. Наука, техника и образование, (9 (62)).
18. Erkinjonovich A. Z. et al. WATER CONSUMPTION CONTROL CALCULATION IN HYDRAULIC RAM DEVICE //E-Conference Globe. – 2021. – С. 119-122.
19. Madaliev E. U. et al. Comparison of Turbulence Models for the Problem of an Asymmetric Two-Dimensional Plane Diffuser //Middle European Scientific Bulletin. – 2021. – Т. 18. – С. 119-127.
20. Abdulkhaev, Z. E., Madraximov, M. M., Rahmankulov, S. A., & Sattorov, A. M. (2021, June). Increasing the efficiency of solar collectors installed in the building. In " ONLINE-CONFERENCES" PLATFORM (pp. 174-177).
21. Madaliev E. U. et al. Investigation of the Spalart-Allmares Turbulence Model for Calculating a Centrifugal Separator //Middle European Scientific Bulletin. – 2021. – Т. 18. – С. 137-147.

© 2021, CAJOTAS, Central Asian Studies, All Rights Reserved

Copyright (c) 2021 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

22. Mamadalievich, M. M., & Erkinjonovich, A. Z. Principles of Operation and Account of Hydraulic Taran. JournalNX, 1-4.
23. Madaliev M. E. U. et al. Investigation of the Influence of the Computational Grid for Turbulent Flow //Middle European Scientific Bulletin. – 2021. – Т. 18. – С. 111-118.
24. Абдукаримов, Б. А., Ё. С. Аббасов, and Н. У. Усмонова. "Исследование рабочих параметров солнечных воздухонагревателей способы повышения их эффективности." Матрица научного познания 2 (2019): 37-42.
25. Мадрахимов, М. М., & Абдулҳаев, З. Э. (2019). Насос агрегатини ишга туширишда босимли сув узатгичлардаги ўтиш жараёнларини ҳисоблаш усуллари. Фарғона Политехника Институти Илмий–Техника Журнали, 23(3), 56-60.
26. Усмонова, Н. А., Негматуллоев, З. Т., Нишонов, Ф. Х., & Усмонов, А. А. (2019). Модели закрученных потоков в строительстве Каркидонского водохранилища. Достижения науки и образования, (12 (53)).
27. Abdullayev, B. X., S. I. Xudayqulov, and S. M. Sattorov. "SIMULATION OF COLLECTOR WATER DISCHARGES INTO THE WATERCOURSE OF THE FERGHANA VALLEY." Scientific-technical journal 24, no. 3 (2020): 36-41.
28. Abdullayev, B. X., S. I. Xudayqulov, and S. M. Sattorov. "VARIABLE FLOW RATE FLOW ALONG A PATH IN A CLOSED INCLINED PIPELINE." Scientific-technical journal 24, no. 4 (2020): 23-28.
29. Рашидов, Ю. К., Исмоилов, М. М., Орзиматов, Ж. Т., Рашидов, К. Ю., & Каршиев, Ш. Ш. (2019). Повышение эффективности плоских солнечных коллекторов в системах теплоснабжения путём оптимизации их режимных параметров. In Экологическая, промышленная и энергетическая безопасность-2019 (pp. 1366-1371).
30. Z.E. Abdulkhaev, M.M. Madraximov, A.M. Sattorov (2020). Calculation Of The Efficiency Of Magnetohydrodynamic Pumps. SCIENTIFIC –TECHNICAL JOURNAL of FerPI, 24(1), 42-47.
31. Рашидов, Ю. К., Орзиматов, Ж. Т., & Исмоилов, М. М. (2019). Воздушные солнечные коллекторы: перспективы применения в условиях Узбекистана. In Экологическая, промышленная и энергетическая безопасность-2019 (pp. 1388-1390).
32. Рашидов, Ю. К., Исмоилов, М. М., Рашидов, К. Ю., & Файзиев, З. Ф. (2019). Определение оптимального количества расчётных слоев многослойного водяного стратификационного аккумулятора теплоты при расчете саморегулирующегося активного элемента. In Экологическая, промышленная и энергетическая безопасность-2019 (pp. 1372-1376).
33. Abdulkhaev, Z. E., M. M. Madraximov, and M. A. O. Shoyev. "Reducing the Level of Groundwater In The City of Fergana." *Int. J. Adv. Res. Sci. Commun. Technol* 2, no. 2 (2021): 67-72.
34. Erkinjonovich, A. Z., Mamadaliyevich, M. M., O'G'Li, S. M. A., & Egamberdiyevich, T. N. (2021). FARG'ONA SHAHAR YER OSTI SIZOT SUVLARINING KO'TARILISH MUAMMOSI VA YECHIMLARI. Oriental renaissance: Innovative, educational, natural and social sciences, 1(3), 138-144.
35. Abobakirovich, Abdukarimov Bekzod, O'Gli Mo'Minov Oybek Alisher, and Shoyev Mardonjon Ahmadjon O'G'Li. "Calculation of the thermal performance of a flat solar air heater." *Достижения науки и образования* 12 (53) (2019).

