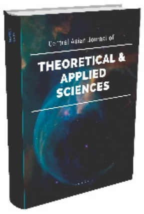

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Modeling Aeration in High Pressure Hydraulic Circulation

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Annotation: *The intensity of the pulsation of water flow rates in high-pressure hydraulic units depends on the flow velocity, which leads to the destruction of small waves arising on the free surface . From gravity acting on air bubbles trapped by a stream of water, and on water droplets in the air; from the force of surface tension, preventing the destruction of the free surface of the water; from the hydraulic coarseness of the bubbles (the speed of their rise in calm water) affect the aeration process. The article addresses the above issues.*

Keywords: *aeration, turbulence scale, averaged speed of high-pressure hydraulic structures, mixing paths.*

In many cases, many reservoir hydrauses, for example, in a tubalangcom, the reservoir, the condition of air penetration into the flow is not only the yield of turbulent perturbations on the free surface, but also the achievement on the surface surface of approximately 3-4 m / s. The location of turbulent perturbations on the free surface depends on the depth of the stream. The destruction of the waves on the surface of the free surface occurs in the result of the action on them from the air force.

Experiments are shown that the air force is proportional to the square of the flow rate of the flow of relationally air, then, naturally, the criterion of the beginning of aeration must be complex and contain depth and square of water velocity. Therefore, the number of fruits enters most of the proposed criteria for the beginning of aeration.

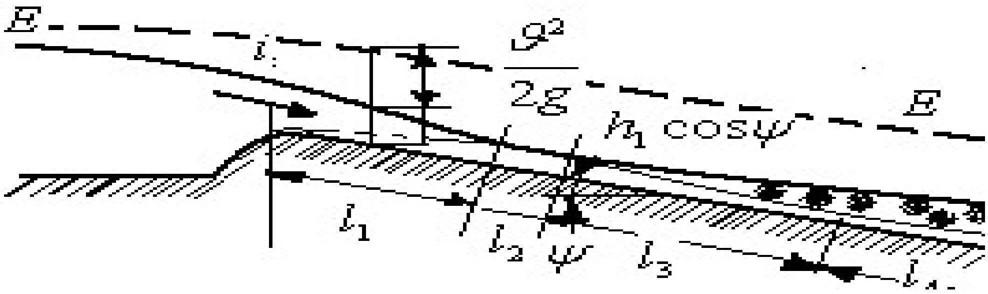


Figure. 1. Replace the flow structure along the length of the speed.

But to reproduce the aeration process on the model, which is notable, is not possible, and the receipt of inventive data is difficult. The intensity of the pulsation of the velocities of the aqueous stream depends on the flow rate, leading to the destruction of small waves arising on the free surface. From the strength of gravity, acting on air bubbles, captured by the flow of water, and on water droplets in the air; from the strength of the surface tension that prevents the destruction of the free surface of the water; From the hydraulic size of bubbles (the speed of their pop-up in calm water) affect the aeration process. And finally, from the perturbation of the free surface by the poor structures and the scientifications of the water. Каждая из выше приведенных сил требуется свой критерий:

Frud. $Fr = \frac{\vartheta^2}{gl}$, Weber $We = \frac{\rho l \vartheta^2}{\nu}$, Reynoldsa $\mathrm{Re} = \frac{l\vartheta}{\nu}$.

When modeling on a fruud on the model, in λ If less nature, the strength of gravity acting on air bubble or water drop is less than in kind, in λ^3 once; Power of surface tension - λ, once; The force of friction on which the hydraulic size of the bubble depends, - $\lambda^{\frac{3}{2}}$ times. The kinetic energy of bubbles and drops decreases in λ^4 Once, the work of the forces of surface tension and friction - respectively in λ^2 и $\lambda^{\frac{5}{4}}$ once. This eliminates the possibility of achieving a complete similarity when modeling the capture process of air flow and started aeration. On the model, in λ Once smaller nature, the size of air bubbles and water drops will not be in Once smaller. It is also important to respect the similarity of the relative roughness of the bed.

Studying aeration in laboratory conditions in NIIIVP is produced in trays with a large drop of the levels of the beef, allowing to reproduce the conditions for its occurrence approaching to one-scale.

