ENGINEER

international scientific journal

A bridge between science and innovation

INTERNATIONAL SCIENTIFIC JOURNAL “ENGINEER”

Published since 2023

TASHKENT STATE TRANSPORT UNIVERSITY

Founder of the scientific and technical journal International Journal of Information Systems. Technologies. Transport” – Tashkent State Transport University (100167, Republic of Uzbekistan, Tashkent, Temiryulchilar str., house No. 1, office: 379, tel. +998712990189; E-mail: nauka@tstu.uz).

In the International Journal of Information Systems. Technologies. Transport” publishes the most significant results of scientific and applied research carried out in universities of transport and information technology profile, other higher educational institutions, research institutes and centers of the Republic of Uzbekistan and foreign countries.

The journal is published 4 times a year and contains publications in the following main areas:

- Technique;
- Construction;
- Bridge and tunnel;
- Power industry;
- High speed train;
- Transport.

Founder - Tashkent State Transport University
100167, Republic of Uzbekistan, Tashkent, Temirulchilar st., 1.
Tel.: +998 71 299 01 89 E-mail: nauka@tstu.uz

CONTENTS

DETERMINATION OF INDUSTRIAL WASTE-BASED PROPERTIES OF STRUCTURAL HEAT PROTECTION AERATED CONCRETE BETON

Shaumarov Said Sanatovich,
Kandakharov Sanjar Ishratovich,
Okilov Zafarjon Omon ogli
Sultonkhodjayeva Gulnoza
Tashkent state transport university, Tashkent, Uzbekistan

Abstract: *This article presents the results of experimental studies that describe the parameters and properties of the porous structure of aerated concrete based on industrial waste. The structurally optimal parameters reflecting the physical, mechanical, and thermal properties of the foam concrete exterior wall structures have been determined. The test results were carried out in research laboratories using gas-block structures with high porosity and optimal composition, and an improved technology of autoclave aerated concrete was proposed.*
Key words: *Aerated concrete beton, strength, porosity, thermal protection, water-cement ratio.*

INTRODUCTION

In the Republic of Uzbekistan, special attention is paid to the introduction of new technologies for the construction of energy-efficient buildings, the localization of the modern construction materials industry and the gradual abandonment of imported products, the reduction of the cost of construction products, and the reduction of energy consumption in the operation of buildings and structures [1-3].

In this direction, the President of the Republic of Uzbekistan Sh.M. Under the leadership of Mirziyoyev, the major reforms in the construction industry were implemented. This is aimed at ensuring a high rate of production and export of competitive products from local raw materials in the Republic of Uzbekistan, as well as modernization of enterprises, processing of industrial waste products, technical and technological structural changes in the building materials industry [4-6].

An important trend in the development of the aerated concrete market is to improve the quality of non-autoclaved concrete products. For this, it is necessary to use all available technological methods in the organization of production, which allow the production of high-quality products with high maturity and high durability. At the molding stage and during heat and moisture processing, attention should be paid to improving the structure of foam concrete, which is carried out with controlled parameters of the temperature and humidity of the heating medium, which leads to a decrease in the residual moisture of the concrete and subsequent shrinkage. A complex approach to the development of technology for the production of aerated concrete without autoclave allows to bring the physical and mechanical properties of this type of material closer to autoclaved concrete.

A.I.Adilkhodzhaev, E.V.Shchipacheva, X.A.Akramov, S.A.Khodzhaev, R.R. Kadyrov, S.T. Suleymanov, I.K. Kasimov, U. .A. Gaziev, M.A. Sagatov, S.S. Shaumarov and other scientists are working on the development of the optimal composition of filler mixtures based on industrial waste.

In these studies, various properties of aerated concrete, strength, heat protection, optimization of porosity, and reduction of humidity were conducted with the help of mineral and organic additives, plasticizers.

Incorporation of industrial waste into aerated concrete protects it from harmful substances for nature and significantly reduces the price of the product.

When performing laboratory research work, it is necessary to ensure the same volume change during the hardening of binders, including cements [8-10]. During the hardening process, different volume changes lead not only to a decrease in strength, but also to different volumes of porosity.

RESEARCH METHODS AND TOOLS

The thermal and technical characteristics of aerated concrete blocks were carried out using the theoretical methods established in accordance with the regulatory requirements of KMK 2.01.04-18 "Construction thermal engineering", and calculations were performed using the following formula:

$$P_0=n(t_v-t_n)/\Delta t_n \alpha_v$$

n - the coefficient depending on the position of the outer surface of the barrier structures relative to the air, t_v - the temperature of the room, t_n - the external temperature of the air, Δt_n - the temperature of the inner surface of the barrier structure, α_v - the temperature coefficient of the inner surface of the barrier structure.

The actual thermal conductivity of aerated concrete blocks is determined as follows:

$$P_0=1/\lambda_n+\delta/\lambda+1/\lambda_v$$

λ_n, λ_v - the coefficient of heat transfer of the external and internal surfaces of the barrier structure, d - the size of the width of the structure, l - the heat transfer coefficient of the barrier structure.

Frost resistance of aerated concrete blocks was carried out by GOST 31359-2007 "Methodology for determining frost resistance of aerated concrete".

Experimental studies were carried out using filling materials based on industrial waste, laboratory tests using non-standard methods developed by scientific research experts according to generally accepted standards.

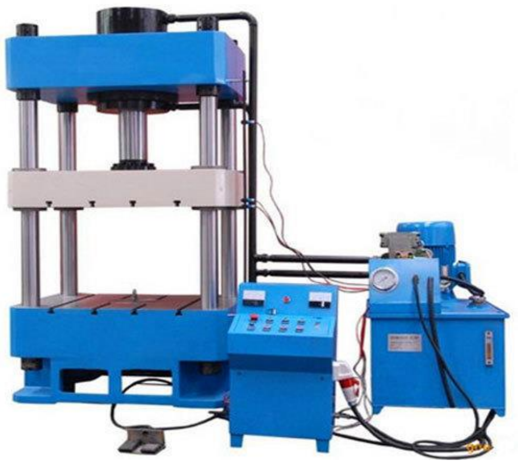

FIGURE 1. *Hydraulic press*

Determining the optimal porosity composition of the specified structural heat-shielding aerated concrete was performed using automated computer software [6-8].

Determination of the strength of aerated concrete samples using a hydraulic press was carried out in the following sequence:

1. 100x100x100 mm cubes of aerated concrete samples were installed in the press in turn.

2. The samples were gradually compressed with a continuously increasing force and lost their cubic shape.

3. Maximum breaking strength values for each sample were recorded.

4. The average breaking strength of several samples was analyzed and its brand was determined.

IMPROVING THE OPTIMAL COMPOSITION OF POROUS EXTERNAL WALL CONSTRUCTIONS BASED ON INDUSTRIAL WASTE

D600 grade aerated concrete blocks, industrial waste sand and industrial waste slag filler and binding materials were selected for laboratory research. The prepared aerated concrete blocks consist of samples with dimensions of 100x100x100 mm.

Two different compositions were prepared for the experiment: the first composition used waste quartz sand as gas block filler, and the second composition was carried out using waste slag. In the first composition, cubic samples with dimensions of 100X100X100 mm were prepared from mixtures with 5, 10, 15, 20% waste sand in relation to the mass of sand, and these compositions are presented in Table 1 [7-8].

TABLE 1.

Composition of 1 m^3 aerated concrete based on industrial waste sand

W/C	Spread of the mixture in Suttard, cm	Industrial waste sand	Average density, kg/m^3	Moisture, %	Strength, MPa	Thermal conductivity
0,44	15	5	645	30	1,64	0,15
	20	10	652	31	1,657	0,14
	25	15	658	32	1,67	0,145
	30	20	660	33	1,665	0,15

The samples were tested for compressive strength using a hydraulic press. According to the results of the research, samples with the best characteristics were identified. The results of this experimental study are presented in Figure 2.

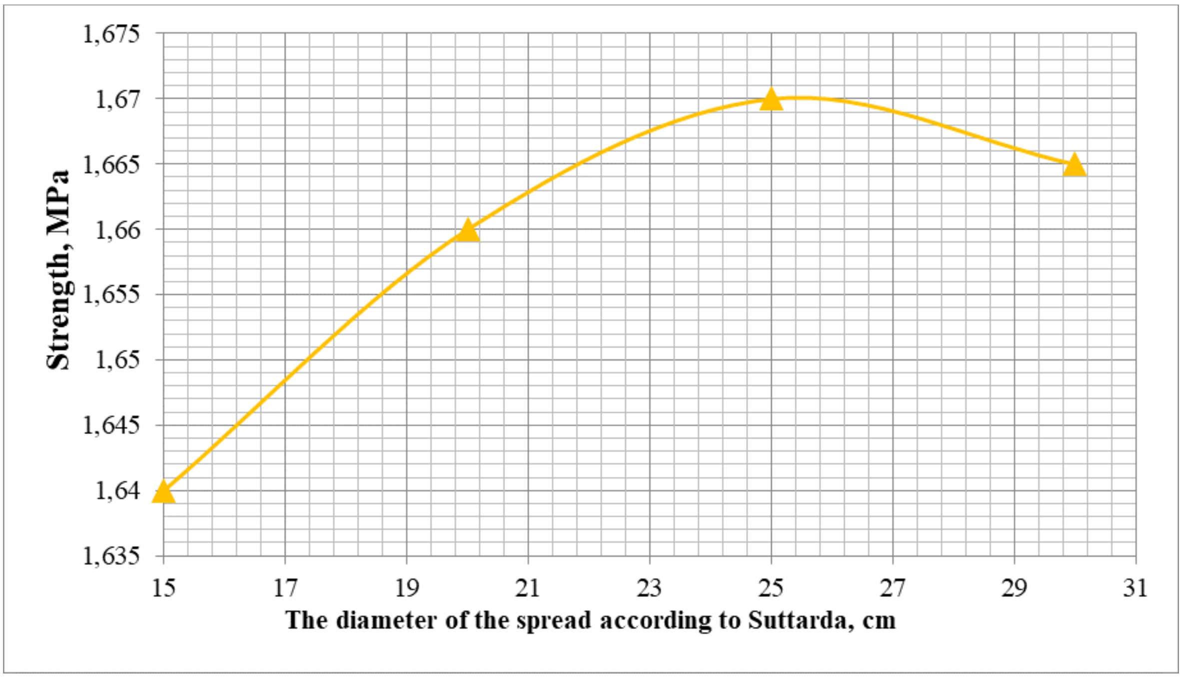

FIGURE 2. *Dependence of the consistency of the mixture density*

In the graph above, you can see the effect of aerated concrete material on the stability of the spreading diameter in the "Suttarda Viscometer" experimental device.

It can be seen from the graph that if waste sand is used as an industrial waste product without changing the ts/s ratio, its strength reaches its optimal strength depending on the diameter of the spread.

In the second composition, waste slag was added in the amount of 8, 10, 12, 14% relative to the mass of cement, and cube samples with dimensions of 100X100X100 mm were prepared. The samples were kept at a constant temperature for 28 days to solidify uniformly. The compositions of the mixtures are presented.

Also in this case, the limit of compressive strength of the samples was determined using a hydraulic press. The most optimal values of these results were selected. The effect of waste slag on gasblock samples and their relative classification are presented in Figure 3.