© 2021, CAJOTAS, Central Asian Studies, All Rights Reserved

Copyright (c) 2021 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/

36. Usarov, M., G. Mamatisaev, G. Ayubov, D. Usarov, and D. Khodzhaev. "Dynamic calculation of boxed design of buildings." In *IOP Conference Series: Materials Science and Engineering*, vol. 883, no. 1, p. 012186. IOP Publishing, 2020.
37. Усаров, М. К., and Г. И. Маматисаев. "Вынужденные колебания коробчатой конструкции панельных зданий при динамических воздействиях." *Проблемы механики* 2 (2010): 23-25.
38. Madraximov, M. M., Abdulxayev, Z. E., Yunusaliev, E. M., & Akramov, A. A. (2020). Suyuqlik Va Gaz Mexanikasi Fanidan Masalalar To'plami. Oliy o 'quv yurtlari talabalari uchun o 'quv qo 'llanma.-Farg'ona, 285-291.
39. Усаров, М. К., and Г. И. Маматисаев. "Свободные колебания коробчатой конструкции здания." *Проблемы механики.* 5-6 (2009): 31.
40. Abdukarimov, B. A., Sh R. O'tbosarov, and M. M. Tursunaliyev. "Increasing Performance Efficiency by Investigating the Surface of the Solar Air Heater Collector." *NM Safarov and A. Alinazarov. Use of environmentally friendly energy sources* (2014).
41. Маликов, З. М., and М. Э. Мадалиев. "Численное моделирование течения в плоском внезапно расширяющемся канале на основе новой двужидкостной модели турбулентности." *Вестник Московского государственного технического университета им. НЭ Баумана. Серия Естественные науки* 4 (2021): 24-39.
42. Маликов, Зафар Маматкулович, and Муродил Эркинжанович Мадалиев. "Численное исследование закрученного турбулентного течения в канале с внезапным расширением." *Вестник Томского государственного университета. Математика и механика* 72 (2021): 93-101.
43. Madraximov, M. M., Nurmuxammad, X., & Abdulkhaev, Z. E. (2021, November). Hydraulic Calculation Of Jet Pump Performance Improvement. In International Conference On Multidisciplinary Research And Innovative Technologies (Vol. 2, pp. 20-24).
44. Malikov, Zafar Mamatkulovich, and Murodil Erkinjanovich Madaliev. "Mathematical modeling of a turbulent flow in a centrifugal separator." *Vestnik Tomskogo Gosudarstvennogo Universiteta. Matematika i Mekhanika* 71 (2021): 121-138.
45. Абдукаримов, Б. А., Акрамов, А. А. У., & Абдухалилова, Ш. Б. К. (2019). Исследование повышения коэффициента полезного действия солнечных воздухонагревателей. Достижения науки и образования, (2 (43)).
46. Maqsudov, R. I., & qizi Abdukhalilova, S. B. (2021). Improving Support for the Process of the Thermal Convection Process by Installing. Middle European Scientific Bulletin, 18, 56-59.
47. Абдулхаев, З. Э., & Сатторов, А. М. (2020). CENTRAL PUMP CASE ADJUSTMENT BY CHANGING THE ROTATION FREQUENCY. Актуальные научные исследования в современном мире, (6-1), 20-25.
48. Mo'minov, O. A., Maqsudov, R. I., & qizi Abdukhalilova, S. B. (2021). Analysis of Convective Finns to Increase the Efficiency of Radiators used in Heating Systems. Middle European Scientific Bulletin, 18, 84-89.

Copyright (c) 2021 Author (s). This is an open-access article distributed under the terms of Creative Commons Attribution License (CC BY).To view a copy of this license, visit https://creativecommons.org/licenses/by/4.0/