In [2, 3], on the basis of attentive and extensive laboratory use of aeration (with relative roughness of the tray $\frac{\Delta}{R} = 0$; 0,01; 0,02; 0,04; 0,06 and 0,1 and meets the beginning of aeration:

$$Fr_{кр} = 45\left(1 - \frac{\Delta}{R}\right)^{14}$$

Where R - Hydraulic radius of non-aeronautical stream. From (4-6), the critical speed corresponding to the start of aeration can be represented by the following formula: $\vartheta_{кр} = 6{,}7\sqrt{gR}\left(1 - \frac{\Delta}{R}\right)^7$ (7)

G.P. Skrebkov and V.S. The synecics [4] proceeded from the calculated model,

Presenting air capture by flow as a result of the water droplets in the airspace. The air bubbles captured by the stream saturate the flow at:

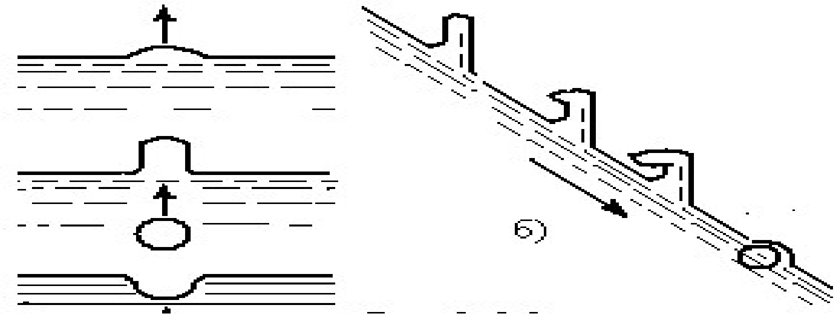


Figure. 2. Meashnism of air colding accept through free

a) angled air

b) in the breaking of waves

$\sqrt{\sigma} \ \phi \ w\cos\psi$ (8)

Where σ - RMS transverse ripple speed; w - Hydraulic air bubbles, equal to 25 cm / s. The transverse pulsation velocity at the free surface can be expressed through dynamic speed:

$$\sqrt{\sigma} = \beta\sqrt{u_*} = \beta\sqrt{gh_0 \sin\psi}$$

where the coefficient β - according to [66] adopted 0,8; h_0 - Depth of the uniform non-aeronated stream; ψ - Angle of inclination of the waterway.

Consequently, inequality (8) can be "represented as:

$$h_0 \sin\psi \ \phi \ \frac{w^2}{\beta g}\cos^2\psi$$

Multiplying the right and left parts of this inequality on C^2 and bearing in mind that when $h_0 \approx R\vartheta = C\sqrt{RI}$ где $I = \sin\psi$, we obtain the formula of the mean velocity at which aeration begins:

$$\vartheta_{кр} = \frac{Cw\cos\psi}{\sqrt{0{,}8g}} \qquad (9)$$

or for $w = 0{,}25\frac{м}{c}$

$$\vartheta_{кр} = 0{,}089C\cos\psi \qquad (10)$$

T. G. Wagoney-Syankhensky [1] proceeded from the formula for the propagation rate of the wave of perturbation on the surface of the water - air of the potential stream. The flow, which shifts on the speed or drainage, can be approximately considered potential, based on the fact that in this case the inertia strength is knowledgeably more resistance forces.

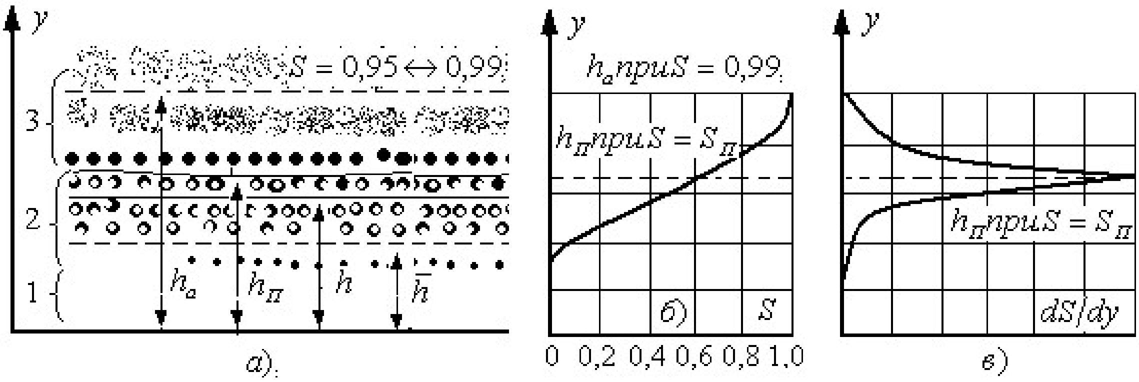


Figure. 3.Cheme impexless water flow

(a) and the nature of the distribution of concentration air (b.v)