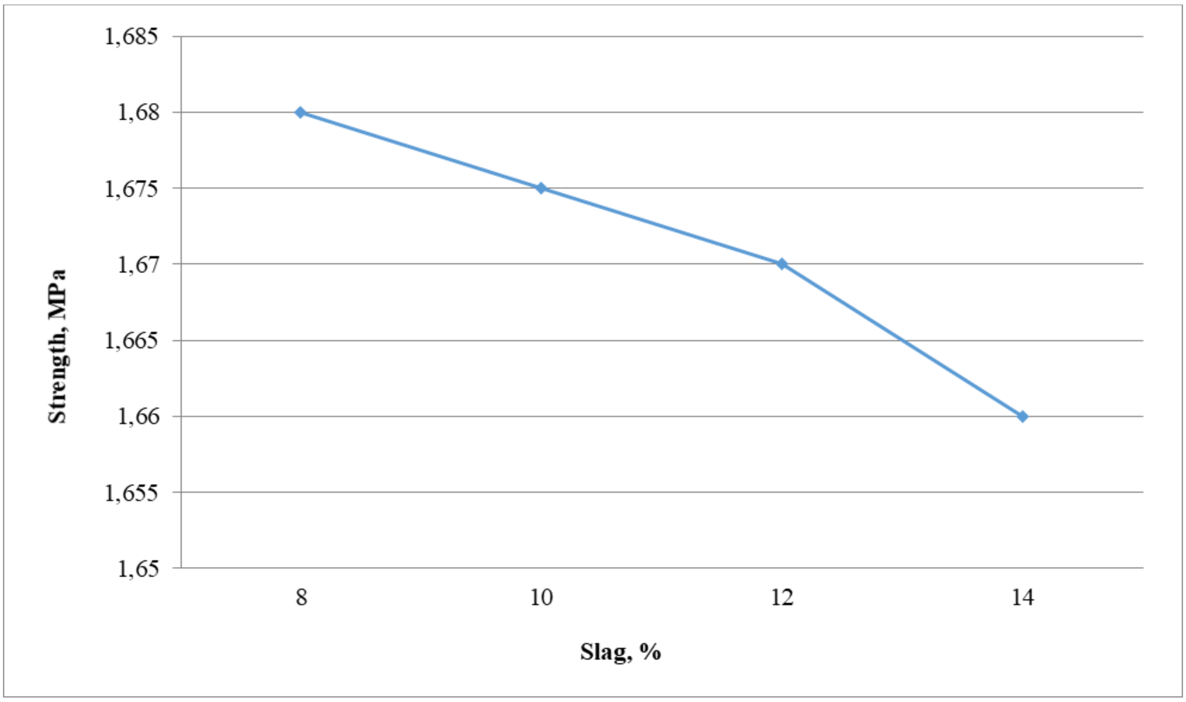

FIGURE 3. *Classification of aerated concrete depending on waste slag*

This graph shows that when waste slag is added to aerated concrete, if its binding property exceeds 12%, the strength will be significantly reduced. So, it can be seen that if waste slag is added to aerated concrete in the amount of up to 12%, its strength index meets the requirements.

The analysis of research laboratories shows that when waste sand and waste slag are added to the composition of non-autoclaved aerated concrete samples, their strength characteristics fully satisfy the requirements of the state standard GOST 10180-2012, and its cost is reduced by 10-11%.

CONCLUSION

1. The laboratory results of the research carried out in production organizations showed that when the same solidification process was ensured when its humidity was less than 5%, there was an improvement of 1-3% in dangerous cracks and 2.1-4.3% in porosity of non-autoclaved gas blocks.
2. It allows to reduce the fillers of the recommended gas blocks by 10-15% due to waste sand.
3. The results of the conducted experimental research laboratories showed that when the gas block is made using waste sand and waste slag, its binding amount allows to save 8-12%. price
4. In the process of production of porous concrete blocks, the inclusion of the above-mentioned and other types of industrial waste in the concrete composition, first of all, creates the possibility of processing (utilization) of waste, saving binder (cement), increasing the operational properties of the manufactured structure.

References:

1. Столяров, Я. В. Введение в теорию железобетона / Я. В. Столяров. -М.: Стройиздат, 1941.-232 с.
2. Хоменко В.Г. Справочник по теплозащите зданий. Киев. Будивельник,1996г.
3. Adilhodzhayev A.I., Shipacheva E.V., Shaumarov S.S., Shermuxamedov U.Z., Kandakhorov S.I. Some Aspects of the Photo-Optical Method of Estimation Composition of Light Concrete // International Journal of Engineering and Advanced Technology (IJEAT). ISSN: 2249-8958, Volume-8 Issue-5, June 2019. – pp.1924-1927.
4. Adilhodzhayev A. I., Shaumarov S.S., Umarov K.S. New Structure Assessment Method Cell Concrete // International Journal of Advanced Science and Technology Vol. 29, No. 5, (2020), pp. 1889-1893
5. Shaumarov S.S., Adilhodzhaev A.I., Shipacheva E.V., Kandakhorov S.I. Development of New Constructive and Heat-Insulating Materials. International Journal of Recent Technology and Engineering (IJRTE). ISSN: 2277-3878. Vol.7. Issue-5S3. p. 577-580. (2019)
6. Adilhodzhaev A., Shaumarov S., Tsoy V., Khodzhaev S. Research of the influence of silicon-organic hydrophobizer on the basic properties of Cement stone and mortar // International Journal of Advanced Science and Technology Vol. 29, No. 5, 2020, pp. 1918-1921
7. Shaumarov S.S., Adilhodzhayev A.I., Kondrazhenko V.I. Experimental research of structural organization of heat-insulating structural building materials for energy efficient buildings. XXII International Scientific Conference on Advanced In Civil Engineering «Construction the formation of living environment», 2019. p. 1-7
8. Shaumarov, S., Kandakhorov, S., Abduraimov, U., Improving the optimal composition of heat-insulating structural aerated concrete based on industrial waste, E3S Web of Conferences, 2021, p. 264-272, 02023.

International scientific journal "ENGINEER"
Tashkent 2023 Issue 1

INVESTIGATING THE TIME-CONSUMING EFFECT OF DELIVERING TRAIN WARNINGS TO THE TRAIN DRIVER VIA A TELEGRAM BOT

N.M. Aripov,
N.S.Toxirov,
M.D.Axmedova
Tashkent State Transport University, Tashkent, Uzbekistan

Abstract: *this article, it is very important to transmit the warnings that occurred in JSC "Uzbekistan railways" in a short period of time for the safety of train traffic, as well as to reduce the time of excessive stopping of trains. It is described how to use Telegram " ЖД _ ПРЕДУПРЕЖДЕНИЕ " bot to deliver warnings to trains to the train driver using information technology and to get information.*
Key words: *Telegram bot, transportation indicators, warning, electricity, fuel, technical condition, freight transportation, freight circulation, electrified section, automated system.*

Warnings to give Bottom to work take down and him to use order

Step 1. This warnings bot is called " JD _ PREDUPREJDENIE " .

this bot username and as " @ vekoto_yangibot " . named _ This bottom to work take down for Telegram messenger of search from the department bottom username according to or bot name according to we look for (Fig. 1).

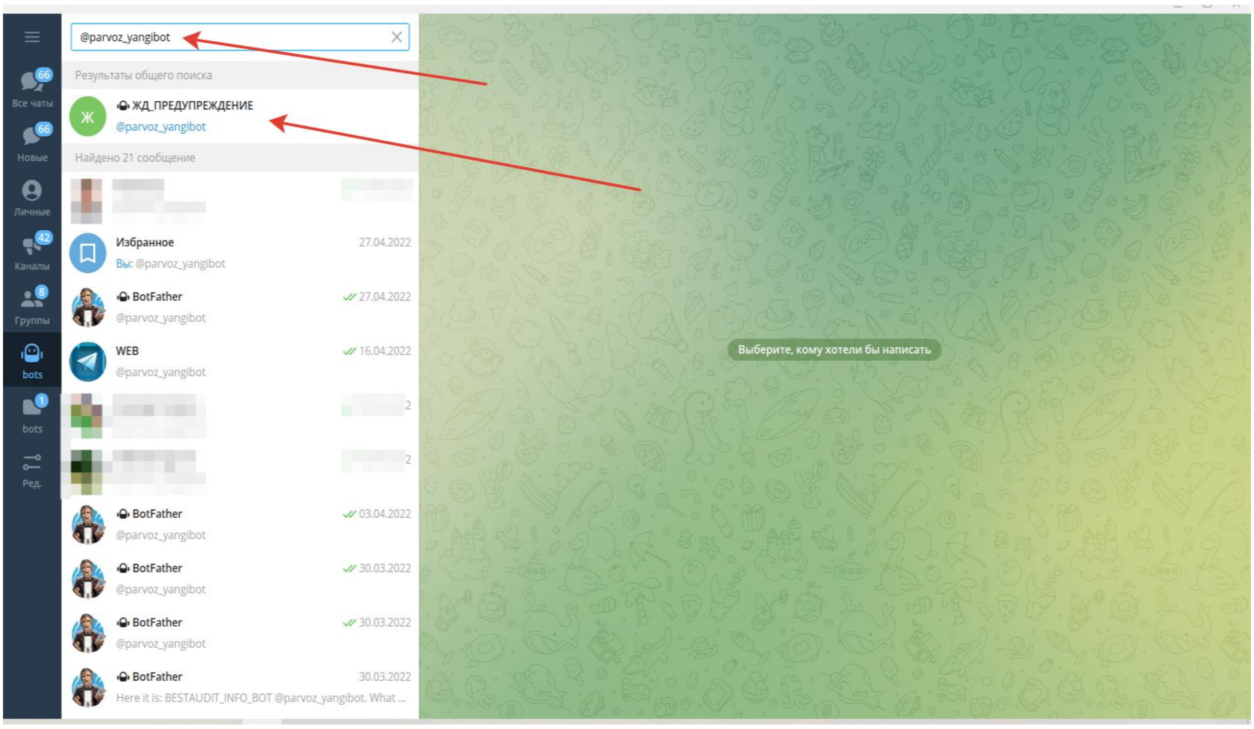

Figure 1. *Search bot*

From here search as a result to us necessary has been JD _ PREDUPREJDENIE bottom we choose and him on top of it click through this bottom to work let's take it down .