In the field of gravity, at the rate of water flow, air velocity and the depth of the wave of perturbation on the surface of the section, it is distributed (excluding the effect of surface tension forces) with ambulance (Fig.4.) [46]:

$$c = \frac{\rho u + \rho_a u_a}{\rho + \rho_a} \pm \sqrt{\frac{g\lambda(\rho - \rho_a)}{2\pi(\rho + \rho_a)} th \frac{2\pi h}{\lambda} - \frac{\rho \rho_a (u - u_a)^2}{(\rho + \rho_a)^2} th \frac{2\pi h}{\lambda}}$$

where ρ, ρ_a - density, respectively water and air; g - acceleration of gravity; λ - wavelength.

insofar as ρ_a ππ ρ, namely $\frac{\rho_a}{\rho} \approx \frac{1}{770}$,

That can be considered

$$\frac{(\rho - \rho_a)}{(\rho + \rho_a)} \approx 1 \text{ и } \frac{\rho \cdot \rho_a}{(\rho + \rho_a)^2} \approx \frac{\rho_a}{\rho}.$$

Then for u ϕϕ u_a and oblique bottom of the bed:

$$c = u \pm \sqrt{\frac{g_* \lambda}{2\pi} th \frac{2\pi h}{\lambda} - \frac{\rho_a u^2}{\rho} th \frac{2\pi h}{\lambda}}$$

where $g_* = g\cos\psi$, ψ - the angle of inclination. For the waves of a small length on the wave propagation rate, in addition to gravity, the forces of the surface tension [50] also have a noticeable effect of [50], which leads to the formula [16] $c = u \pm \sqrt{\frac{g_* \lambda}{2\pi} th \frac{2\pi h}{\lambda} + \frac{2\pi\sigma}{\rho\lambda} th \frac{2\pi h}{\lambda} - \frac{\rho_a u^2}{\rho} th \frac{2\pi h}{\lambda}}$ (12)

σ - поверхностное натяжение жидкости.

Wave propagation rate in fixed liquid ($u = 0$)excluding surface tension and when assumed that $\rho_a = 0$, Determined by the formula:

$$c = \sqrt{\frac{g_* \lambda}{2\pi} th \frac{2\pi h}{\lambda}} \tag{13}$$

With an increase in the flow rate to a certain limit value, the conditioned expression of formula (12) becomes negative. This means that the wave motion under consideration is impossible physically: waves are degraded, causing aeration. Thus, the condition of the beginning of aeration is the equality zero of the courted expression of formula (12) or

$$u^2 = \frac{g_* \lambda \rho}{2\pi \rho_a} + \frac{2\pi\sigma}{\lambda \rho_a} \tag{14}$$

To obtain the calculated formula, the wavelength λ in (14) expressed through the length of the mixing path l and then through the hydraulic radius R, And surface speed u - through average speed ϑ.

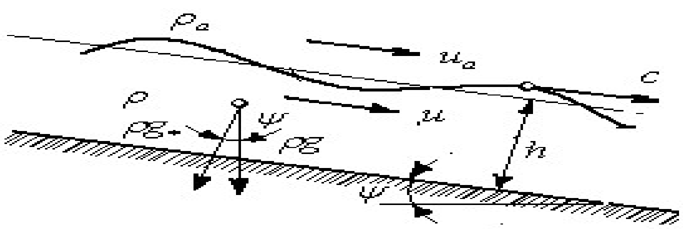


Figure. 4. Inspection of perturbation waves on the surface of the section

One of the values determining the scale of the flow turbulence is determined as it is known, the length of the mixing path l, Equal on L. Prandtlu Distance on which the final volumes of liquid (moths) are penetrated in the transverse direction under the influence of velocity ripples. The length of the mixing path, and therefore, the size of the vortex originated at the bottom of the DNA increase in proportion to the distance from the bottom to $l = \chi y$ (χ-constant Pocket). According to the explicit data Nikuraradsis $\chi = 0{,}36 \longleftrightarrow 0{,}40$ and constant value χ- saved at distances from the bottom to $y \le 0{,}2h$. Vortices reaching a free surface have dimensions $l = \chi h$, where $\chi = 0{,}36$; wavelength l Determined by the size of the vortices. Because for widespread $R = h$, finally taken into expression (14) $\lambda = 0{,}36R$.