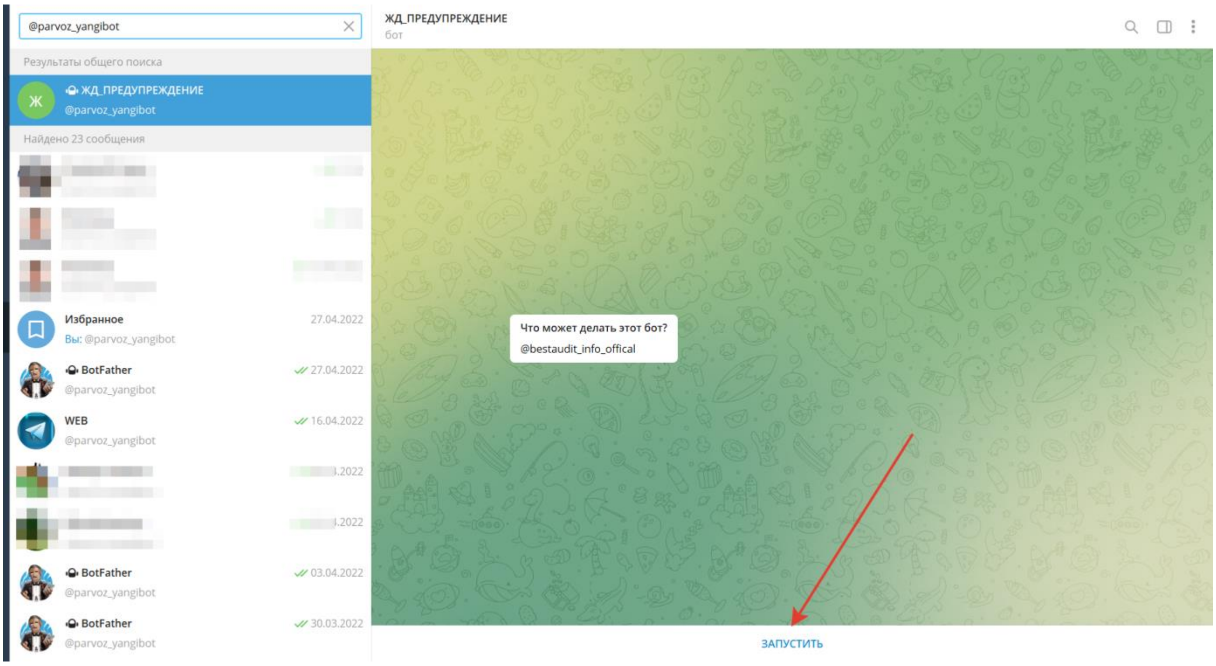

Figure 2. *Botany to work take down*

Step 2. "PEREZAPUSTIT" button pressing To the bog a member we will be and him to work down we can Botany to work take down in the process steps to the sequence action Do the next steps or of the bot sure work provides.

Botany to work down from what we received after to us What is this Telegram bot for made up and then next what affairs what we do need about data gives (Figure 3).

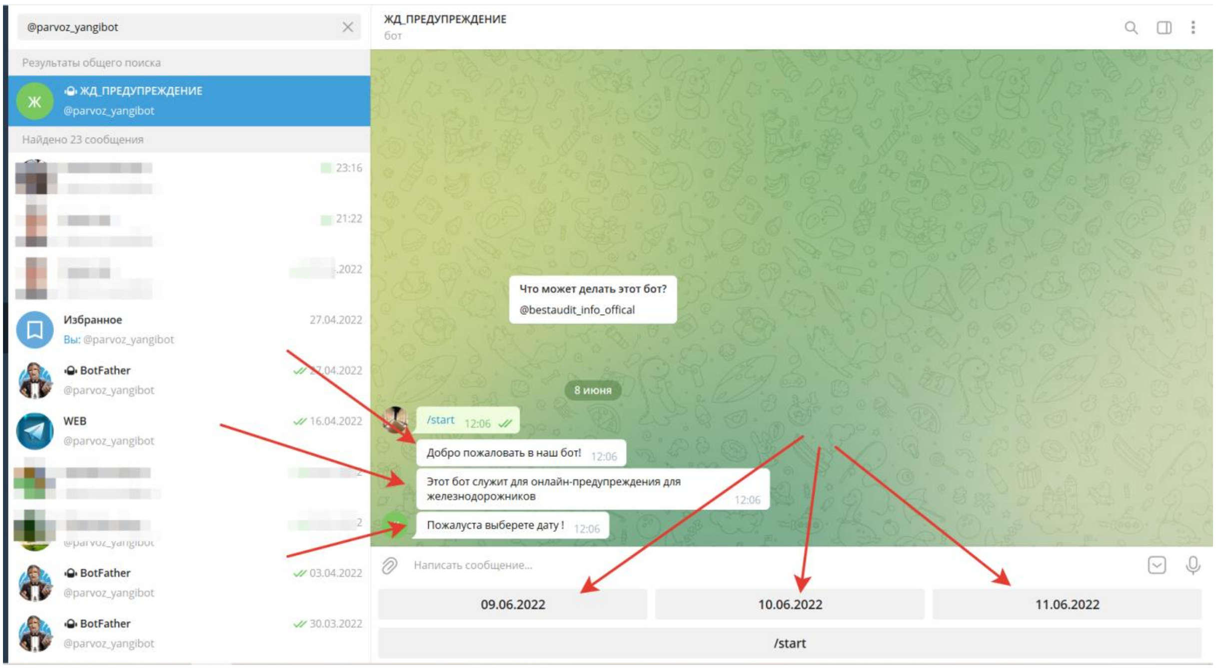

Figure 4. *From bot to us need has been in time warnings get for moon the dates input*

Step 3. Botany to work down from what we received then we bot to ourselves kerala has been date we choose

This Telegram bot trains to be given warnings train machinist locomotive in the cabin sitting out of place get and then actions set get enable gives _

Here : 09.06.2022 ; 10.06.2022 ; 11.06.2022 is it from the button one click through this we are to the date belongs to has been warnings let's see possible (Fig. 4);

/start – button we click through we botni again to work let's take it down. This from doing the goal to "restore" the bot ie bot included new information download is to get This is the button of the bot all in the department is available . Through this bot we are one day previous , current of the day and if data loaded if one day after the data get enable gives _ If we trip bottom updated to work if we drop new included changes and warnings let's see possible it will be while void done warnings fast get enable gives _ (Figure 4).

Next in step we to ourselves necessary has been the date we choose and from the bot in use continue we will

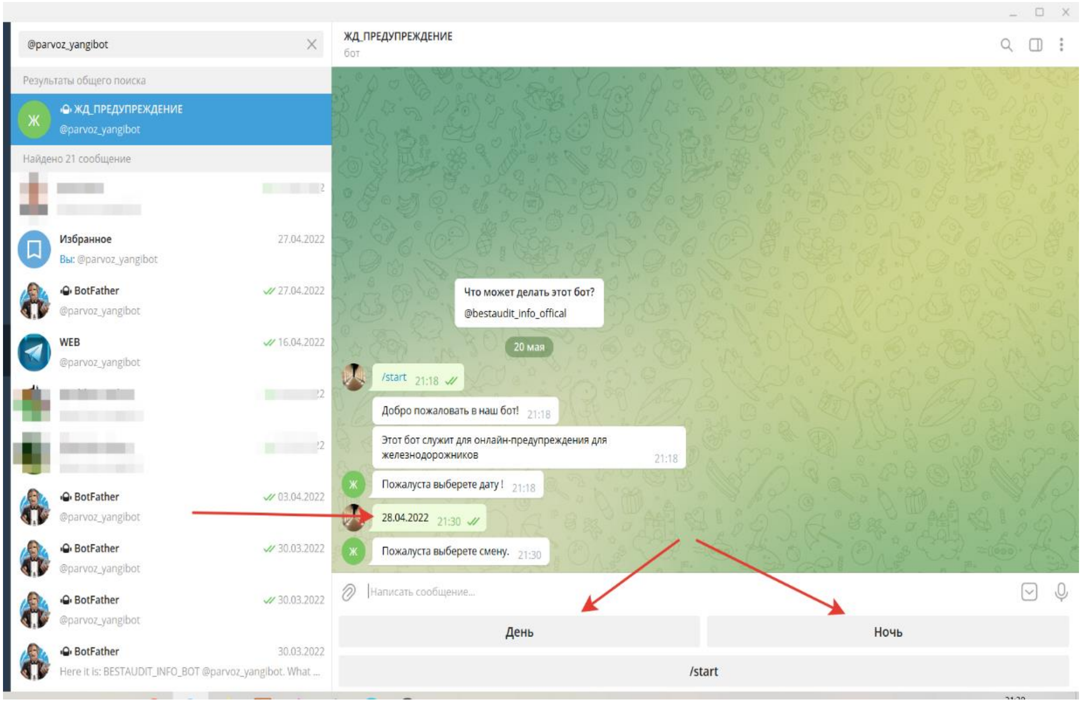

FIGURE 5. From bot necessary on duty the time choose

Step 4. We to ourselves necessary has been the day from our choice after that's it of the day which on duty in time warnings that we want to know we choose ie daytime or evening _ (Figure 4.5).

this section is the /start button there is being this mirror botni also through our update possible will be

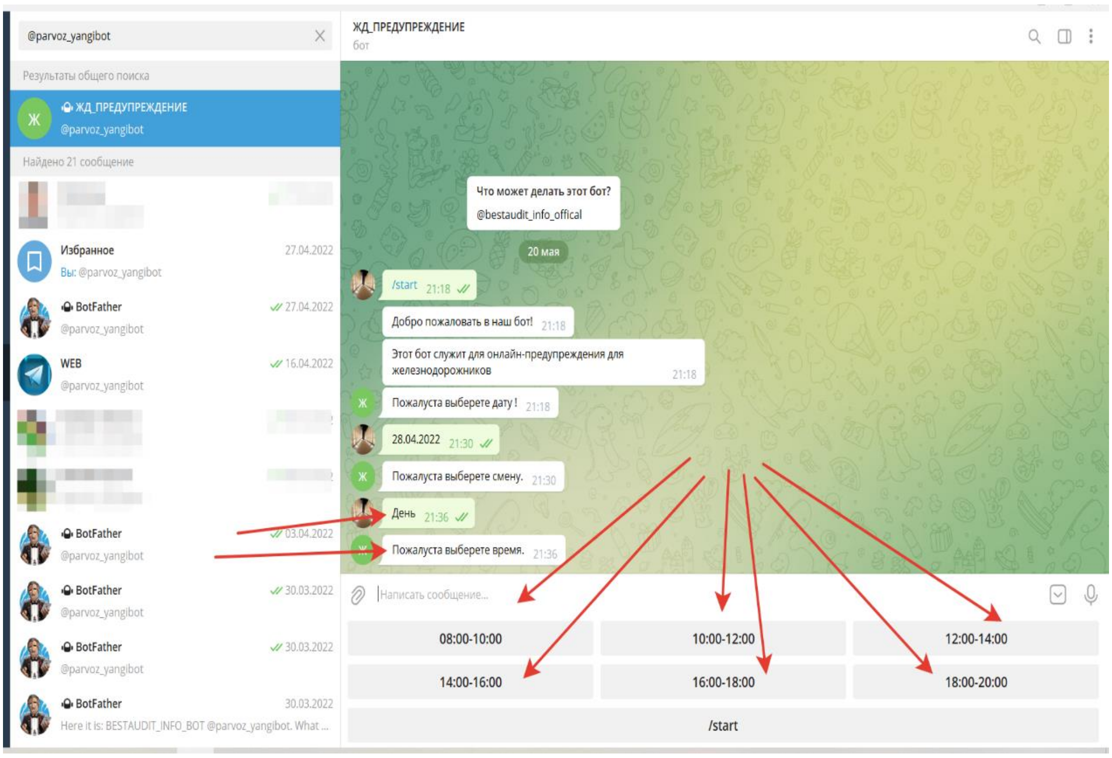

FIGURE 6. *From bot necessary the time choose*

Step 5. To ourselves necessary on duty the time from our choice after that's it on duty in time time range we choose This is a bot each on duty 2 hours _ time from the interval to intervals separated into 6 buttons in total placed (Fig. 6).

this step we are to ourselves necessary has been time range suitable button click through we choose

We entered data the result ie train to the drivers warning DU-61 issued form to get the ground creates _ Figure 7.

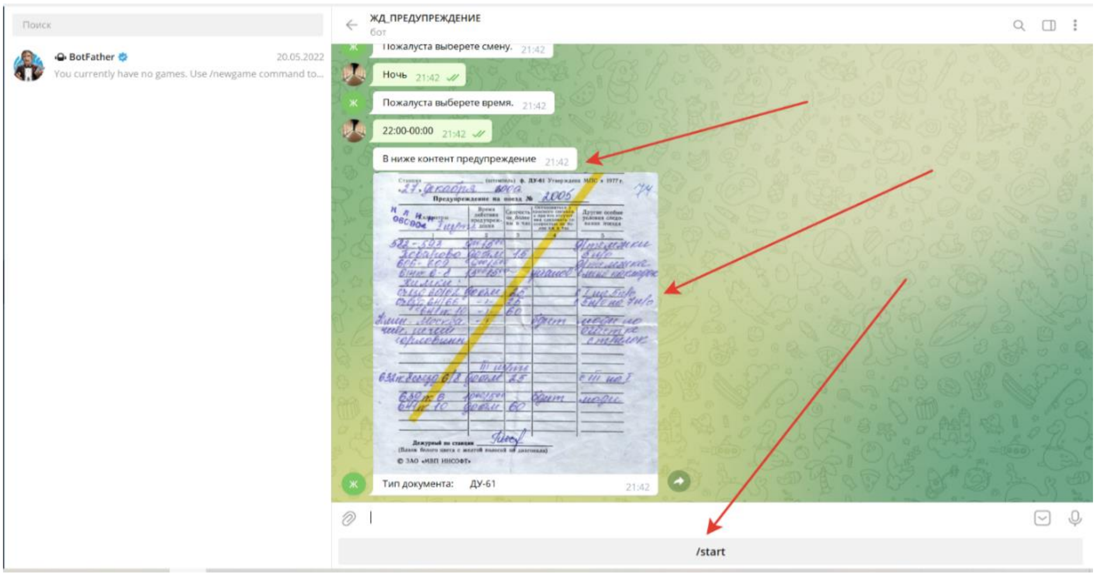

FIGURE 7. *From bot warnings form get*

Step 6. We to ourselves necessary time range from our choice then bot to us that's it time between there is warnings form shows .

It 's here **/start** button we click through we botni again from the beginning to work let's take it down or bottom our update possible will be

So as " JD _ PREDUPREJDENIE " bot through we in 6 steps to ourselves necessary has been in time alerts online _ in advance we get and own our work that's it looking planning , etc warnings locomotive to the typist delivered in giving time spending reduce enable gives _

Caution forms in giving automated and not automated in systems time consumption is presented in figures 8 and 9 .

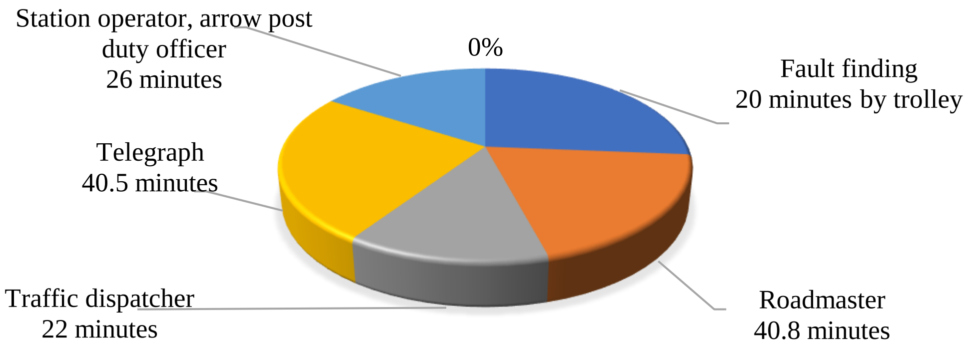

FIGURE 8. *Not automated in the system warnings in giving expendable time standards , minutes*

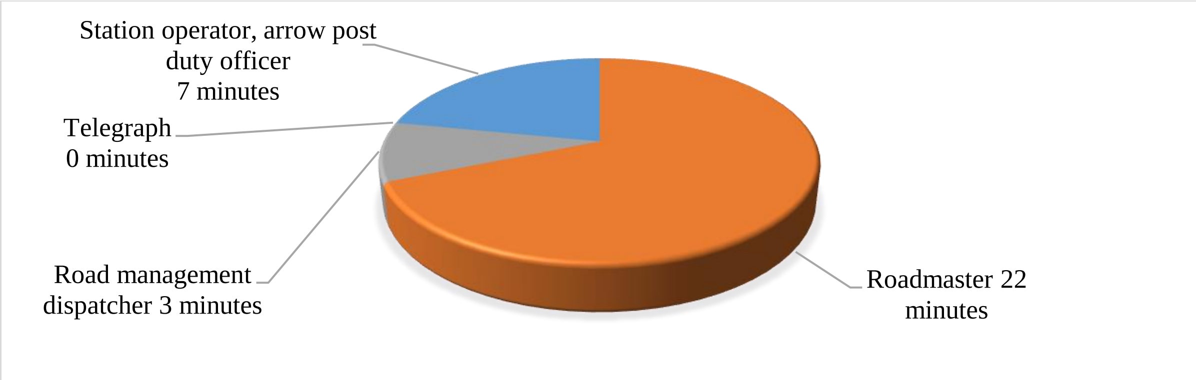

FIGURE 9. *Automated in the system warnings in giving expendable time standards , minutes*

Take it went studies that's it showed that "Uzbekiston temir yollari" JSC allows to have many electronic data warehouses by sending alerts in an automated manner. Along with this, it has many advantages in controlling employees online. The online document database provides us with many conveniences and is very important in maintaining the history of the work. By creating an online document database, we can compete with other state railways, as well as enable safe organization of train movement in railway transport.

In order to deliver the warnings to the trains to the train driver accurately and in a short time, the integration of all the warnings into a single system will serve to apply information technologies in this process and to make the entire process electronic.

Automatic transmission of warnings allows you to quickly carry out work in any weather conditions.

References:

1. NM Aripov, AA Svetashev, Sh.Sh. Kamaletdinov, and NS Tokhirov. Mathematical Modeling of the Automated Process of Transmission of Applications for Train Warning by Distance of Roads. AIP Conference Proceedings 2432, 030116 (2022); https://doi.org/10.1063/5.0089539
2. Aripov N.M., Toxirov N.S. Creating an automated system for issuing warnings to trains in railway transport. Tashkent-2020. – Pp. 168-172.
3. Sh.Sh. Kamaletdinov, N.S. Tokhirov, Qualitative and temporal characteristics of electronic document management processes in cargo and commercial operations// E3S Web of Conferences 264, 05042 (2021) https://doi.org/10.1051/e3sconf/202126405042.
4. Aripov N.M., Kamaletdinov Sh.Sh., Toxirov N.S. Measures to increase train safety on the basis of the creation of an automated system of warnings to trains in JSC "Uzbekistan railways" " // Scientific-technical journal (STJ FerPI, 2021, T.25, №4). – Pp. 168-172.
5. Aripov N. M., Kamaletdinov Sh. Sh. Improvement of cargo and commercial work in the conditions of application of electronic document management in railway transport of the Republic of Uzbekistan // VESTNIK, Tashkent: TASHSTU, No. 2, 2018. pp. 39-45.
6. N. M. Aripov, Sh. Sh. Kamaletdinov, N. S. Toxirov, "Automation of train warning processes" vol. 2, no. 9, pp. 483–490, 202, DOI: 10.24412/2181-1385-2021-9-474-482
7. N. M. Aripov, Sh. Sh. Kamaletdinov, N. S. Toxirov, end M. D. Axmedova, "To examine the effect of train awarding on the ability of The area to be transferred" vol. 2, no. 9, pp. 474–482, DOI: 10.24412/2181-1385-2021-9-483-490.
8. Nazirjon Aripov, Shokrukh Kamaletdinov, Nosir Tokhirov, Zebo Abduraxmanova. Simulation Modeling of Train Traffic Based on GIS Technologies. EUROPEAN JOURNAL OF LIFE SAFETY AND STABILITY (EJLSS).
9. N. M. Aripov, Sh. Sh. Kamaletdinov, N. S. Tokhirov. Choosing of wireless technology among the internet of things to improve the organization of the transportation process in railway transport.: Tashkent, 2019. No. 3. pages 181-195. (https://uzjournals.edu.uz/cgi/viewcontent.cgi?article=1074&context=tashiit)
10. N. M. Aripov, Sh. Sh. Kamaletdinov, N. S. Tokhirov. "Practical application of LORAWAN technology for tracking rolling stock in railway transport," Academic Research in Educational Sciences Volume 3, Issue 8, 2022: https://scholar.google.com/citations?user=Rs_3Up0AAAAJ&hl=en&authuser=2

TO THE RESEARCH QUESTION WARMLY WEIGHT OF EXCHANGE PROCESSES AT PASSIVE COOLING OF THE GARRET IN THE CONDITIONS OF THE HOT CLIMATE

Nozima Rakhimova ,
Elena Shchipacheva Vladimirovna,
Tashkent State Transport University, Tashkent, Uzbekistan

Abstract: *Numerous scientific studies are being carried out around the world to development mathematical models that qualitatively describe the processes occurring in the external fencing thermophysical processes under the influence of external climatic factors and the internal environment of the premises. In countries with hot climates, attention of specialists is directed to the protection buildings from overheating. In the article the issues of heat and mass transfer in the "water-air" system are considered, taking into account non-stationary conditions of the temperature and humidity regime of the attic space.*
Key words : *Attic space, temperature and humidity conditions, evaporation liquids, hot climate, heat and mass transfer, living quarters, non-stationary conditions, mathematical model*

INTRODUCTION

In areas of construction with a hot climate, providing comfortable living conditions for the upper floors of buildings that are most exposed to heat from the attic space can be achieved through the use of natural environmental conditions. In previous studies, we found that the use of a cuvette with water in the construction of the attic contributes to the cooling of the air in the attic space due to the process of water evaporation [1-3]. To assess the effectiveness of such a technique, it is necessary to consider the issues of heat and mass transfer in the "water-air" system, taking into account the non-stationary conditions of the temperature and humidity regime of the attic space.

OBJECTS AND METHODS OF RESEARCH

The process of evaporation of a water drop (the rate of decrease in its radius) was considered on the basis of the diffusion equation, while it was assumed that it proceeds under conditions of a change in temperature and humidity of two media (water, air). An integral part of the non-stationary evaporation model should be the description of the distribution of the vapor concentration and the temperature field in the medium surrounding the drop, as well as the time dependence of the concentration of saturated vapors on the surface of the drop.

According to Maxwell [4, 5], we assume that the vapor concentration at the droplet surface is equal to the concentration of saturated vapor at its surface temperature.