For transition in expression (14) from surface speed; The logarithmic law of the distribution of the rainy, obtained by the pocket [121, p.546]:

$$\frac{u_{пов} - u}{u_*} = -\frac{1}{\chi}\left\{ \ln\left[1 - \sqrt{\frac{y}{h}}\right] + \sqrt{\frac{y}{h}} \right\} \tag{15}$$

where $u_{пов}$- Surface speed; u - Local averaged speed at a point immersed on the depth y; u_* - Dynamic speed. Expressing u_* Through average speed:

$$u_* = \sqrt{gRI} = \frac{\vartheta\sqrt{g}}{C}$$

Formula (15) give the form:

$$\frac{u_{пов}}{\vartheta} = \frac{u}{\vartheta} - \frac{\sqrt{g}}{\chi C}\left\{\ln\left[1-\sqrt{\frac{y}{h}}\right]+\sqrt{\frac{y}{h}}\right\} \qquad (16)$$

If we take that at a distance from a free surface $\frac{y}{h} = 0{,}84$ local averaged speed $u = \overline{\vartheta}$, That instead (4-16) we get:

$$\frac{u_{пов}}{\vartheta} = 1 + \frac{\sqrt{g}}{\chi C} \qquad (17)$$

Since accepted

$\ln\left[1-\sqrt{0{,}84}\right]+\sqrt{0{,}84} \approx -1$.

From the power law distribution law in the radius round pipe r_0 :

$$\frac{u}{u_{\max}} = \left(\frac{y}{r_0}\right)^{\frac{1}{n}}$$

[1] when $\frac{1}{n} = \frac{1}{10}$ has a local averaged speed $u = \vartheta$ at a distance from the surface $\frac{y}{h} = 0{,}763$. With coefficient of coefficient for manning $C = \frac{1}{n}R^{\frac{1}{6}}$

$$\frac{u_{пов}}{\vartheta} = 1 + \frac{\sqrt{g}n}{\chi R^{\frac{1}{6}}} \qquad (18)$$

Substituting in (18) speed $u_{пов}$ по (14) when $\lambda = 0{,}36R$, separate critical number

frud. $Fr_{кр} = \frac{\vartheta^2}{gR}$, at which aeration begins:

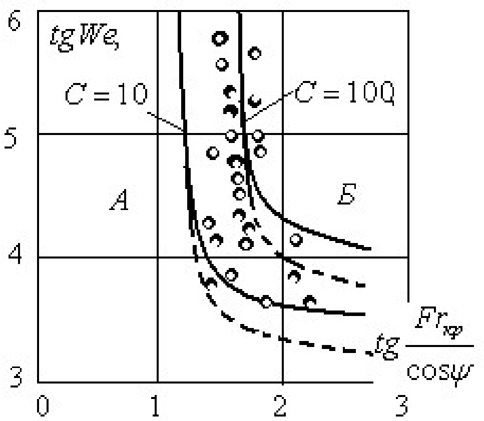
$$Fr_{кр} =\geq \frac{\rho\chi}{2\pi\rho_a}\frac{1+\frac{4\pi^2\sigma}{\rho g_*\chi^2R^2}}{\left(1+\frac{n\sqrt{g}}{\chi R^{\frac{1}{6}}}\right)}\cos\psi, \qquad (19)$$

when $\sigma = 36\cdot 10^{-2}\frac{H}{м}$.

$$\vartheta_{кр} = 6{,}63\sqrt{gR\cos\psi\left(1+\frac{0{,}0011}{R^2}\right)}\left(1+8{,}7\frac{n}{R^{\frac{1}{6}}}\right)^{-1} \qquad (20)$$

Surface tension for distilled water at a temperature of 20 parts equals $72\cdot 10^{-3}\frac{H}{м}$. If there are organic impurities in water σ decreases, however, the decrease σ до $36\cdot 10^{-3}\frac{H}{м}$ It should be considered as an empirical directing, increasing calculation accuracy $\vartheta_{кр}$ Aeratorial criteria is given to mind:

$$\frac{Fr_{кр}}{cos\psi} = \frac{44}{\left(1+\frac{8{,}7}{C}\right)^2 - \frac{13300}{We}} \qquad (21)$$



Rice. 5. Effect of surface tension Number of Weber WE on the number of FRU Yes FR corresponding to the beginning of the aratration