We represent the initial equations of diffusion (thermal conductivity) in the form [6]:

$$\frac{\partial c_1}{\partial \tau} = D\left(\frac{\partial^2 c_1}{\partial r^2} + \frac{2}{r}\frac{\partial c_1}{\partial r}\right), \qquad (1)$$

$$\frac{\partial T}{\partial \tau} = a\left(\frac{\partial^2 T}{\partial r^2} + \frac{2}{r}\frac{\partial T}{\partial r}\right). \qquad (2)$$

The initial and boundary conditions of equations (1) and (2) for relative vapor concentrations c_1 and temperature T are written as:

$$s_1(r,t)\big|_{t=0} = s_{10},\ s_1(r,t)\big|_{r=\infty} = s_{1\infty} = s_{10}, \qquad (3)$$

$$T(r,t)\hat{e}_{t=0} = T_0, \quad T(r,t)\hat{e}_{r=\infty} = T_\infty = T_0, \qquad (4)$$

$$Dm_1nq \frac{\partial c_1}{\partial r}\hat{e}_{r=R} = -l\frac{\partial T}{\partial r}\hat{e}_{r=R}, \qquad (5)$$

where r is the radial coordinate in the spherical system (the origin is at the center of the drop), t is the time, $D = nm_2 D_{12} / r_e$, D_{12} is the mutual diffusion coefficient, $n = n_1 + n_2$, n_1, n_2 is the concentration of water and air molecules, respectively, m_2 is the mass of an air molecule, r_e is the density of the vapor-gas mixture, a is the thermal diffusivity, l - the thermal conductivity, q is the specific heat of the phase transition. Conditions (3) and (4) mean that at the moment of time t the relative concentration c_1 and relative temperature T at $r = \infty$are the same as at the initial moment $t = 0$. Equation (5) shows that at a fixed droplet radius ($r = R$) there is an obvious correspondence between the vapor concentration c_1 and the temperature T .

Let us write down the boundary condition that allows us to take into account the effect of the evaporation coefficient a on the process under consideration:

$$D\frac{\partial c_1}{\partial r}\hat{e}_{r=R} = \alpha \cdot \frac{v}{4} \cdot (c_{1s} - c_1)\hat{e}_{r=R}. \quad (6)$$

In (6) $v = 4 \cdot \sqrt{kT_o/2\pi m_1}$ - the average absolute thermal velocity of vapor molecules, where k is the Boltzmann constant, c_{1s} is the diffusion flux concentration , *from* $_1$ - the concentration of the flow according to the Hertz-Knudsen formula [5,7] discharged through the Knudsen layer from the surface of the drop.

Addiction evaporation coefficient a on the temperature T of the water in the cuvette, we obtain by the method of molecular dynamics [8], based on the theory of translational motion of Ya . According to [9], the time t of the stay of a molecule in the liquid volume is determined by the expression

$$\tau = \tau_0 \mathrm{EXP}\left(\frac{E_0}{kT}\right), \qquad f = \frac{1}{\tau} = f_0 \mathrm{EXP}\left(\frac{E_0}{kT}\right), \qquad (7)$$

where t_0, f_0 are the oscillation period and the frequency of the molecule, E_0 is the activation energy of the molecules required to remove the liquid molecule from its free surface, determined by the expression:

$$E_0 = \frac{LM}{N_A}, \quad (8)$$

where L is the specific heat of vaporization, M is the molar mass, N_A is the Avogadro number.

Taking into account that the movement (movement) of molecules in all directions is equally probable, the probability P of the escape of molecules from the liquid volume, as a function of its temperature, will be expressed as the ratio of the frequency of change of position f to the frequency of vibrations of the molecule f_0, and the evaporation coefficient a - through the probability P by the method least squares (Fig. 1):

$$P = \frac{f}{f_0} = \mathrm{EXP}\left(-\frac{E_0}{kT}\right). \qquad (9)$$

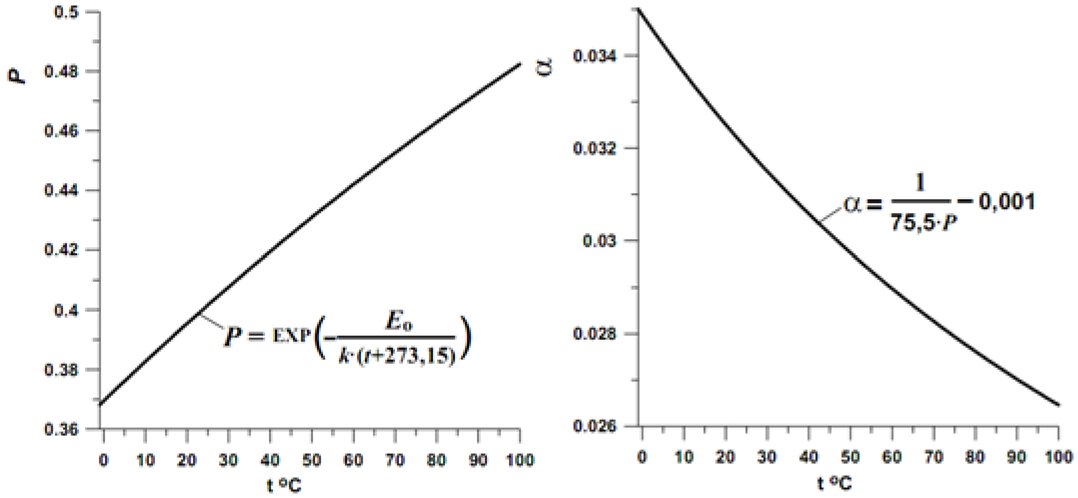

FIGURE 1.

Probability *P* the escape of a molecule from the bulk of the liquid and the evaporation coefficient *a* as a function of the temperature of the water in the temperature range from the freezing point to the boiling point.

The formula that determines the concentration of saturated vapors over the spherical surface of a droplet will be obtained based on the approximate Kelvin (Thomson) equation [10]

$c_{1s}(\tau) = \overline{c}_{1s}(\tau)\left(1 + \frac{k_\sigma}{R}\right)$(10)

and Klaiperon-Clausius [11]

$\overline{c}_{1s}(\tau) = \overline{c}_{1s0}\{1 + k_q[T_s(\tau) - T_0]\}$.(eleven)

In (11), the line above the letter indicates the value $\overline{c}_{1s}$at its surface temperature $T_s = T_s(t) = T_s(r, t)$ ê $_{r = R}$, namely

$$\overline{c}_{1s}(\tau) = c_1(T_s) = \frac{n_1(T_s)}{n}, \quad \overline{c}_{1s0} = \overline{c}_{1s}(\tau) \text{ ê }_{t=0}. \qquad (12)$$

In (10), (11) the notation is adopted:

$k_\sigma = \frac{2m_1\sigma}{kT\rho_i}, k_q = \frac{qm_1 - kT_0}{kT_0^2}$, (13)

Where, r_i is the density of a water drop, s is the coefficient of surface tension.

The final formula for $c_{1s}(t)$ is obtained by excluding the function from equations (10), (11) $\overline{c}_{1s}(\tau)$:

$\mathrm{c}_{1s}(\tau) = \mathrm{c}_{1s0}\{1 + k_q[T_s(\tau) - T_0]\}$,(14)

Where, $c_{1s0} = \overline{c}_{1s0}\left(1 + \frac{k_\sigma}{R}\right)$.

The solution of the problem of the nonstationary process of evaporation of a drop (the rate of change of its radius) will be carried out by the method of Laplace integral transformations [12]. The Laplace transform establishes a relationship between the original $f(t)$ and its image $F(p)$:

$$F(r,p) = L\{f(r,\tau)\} = \int_0^\infty f(r,\tau)\, exp(-p\tau) d\tau, \tag{15}$$

Where, p is a complex parameter.

To find the corresponding images of equations (1) and (2), we introduce the notation

$$S(r,p) = L\{c_1(r,\tau)\}, \;\; \Theta(r,p) = L\{T(r,\tau)\}$$

and taking into account the boundary conditions (3), (4), we write:

$$DS^{//} + \frac{2D}{r} S^{/} - pS + c_1 = 0, \tag{16}$$

$$a\Theta^{//} + \frac{2a}{r}\Theta^{/} - p\Theta + T_0 = 0. \tag{17}$$

Equations (16), (17) are second-order ordinary differential equations for unknown functions $S(r,p)$, $\Theta(r,p)$, where r is an independent variable and p is a parameter. Their general solution has the form [12]:

$$S(r,p) - \frac{c_1}{p} = \frac{A}{r} exp\left(-\sqrt{\frac{p}{D}} r\right) + \frac{A_1}{r} exp\left(\sqrt{\frac{p}{D}} r\right) \tag{18}$$

$$\Theta(r,p) - \frac{T_0}{p} = \frac{B}{r} exp\left(-\sqrt{\frac{p}{a}} r\right) + \frac{B_1}{r} exp\left(\sqrt{\frac{p}{a}} r\right), \tag{19}$$

where A, A_1, B, B_1 are arbitrary constants determined from the boundary conditions of the problem. Taking into account (3), (4) we find:

$$A_1 = B_1 = 0. \tag{20}$$

the unknowns A, B by expressing the boundary conditions (5), (6), (14) in the space of images, taking the notation $S_s(p) = L\{c_{1s}(t)\}$:

$$\left.\begin{aligned} \gamma p_1 q_1 A + \lambda p_2 q_2 B &= 0, \\ (Dp_1 av) q_1 A - \lambda avRS_s &= -\frac{avc_{10}R}{p}, \\ c_{10} k_q q_2 B - RS_s &= -\frac{c_{10}R}{p}, \end{aligned}\right\} \tag{21}$$

Where

$$\gamma = Dm_1 nq, \;\; p_1 = \sqrt{\frac{p}{D}} + \frac{1}{R}, \;\; p_2 = \sqrt{\frac{p}{a}} + \frac{1}{R},$$

$$q_1 = exp\left(-R\sqrt{\frac{p}{D}}\right), \;\; q_2 = exp\left(-R\sqrt{\frac{p}{a}}\right).$$

The system of equations (21) is an algebraic system of equations, solving it, we find the function S_s and the desired coefficients A, B:

$$A = \frac{\varepsilon\lambda R p_2}{p\delta q_1}, \;\; B = \frac{\varepsilon\gamma R p_1}{p\delta q_2}, \tag{22}$$

$$S_s = \frac{c_{1s0}}{p} + \frac{\varepsilon k_{q\sigma} p_1}{p\delta}, \tag{23}$$

Where

$$\varepsilon = \alpha v(c_{10} - c_{1s0}), \qquad k_{q\sigma} = c_{1s0} k_q \gamma,$$

$$\delta = q_0 p + q_1\sqrt{p} + q_2, \quad q_0 = \lambda\sqrt{\frac{D}{a}},$$

$$q_1 = \frac{\alpha v(\lambda\sqrt{D}+k_{q\sigma}\sqrt{a})}{\sqrt{Da}} + \frac{q_0}{R}(\sqrt{D}+\sqrt{a}),$$
$$q_2 = \frac{1}{R^2}[D\lambda + \alpha vR(\lambda + k_{q\sigma})].$$

If we denote z = $\sqrt{p}$, then the solution of the problem is reduced to solving the quadratic equation d = $K_0 z^2 + K_1 z + K_2$ with real and different roots, since its determinant D_d :

$$D_\delta \equiv K_1^2 - 4K_0K_2 = \left[\frac{K_0(\sqrt{D}-\sqrt{a})}{R} + \alpha v\frac{(\lambda\sqrt{D}-k_{q\sigma}\sqrt{a})}{\sqrt{Da}}\right]^2 + \frac{4k_{q\sigma}\lambda(\alpha v)^2}{\sqrt{Da}} > 0\,.$$

Next, introducing the notation for positive quantities:

$$\beta_1 = -z_1 = \frac{(K_1-\sqrt{D_\delta})}{2K_0}, \quad \beta_2 = -z_2 = \frac{(K_1+\sqrt{D_\delta})}{2K_0}, \ (b_1 > 0,\ b_2 > 0),$$

we get

$$\delta = K_0(\sqrt{p}+\beta_1)(\sqrt{p}+\beta_2).$$

By virtue of relations (20) and (22), we find the following expressions for functions (18) and (19):

$$S(r,p) = \frac{c_{10}}{p} - \frac{\varepsilon\lambda R}{r}\cdot\frac{p_2}{p\delta}exp(-r_c\sqrt{p}),(24)$$
$$\Theta(r,p) = \frac{T_0}{p} + \frac{\varepsilon\gamma R}{r}\cdot\frac{p_1}{p\delta}exp(-r_T\sqrt{p}),(25)$$

Where

$$r_c = (r-R)/\sqrt{D},\ r_T = (r-R)/\sqrt{a}.$$

Now we introduce the notation used in the space of originals of the functions:

$$\Phi(x,\beta,\tau) = erfc\left(\frac{x}{2\sqrt{\tau}}\right) - exp(\beta^2\tau + x\beta)\cdot erfc\left(\frac{x}{2\sqrt{\tau}} + \beta\sqrt{\tau}\right),$$
$$\varphi(\beta,\tau) = 1 - \Phi(0,\beta,\tau) = exp(\beta^2\tau)\cdot erfc(\beta\sqrt{\tau}),$$

Where

$rfc(z) = 1 - erf(z) = \frac{2}{\pi}\int_z^\infty exp(-u^2)du$ - probability integral [13, 14].

In accordance with the theory of the Laplace transform, the distribution of vapor concentration and the temperature field in the medium surrounding the drop and the dependence of the concentration of saturated vapor on the surface of the drop on time (non-stationary condition) will be obtained by passing to the space of the originals, bearing in mind expressions (24), (25) and (23):

$$c_1(r,\tau) = c_{10} - \frac{\varepsilon\lambda}{r\sqrt{a}}\sum_{j=1}^2 A(\beta_j)\cdot\Phi(r_c,\beta_j,\tau), \qquad (26)$$

$$T(r,\tau) = T_0 + \frac{\varepsilon\gamma}{r\sqrt{D}}\sum_{j=1}^2 B(\beta_j)\cdot\Phi(r_T,\beta_j,\tau),(27)$$

$$c_{1s}(\tau) = c_{1s0} + \frac{\varepsilon k_{q\sigma}}{R\sqrt{D}}\left[\frac{\sqrt{D}}{K_2} - \sum_{j=1}^2 B(\beta_j)\cdot\varphi(\beta_j,\tau)\right],(28)$$

Where

$$A(\beta_j) = \frac{R\beta_j-\sqrt{a}}{K_0\beta_j^2-K_2},\quad B(\beta_j) = \frac{R\beta_j-\sqrt{D}}{K_0\beta_j^2-K_2}.$$

The rate of change in the droplet radius under nonstationary conditions can be written as the expression [5]

$$\frac{dR}{d\tau} = \frac{Dnm_1}{\rho_i} \cdot \frac{\partial c_1}{\partial r} \,\hat{e}\, r = R\,. \tag{29}$$

Having determined the expression for ($\partial c_1 / \partial r$) $_{\hat{e}\, r = R}$ from relation (26), by formula (29) we obtain an expression for the rate of change of the droplet radius, taking into account non-stationary conditions:

$$\frac{dR}{d\tau} = \frac{\varepsilon Dnm_1\lambda}{\rho_i R^2} \cdot \left[\frac{1}{K_2} + \frac{1}{\sqrt{Da}} \sum_{j=1}^{2} C(\beta_j) \cdot \varphi(\beta_j, \tau)\right], \text{(thirty)}$$

Where

$$C(\beta_j) = \frac{R^2\beta_j^2 - R(\sqrt{D}+\sqrt{a})\beta_j + \sqrt{Da}}{K_0\beta_j^2 - K_2}.$$

Note that in (30) the sign of the quantity e = a $\nu \cdot$ (from $_{10}$ - c $_{1\,so}$) determines the direction of the process: at c $_{10}$ > c $_{1\,so}$ – evaporation; for c $_{10}$ < c $_{1\,so}$ - condensation.

The formula for changing the drop velocity, taking into account the nonstationarity of process (30), is rather cumbersome in numerical calculations. Bearing in mind that for our purposes we can confine ourselves to asymptotic approximations with sufficient accuracy, we obtain them by passing to the limiting expressions for the rate of change of the droplet radius.

Let us transform the right side of expression (30):

$$\frac{dR}{d\tau} = \frac{\varepsilon Dnm_1\lambda}{\rho_i R^2} \cdot \left[\frac{D\lambda}{D\lambda + \alpha\nu R(\lambda + k_{q\sigma})} - \frac{K_0}{\sqrt{D_\delta}}\left(\beta_j - \frac{\sqrt{D}+\sqrt{a}}{R} + \frac{\sqrt{Da}}{R^2\beta_j}\right) \cdot \varphi(\beta_j, \tau)\right]. \text{(30a)}$$

It is easy to see that

$$\lim_{\tau\to 0} \varphi(\beta_j, \tau) = 0; \ \lim_{t\to\infty} \varphi(\beta_j, \tau) = 1.$$

Then, by formula (30a), we find the limit expressions

$$\left(\frac{dR}{d\tau}\right)_0 = \lim_{\tau\to 0}\left(\frac{dR}{d\tau}\right) = \frac{\varepsilon nm_1}{\rho_i}, \tag{31}$$

$$\left(\frac{dR}{d\tau}\right)_\infty = \lim_{\tau\to\infty}\left(\frac{dR}{d\tau}\right) = \frac{\varepsilon nm_1}{\rho_i} \cdot \frac{D\lambda}{D\lambda + \alpha\nu R(\lambda + k_{q\sigma})}. \tag{32}$$

RESULTS AND THEIR DISCUSSION

An analysis of expressions (31) and (32) showed that at small time intervals, the diffusion coefficient under non-stationary conditions of the evaporation process is not included in expression (31), that is, under conditions of simultaneous changes in the temperature of the evaporating liquid and ambient air, a certain time is required, after which , the diffusion process begins to affect the rate of evaporation. Considering the right side of relation (31) as a function of *R* , we can say that the greater the curvature of the spherical surface of the evaporating drop, the higher the absolute value of the initial rate of change in its radius. Bearing in mind the asymptotic meaning of the analyzed expressions, if we consider the ratio (dR / dt) $_\infty$/ (dR / dt) $_0$ as a function of *R* , then we can conclude that this ratio increases to a certain constant value with increasing curvature of the surface of a spherical drop , and

(dR / dt) $_\infty$< (dR / dt) $_0$, which is an obvious result in non-stationary conditions, when the temperatures of the evaporating liquid and the surrounding air tend to equalize, that is, to thermodynamic equilibrium, which means that the evaporation rate decreases with time.

CONCLUSION

Comparing the results of numerical calculations of the rate of evaporation of water from the cuvette (the time of complete evaporation), performed by us for stationary and non-stationary evaporation conditions, we found that the time of complete evaporation in the non-stationary mode slows down somewhat relative to the time of complete evaporation in the stationary mode. However, this difference is not significant, which allows in solving the problem of heat and mass transfer in the attic, taking into account the process of passive cooling, to be limited to the approximation of a stationary mode.

References:

1. Shchipacheva E.V., Rakhimova N.B. Improving the energy efficiency of civil buildings in a dry hot climate due to passive cooling of attic spaces // Architecture and Construction of Uzbekistan, No. 5, 2015. - P. 16 - 22.
2. Schipacheva E.V., Rakhimova N.B. On the issue of improving the energy efficiency of residential buildings / Collection of scientific papers of the Institute "BashNIIstroy", Issue-79, Ufa 2016.
3. Schipacheva E.V., Shaumarov S.S., Rakhimova N.B. On the improvement of design solutions for attic roofs of residential buildings in order to increase the comfort of the premises of the upper floors in the hot season. - TRANSPORT. TRANSPORT FACILITIES. ECOLOGY, No. 3, 2020. - P. 52-59.
4. Maxwell JC Collected Scientific Papers. – Cambridge: 1890.11. PP. 625-649.
5. Fuks NA Evaporation and growth of drops in a gaseous medium. - M.: Publishing House of the Academy of Sciences of the USSR, 1988. - 91 p.
6. Kuzmin MK The theory of non-stationary process of evaporation of a spherical aerosol drop taking into account the dependence of saturated vapor pressure on the curvature of its surface. Vestnik MGOU. Ser. " Physics - Mathematics ", No. 3, 2012. - P. 39-49.
7. Hirs D., Pound G. Evaporation and condensation. - M.: Metallurgy, 1966. - 196 p.
8. Zunjing W., Min C., Zengyuan G. // Xi'an Jiaotong Univ., 35 , N 11, 2001. - PP. 1126-1130.
9. Frenkel Ya.I. Kinetic theory of liquids. - M.: Science. - 1975. - 592 p.
10. Sivukhin DV Thermodynamics and molecular physics. - M.: MIPT, 2003 - 276 p.
11. Nix N., Fukuta N. Nonsteady - state theory of droplet growth // J. Chem. Phys., v.58, no. 4. 1972 - PP. 1735-1740.
12. Dec G. Guide to the practical application of the Laplace transform and Z -transform - M.: Nauka, 1971. - 288 p.
13. Shchipacheva E.V. Fundamentals of thermal protection of civil buildings in a dry hot climate. Dokt. thesis. - Tashkent: Library of the Academy of Sciences of the Republic of Uzbekistan. - 2008. - 273 p.
14. Special Functions Reference. – M.: Nauka, 1979. – S. 119-153.

METHODS OF INCREASING THE STRENGTH OF AERATED CONCRETE

Shaumarov Said Sanatovich,
Kandakhorov Sanjar Ishratovich,
Okilov Zafarjon Omon ogli
Sultonkhodjayeva Gulnoza
Tashkent state transport university, Tashkent, Uzbekistan

Abstract: *This article presents the results of experimental research, which describes the parameters and properties of the porous structure of aerated concrete based on industrial waste. Structurally optimal parameters representing the physical-mechanical, thermal-technical properties of external wall structures based on aerated concrete have been identified. The test results were carried out in research laboratories using aerated block structures with high porosity and optimal composition, and improved technology of autoclaved aerated concrete was proposed.*
Key words: *Aerated concrete beton, aerated concrete composition design, strength, porosity, thermal protection, technological methods.*

INTRODUCTION

As humanity strives for progress, so do techniques and technologies. That is why the demand for modern technologies is growing.

In the construction industry, as in all industries, it is important to use energy-saving materials, reduce costs, reduce the negative impact on the environment, the introduction and production of seismic materials.

In developed countries, by reducing the cost of building materials, attention is paid to the production of aerated concrete, increasing its heat, strength, moisture permeability [1]. This, in turn, makes it advisable to use aerated concrete fillers as they are cheaper.

Many foreign and domestic scientists have conducted scientific research in this regard. In particular, the results of laboratory tests showed that the quartz sand used as industrial waste consisted of the following indicators.

Use of heat-insulating effective building materials with an average density of 500-700 kg / m3 and structural cellular concrete with an average density of 800-1200 kg / m3 as energy-saving building materials, increase its economic efficiency in this regard. issues are becoming increasingly important.

M.A. Mikheev, B.F. Vasilev fully demonstrated the technology of aerated concrete barrier structures and its capabilities. In this case, the thermal conductivity of aerated concrete construction

7-10%, which allowed to eliminate the moisture formed on the inner surface of the structure.

K.F. Fokin, I.S. Sukhanov, Y.A. Matrosov, A.M. Protasevich, EA Soldatov The results of scientific research are aimed at improving the technology of aerated concrete and increasing its efficiency [1-3].