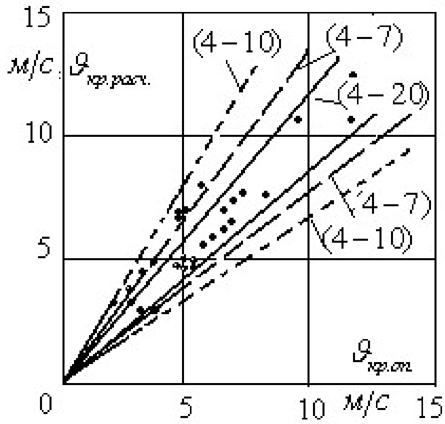


Fig.6. Radiatric rejection of settlement values of the speed of starting aeriality of experimental data. Fativity

This expression allows you to identify the effect of surface tension on the occurrence of aeration, i.e., the number of Web $We = \frac{\rho R\vartheta^2}{\sigma}$, expressing the relationship of the power of inertia to the forces of surface tension. In Fig. 5. The expression (21) is presented in the form of a graph, the meaning of which is as follows. In the area of *A* when $\lg Fr$ π 1

($Fr = 10$)and any values $\lg We$, as well as $\lg Fr$ ϕ 1 и $\lg We$ π 3,5 Aeration does not occur. It occurs at $\lg Fr$ ϕ 1 и $\lg We$ ϕ 3,5. And always takes place in the region *B*.

Fig. 6. The comparison of the experimental speed data is given. $\vartheta_{кр}$ with calculated and shown borders corresponding to the standard deviations of settlement values $\vartheta_{кр}$ from observed (in percent). The standard deviation of the software (20) was 15%, according to (7) - 22%, software (10) - 39.9%.

LIST OF USED LITERATURE

1. Woalk - Xionozhentsky T.G. On the criterion condition for the emergence of aeration of smoothly changing rapid flows. - Proceedings of the I Transcaucasian Conference of Molo-Differs. Yerevan: 1960.
2. Isachenko N.B. The effect of the roughness of the water-supply surface on the degree of intelligence of the open flow. - Izvestia VNIIG, 1965, vol. 78.
3. Veksler A.V. The main equations of one-size channel weigonflowing flow // Reservitution and the fight against it. M.: Kolos, 1970. - 156 p.
4. Warnevo-Syankhensky T.G., Lttatidze V.G., Tavarkkaladze N.E. On the turbulent flow of two-phase water-air flow with variable flows along the path // News of TNISHEI. 1960. № 12 (46). Pp. 134 - 138.
5. Kiselev P.G. Movement of fluid with variable mass // Questions of hydraulic engineering. Sat MII works. 1955. No. 5. P. 43 - 55.
6. Abdullayev B. X., Xudayqulov S. I., Sattorov S. M. SIMULATION OF COLLECTOR WATER DISCHARGES INTO THE WATERCOURSE OF THE FERGHANA VALLEY //Scientific-technical journal. – 2020. – Т. 24. – №. 3. – С. 36-41.
7. Abdullayev B. X., Xudayqulov S. I., Sattorov S. M. VARIABLE FLOW RATE FLOW ALONG A PATH IN A CLOSED INCLINED PIPELINE //Scientific-technical journal. – 2020. – Т. 24. – №. 4. – С. 23-28.
8. 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.
9. Alimardon, [09.12.2021 13:35]
10. Hamdamalievich, S. A., & Nurmuhammad, H. (2021). Analysis of Heat Transfer of Solar Water Collectors. Middle European Scientific Bulletin, 18, 60-65.
11. Сатторов, А.. (2020). Повышение эффективности калорифера, используемого в системе вентиляции. Достижения науки и образования, (5 (59)), 9-12.
12. Madraximov, M. M., Abdulkhaev, Z. E., & Orzimatov, J. T. (2021). GIDRAVLIK TARAN QURILMASINING GIDRAVLIK HISOBI. Scientific progress, 2(7), 377-383.
13. 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)).
14. 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.
15. ugli Moʻminov, 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.