In these studies, with the help of mineral and organic additives, plasticizers, research was conducted on various properties of aerated concrete, strength, thermal protection, optimization of porosity, reduction of moisture.

RESEARCH METHODS AND TOOLS

Experimental studies and data processing were carried out according to GOST 23789-2018 in the following sequence:

The mixture was prepared in several ways according to the ratio of water content to cement mass.

The VS-GEO-NDT Suttard viscometer was installed horizontally.

3. The mixture was slowly placed in the cylinder and lifted when the cylinder was full.

4. The diameter of the spread of the mixture was determined and the thermal conductivity was checked accordingly.

After the completion of the laboratory analysis, it was studied to what extent the water-cement ratio affects the thermo-technical properties.

The moisture content of aerated concrete samples was determined using the DT-125G - Vlagometer according to the standard requirements of GOST 29027-91 (Fig. 1).

FIGURE 1. *DT-125G - Vlagomer*

Determination of the absolute moisture content of aerated concrete samples using the DT-125G - Vlagometer was carried out in the following sequence:

1. Cubed aerated concrete samples of 100x100x100 mm size were prepared and stored in laboratory conditions for 28 days.

2. The moisture content of the samples was determined sequentially.

3. The average humidity of several samples was determined and its effects on thermal technical properties were determined.

The necessary values of heat transfer coefficient of energy-efficient civil buildings external wall constructions for different climatic conditions of the Republic of Uzbekistan were implemented using "Base" computer programs.

Experimental studies were carried out using filler materials based on specified industrial waste, and laboratory tests using binding industrial waste materials using non-standard methods developed by scientific research specialists according to specified standards.

STUDY OF PHYSICAL, MECHANICAL AND HEAT-TECHNICAL PROPERTIES OF AERATED CONCRETE BETON

The experiment was performed using waste quartz sand as a gas block filler to perform the test processes. The fraction size of the sand used in the normal composition is 0.315-0.63 mm. The hypothesis put forward in the composition of the study is that the particle size fractions of this waste quartz sand are 0.16-0.315 mm. This in turn leads to an increase in the strength properties of aerated concrete. The samples were stored at constant temperature for 28 days to ensure uniform solidification. Compositions of mixtures Shown in Table 1.

TABLE 1.

The amount of waste sand in the study

№	Titles	Amount of waste sand (relative to ordinary sand),%
1	Typical content	0
2	1-Content under study	6
3	2-Content under study	12
4	3-Content under study	18

Analysis of the data obtained showed that the inclusion of "industrial waste quartz sand" in the composition of the aerated concrete mixture in the amount of 16% of the mass of sand allowed to obtain aerated concrete with increased strength. However, when 6% waste sand is added to the 2-Content under study, the value of the quality coefficient is much higher than when the 1-Content under study is 12% and 18% from the aerated concrete.

Aerated concrete blocks were prepared according to this composition and the analysis of its strength properties is shown in Figure 1.

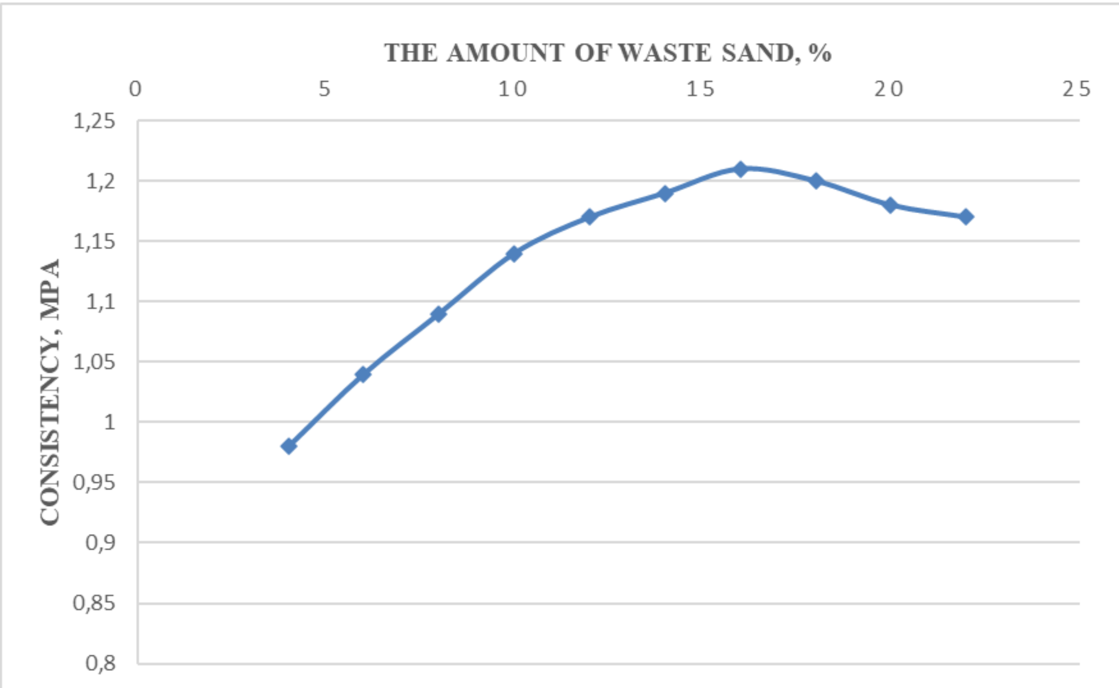

FIGURE 1. *Influence of aerated concrete on the strength properties of industrial waste*

Aerated concrete blocks of D500 brand were selected for laboratory research. The mutual appearance of the samples in the production plants and research laboratories of the prepared aerated concrete blocks is as follows (Figure 2).

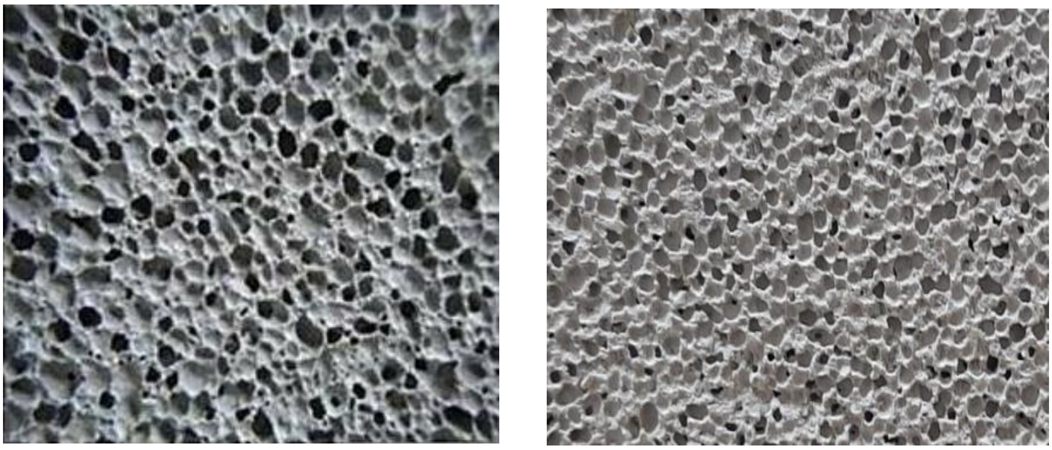

FIGURE 2. *Surface view of aerated concrete samples of D500 brand (1) production organization gas block, (2) research laboratory gas block sample.*

The optimum thickness of the aerated concrete mix was determined in Suttar and the block samples were stored under the same conditions for 28 days until the humidity reached 5%. The samples were tested using a porosimeter to determine the porosity structure as a function of the water-cement ratio. According to the results of the study, the samples with the best characteristics were identified.

Analysis of the results of scientific research in autoclaved aerated concrete structures in research laboratories and production organizations showed that the amount of water in the material has a significant impact on its thermal and technical properties, strength.

The characteristics of aerated concrete samples of industrial organizations in accordance with GOST 10180-2012 are given in Table 2.

TABLE 2.

Characteristics of aerated concrete in traditional composition

№	Average density, kg/ m^3	Strength R_{ya}, Mpa	Porosity P, %	Thermal conductivity of aerated concrete in the dry state λ_0[Вт/(м · ^{0}C)]
1	544	0,822	67,6	0,129
	545	0,825	68,0	0,13
	546	0,828	68,3	0,132
2	562	0,983	66,0	0,138
	560	0,985	66,4	0,14
	559	0,988	66,8	0.143
3	550	0,939	67,3	0,121

	552	0,940	67,8	0,125
	553	0,942	68,1	0,128
4	561	0,962	66,9	0,12
	558	0,964	67,1	0,121
	556	0,967	67,3	0,124

The technology for the production of autoclaved aerated concrete was tested in the conditions of production organizations. For this purpose, aerated concrete blocks were prepared in accordance with the technology developed by D500 compositions [3-5].

The results of experimental tests conducted in the research laboratory of the Tashkent State University of Transport are given in Table 3.

TABLE 3.

Characteristics of aerated concrete under study

№	Average density, kg/ m^3	Strength R_{ya}, Mpa	Porosity P, %	Thermal conductivity of aerated concrete in the dry state λ_0[Вт/(м · ^{0}C)]
1	550	1,06	65,8	0,12
	552	1,08	66,0	0,121
	553	1,09	66,3	0,122
2	561	1,16	64,7	0,129
	563	1,19	64,4	0,128
	567	1,21	64,1	0,125
3	553	0,97	66,1	0,114
	557	0,98	65,8	0,118
	559	1,01	65,3	0,12
4	559	1,14	64,8	0,113
	561	1,17	65,1	0,116
	562	1,19	65,6	0,118

A comparison of the average density, strength, and porosity of non-autoclaved aerated concrete samples determined by the proposed standard methods showed that the average density difference was (2-5)%; strength - (8.5 - 13.4)%; in terms of porosity - (1 - 3.5%).

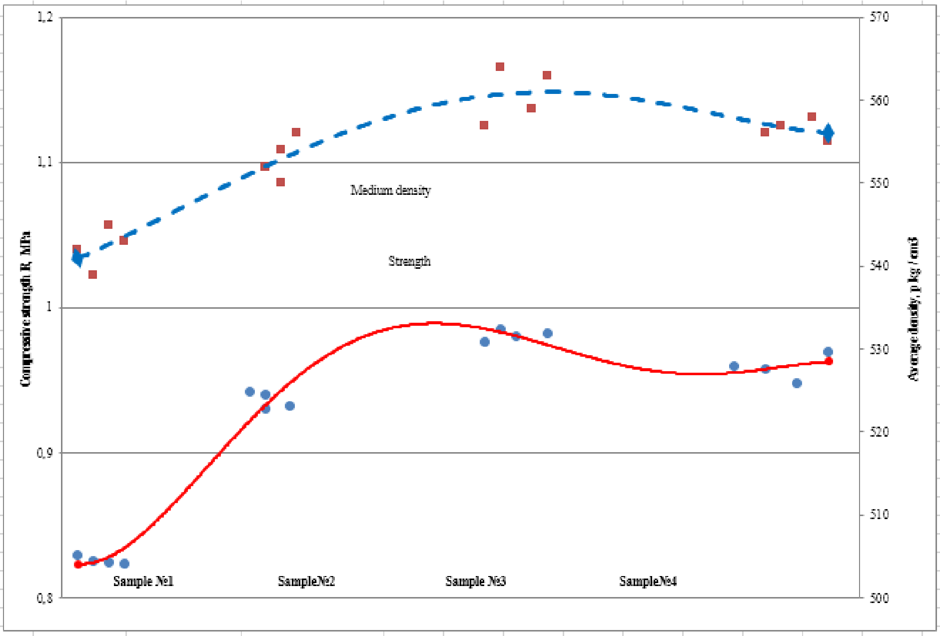

FIGURE 2. *Research results of aerated concrete samples*

The waste sand in the samples taken from this graph is much stronger due to the fine dispersion of its particles, but its average density is aggravated by 8-10%.