16. 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.
17. 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).
18. Mirzoev, Akmal Ahadovich, Murodil Madaliev, and Doniyor Yakhshibayev Sultanbayevich. "Numerical modeling of non-stationary turbulent flow with double barrier based on two liquid turbulence model." In *2020 International Conference on Information Science and Communications Technologies (ICISCT)*, pp. 1-7. IEEE, 2020.
19. Мадалиев, Муродил Эркинжон Угли. "Численное исследование осесимметричных струйных течений на основе турбулентной модели νt-92." *Вестник Южно-Уральского государственного университета. Серия: Вычислительная математика и информатика* 9, no. 4 (2020).
20. Erkinjonovich, Abdulkhaev Zokhidjon, and Madraximov Mamadali Mamadaliyevich. "WATER CONSUMPTION CONTROL CALCULATION IN HYDRAULIC RAM DEVICE." In E-Conference Globe, pp. 119-122. 2021.
21. Madaliev, Erkin, Murodil Madaliev, Kamol Adilov, and Tohir Pulatov. "Comparison of turbulence models for two-phase flow in a centrifugal separator." In *E3S Web of Conferences*, vol. 264. EDP Sciences, 2021.
22. 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.
23. 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.
24. Madaliev, E. U., Madaliev, M. E. U., Mullaev, I. I., Shoev, M. A. U., & Ibrokhimov, A. R. U. (2021). Comparison of Turbulence Models for the Problem of an Asymmetric Two-Dimensional Plane Diffuser. Middle European Scientific Bulletin, 18, 119-127.
25. Mamadalievich, M. M., & Erkinjonovich, A. Z. Principles of Operation and Account of Hydraulic Taran. JournalNX, 1-4.
26. Madaliev, M. E. U., Rakhmankulov, S. A., Shoev, M. A. U., & Ibrokhimov, A. R. U. (2021). Modeling of Deformation Processes and Flow of Highly Concentrated Suspensions in Cylindrical Pipelines. Middle European Scientific Bulletin, 18, 128-136.
27. 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).
28. Madaliev, M. E. U., Rakhmankulov, S. A., & Tursunaliev, M. M. U. (2021). Comparison of Finite-Difference Schemes for the Burgers Problem. Middle European Scientific Bulletin, 18, 76-83.
29. Koraboevich, Usarov Makhamatali, and Mamatisaev Giyosiddin Ilhomidinovich. "CALCULATION OF THE FREE VIBRATIONS OF THE BOXED STRUCTURE OF LARGE-PANEL BUILDINGS." In *" ONLINE-CONFERENCES" PLATFORM*, pp. 170-173. 2021.

30. Mirsaidov, Mirziyod, Makhamatali Usarov, and Giyosiddin Mamatisaev. "Calculation methods for plate and beam elements of box-type structure of building." In *E3S Web of Conferences*, vol. 264. EDP Sciences, 2021.

31. Усаров, Махаматали Корабоевич, and Гиёсиддин Илхомидинович Маматисаев. "КОЛЕБАНИЯ КОРОБЧАТОЙ КОНСТРУКЦИИ КРУПНОПАНЕЛЬНЫХ ЗДАНИЙ ПРИ ДИНАМИЧЕСКИХ ВОЗДЕЙСТВИЯХ." In *Научный форум: технические и физико-математические науки*, pp. 53-62. 2019.

32. Abdulkhaev, Zokhidjon, Mamadali Madraximov, Axmadullo Abdurazaqov, and Mardon Shoyev. "Heat Calculations of Water Cooling Tower." *Uzbekistan Journal of Engineering and Technology* (2021).

33. ABDULKHAEV, ZOKHIDJON ERKINJONOVICH. "Protection of Fergana City from Groundwater." *Euro Afro Studies International Journal* 6 (2021): 70-81.

34. Erkinjonovich, Abdulkhaev Zokhidjon, Madraximov Mamadali Mamadaliyevich, Shoev Mardonbek Axmadjon O'G'Li, and Toshpulatov Nosirbek Egamberdiyevich. "FARG'ONA SHAHAR YER OSTI SIZOT SUVLARINING KO'TARILISH MUAMMOSI VA YECHIMLARI." *Oriental renaissance: Innovative, educational, natural and social sciences* 1, no. 3 (2021): 138-144.

35. Рашидов, Ю. К., Исмоилов, М. М., Рашидов, К. Ю., & Файзиев, З. Ф. (2019). Повышение равномерности распределения потока жидкости по подъемным трубам лучепоглощающей теплообменной панели солнечного водонагревательного коллектора листотрубного типа в условиях принудительной циркуляции при действии объёмных сил. In Экологическая, промышленная и энергетическая безопасность-2019 (pp. 1377-1382).

36. 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).

37. 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).

38. 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.

39. 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)).

40. Abdulkhaev, Zokhidjon Erkinjonovich, Mamadali Mamadaliyevich Madraximov, Salimjon Azamdjanovich Rahmankulov, and Abdusalom Mutalipovich Sattorov. "Increasing The Efficiency Of Solar Collectors Installed In The Building." In *" ONLINE-CONFERENCES" PLATFORM*, pp. 174-177. 2021