Research has shown that the porous structure of aerated concrete can be improved by taking into account a number of factors, improving the thermal and structural properties and obtaining many real practical results from the analysis of the literature, optimizing the porous structure of concrete and its application in thermal insulation buildings of III degree. successfully applied technological methods have been developed. The amount of chemical structure of aerated concrete blocks has led to an improvement in its strength, porosity, moisture, density, durability, frost resistance, thermal and technical properties [7-8].

TABLE 4.

Technical characteristics of non-autoclaved gas units obtained on the basis of different technologies in different conditions

Composition, production conditions, technology	Aerated concrete brand		
	D500		
	Characteristics of aerated concrete		
	Strength R_{ya}, MPa	Porosity P, %	Thermal conductivity of aerated concrete in the dry state λ_0[Вт/(м*^{0}C)]
Features of gas blocks in the production organization	0,86	71,1	0,129
Features of the proposed gas block	1,12	70,5	0,12

Analysis of the results of scientific research conducted on autoclaved aerated concrete structures in research laboratories and production organizations showed that the porosity of the material has a significant impact on its thermal and technical properties, strength [9].

CONCLUSION

1. According to the results of the research laboratory and the developed method, the risk of dangerous cracks of porous autoclaved non-autoclaved gas blocks produced by 1-3%, 3-6% improvement in thermal conductivity was observed.
2. It is possible to increase the strength of the proposed gas units by 20-23%.
3. The results of the experimental research laboratories showed that when the gas block was formed using waste sand, its cost was reduced by 5-7%.

References:

1. Weber H., Hullmann H. Porobeton Handbuch. Planen und Bauen mit System. – Gtersloh: Bertelsmann Springen Bauverlag, 2002. 278 p.
2. Schlaich M. Infra lightweight concrete – potencial for fair-faced concrete applications. M. Schlaich. BFT INTERNATIONAL. -2007. №2. P. 118-120
3. Lagoaz A., Szymanski P., Walczak P. Influence on the fly ash properties on properties of autoclaved aerated concrete. International Conference on Autoclaved Aerated Concrete. 14-17 September. 2011. Poland.
4. Adilhodzhayev A.I., Shipacheva E.V., Shaumarov S.S., Shermuxamedov U.Z., Kandakhorov S.I. Some Aspects of the Photo-Optical Method of Estimation Composition of Light Concrete // International Journal of Engineering and Advanced Technology (IJEAT). ISSN: 2249-8958, Volume-8 Issue-5, June 2019. – pp.1924-1927.
5. Adilhodzhayev A. I., Shaumarov S.S., Umarov K.S. New Structure Assessment Method Cell Concrete // International Journal of Advanced Science and Technology Vol. 29, No. 5, (2020), pp. 1889-1893
6. Shaumarov S.S., Adilhodzhaev A.I., Shipacheva E.V., Kandakhorov S.I. Development of New Constructive and Heat-Insulating Materials. International Journal of Recent Technology and Engineering (IJRTE). ISSN: 2277-3878. Vol.7. Issue-5S3. p. 577-580. (2019)
7. Adilhodzhaev A., Shaumarov S., Tsoy V., Khodzhaev S. Research of the influence of silicon-organic hydrophobizer on the basic properties of Cement stone and mortar // International Journal of Advanced Science and Technology Vol. 29, No. 5, 2020, pp. 1918-1921
8. Shaumarov S.S., Adilhodzhayev A.I., Kondrazhenko V.I. Experimental research of structural organization of heat-insulating structural building materials for energy efficient buildings. XXII International Scientific Conference on Advanced In Civil Engineering «Construction the formation of living environment», 2019. p. 1-7
9. Shaumarov, S., Kandakhorov, S., Abduraimov, U., Improving the optimal composition of heat-insulating structural aerated concrete based on industrial waste, E3S Web of Conferences, 2021, p. 264-272, 02023.

THE CONCEPT OF IMPROVING THE PERFORMANCE INDICATORS OF GAS-CYLINDER VEHICLES

Bazarov Baxtiyor Imamovich,
Axmatjanov Ravshanjon Nematjonovich,
Azimov Akmal
Tashkent state transport university, Tashkent, Uzbekistan

Abstract: *This article presents the analysis of operational and environmental indicators of gas cylinder vehicles, their prospects and optimal installation of gas cylinder equipment. In order to improve the operational performance of gas cylinder gas-cylinder vehicles and ensure their environmental safety, the method of choosing gas cylinder equipment according to the technical specifications of the vehicle and setting the appropriate program settings in the optimal state is shown.*
Key words: *alternative fuels, vehicle operation, environmental safety, compressed natural gas, gas cylinder equipment, fuel supply system.*

INTRODUCTION

Today, there are more than 1.45 billion vehicles in the world [6], and most of them use petroleum-based gasoline and diesel fuels. Vehicles powered by this fuel have been in operation for almost a century, but the use of conventional fuels has created global environmental problems, while limited oil reserves have led to a deficit of fuel products for these vehicles. In order to prevent these problems, it is necessary to use alternative fuels and popularize them.

Alternative fuels used in modern vehicles include methanol and benzomethanol mixture; hydrogen; liquefied petroleum, propane-butane mixtures (PBM), compressed natural gas (CNG) or liquefied petroleum gas (LPG), gas generator, biogas, gas condensate fuels, include aqueous fuel emulsions and others [1,2].

The use of CNG as an vehicle fuel was discovered in Italy in the early 1930s [4], Since the 1970s, it has become popular around the world, and this was caused by the shortage of petroleum products that began at that time. After that, CNG began to appear as a comprehensively promising alternative as a vehicle fuel. The sharp rise in oil prices in the late 1970s and early 1980s led to a further increase in the number of CNG vehicles and their improvements.

The number of natural gas vehicles in the world is more than 29,793 million as of 2019-2020, and the number of gas filling compressor stations for vehicles is 33,383 [8, 12]. Asia is the leader in the distribution of the amount of natural gas vehicles by region (Table 1).

TABLE 1.

Distribution of CNG vehicles and compressed natural gas (CNG) refueling stations by region [8]

Regions	**CNG vehicle**	**CNG filling stations**
Asia	20 473 673	20 275
Yevropa	2 062 621	5194
North America	224 500	1856
South America	5 484 676	5848
Africa	295 349	210

LITERARY ANALYSIS

CNG is obtained directly from gas fields and accompanying gases released during the processing of oil products. CNG is mainly composed of methane (82...98%), and additionally contains ethane (up to 6%), propane (1.5%) and butane (up to 1%). CNG is delivered through branched gas pipelines to gas-collecting compressor stations, and from there it is distributed as fuel to vehicles. Methane is a colorless and odorless gas, slightly soluble in water, lighter than air (specific density 0.55 compared to air) and belongs to the class of saturated hydrovehiclebons. Methane molecules are composed only of vehiclebon and hydrogen, therefore, when ignited, it does not emit toxic gas. The high amount of hydrogen in CNG ensures more complete combustion of fuel in the engine cylinders compared to liquefied petroleum gas or gasoline.

The main characteristics of CNG and gasoline fuels are presented in Table 2 [1,2]. Comparing these characteristics to each other, the use of CNG as a fuel in an internal combustion engine gives 12 different efficiency indicators during operation.

TABLE 2.

The main characteristics of CNG and gasoline fuels

Indicators	**CNG**	***Gasoline***
1	2	3
Molecular mass	16,03	114,2
Elemental Composition, %: *H* **C**	 25,03 74,57	 15,0 85,0
H/C ratio	**4,0**	2,25
Gas constant: *kgsm/kg·K* *kkal/kg·^{0}C*	 52,81 0,124	 7,6 -
Density of the vapor state under standard conditions: *kg/m^3* when the fuel is liquid *kg/l*	 0,670 0,415	 - 0,626
Evaporation Temperature, *kkal/kg*	122,6	65
Relative density	0,554	3,18
Oxygen required from air for the complete combustion of fuel will be: *m^3/m^3* fuel *m^3/kg* fuel	 9,52 14.2	 - 12,35
The heat of combustion of a stoichiometric mixture under standard conditions; *kkal/m^3*	770	850
Boiling point, ^0C	-161,6	99,2
Boiling Temperature, ^0C	590…690	480-520
The ignition temperature of a stoichiometric mixture, ^0C	2020	2100

Coefficient of molecular change when a stochnometric mixture burns	1,0	1,058
Octane rating	100…120	100
The maximum value of the normal speed of flame propagation, *m/s*	3,4…3.7	4,0-4,2
The coefficient of excess air at the same speed	0,95	0,89
The value of this coefficient at the lower concentration limit	2,0	1,76
Value at the limit of high concentration	0,65	0,3
Flammability limits in air,g/m^3 %	5...15; 16,66...102,6	1,5/6,0
The amount of gas in a stochnometric combustible mixture, *%*	9,51	-
The minimum energy of ignition, 10-3 J oil heat	0,23	0,28
Wobbe Index (or Wobbe Number): high value lower value	12300 11300	- -

The conversion of vehicles from gasoline to gas makes it possible to reduce the harmful emissions five times, on average, and the effect of noise by half [3]. According to research conducted by Kenedy Aliila Grayson and others [4], 280 barrels of gasoline are saved annually for one light vehicle, and $46,500 is saved through the use of CNG in vehicles. According to many research, the amount of harmful gases and noise emitted by vehicles running on CNG is significantly reduced compared to gasoline vehicles. The service life of the engine lubrication system is extended and the oil viscosity is maintained optimally for a long time due to the use of this fuel.

CNG fuel cheaper than gasoline or diesel[1] (As an example of fuel prices in the Republic of Uzbekistan, CNG fuel for vehicles is 3.18 times cheaper than gasoline fuel and almost 4.54 times cheaper than diesel fuel) [9]. It has inherently lower air pollution emissions. It has lower greenhouse gas emissions. Its use extends petroleum supplies, and there are large quantities of the fuel available in the world [13]. The CNG has an advantage of higher brake thermal efficiency on an average of 1.1% and 1.6% than that of gasoline [11].

THE RESULT AND DISCUSSION

When using CNG fuel in vehicles, they are retrofitted with gas cylinder equipments (GCE). As a GCE installed for modern vehicles, mainly pressure regulator petrol solenoid valve with manual override switch (It stops petrol flow when operating on CNG), on-off valve and refueling connector, control module/change-over switch (It is an electronic control component with fuel selection switch), CNG level indicator (LED Indicator), gas air mixer, CNG cylinder with valve, vapor bag & bracket, petrol hose, low- pressure gas hose, ignition advance processor, high pressure gas tube, wire harness, non-return valve (NRV) in petrol return line, pressure gauge consists of parts.

The price of STG ranges from 1900 to 2850 soums per m3 (1 m3 = 1.1 liters), with an average of 2500 soums.

Dimensions : 52. 62. 63. 65. 68. 72

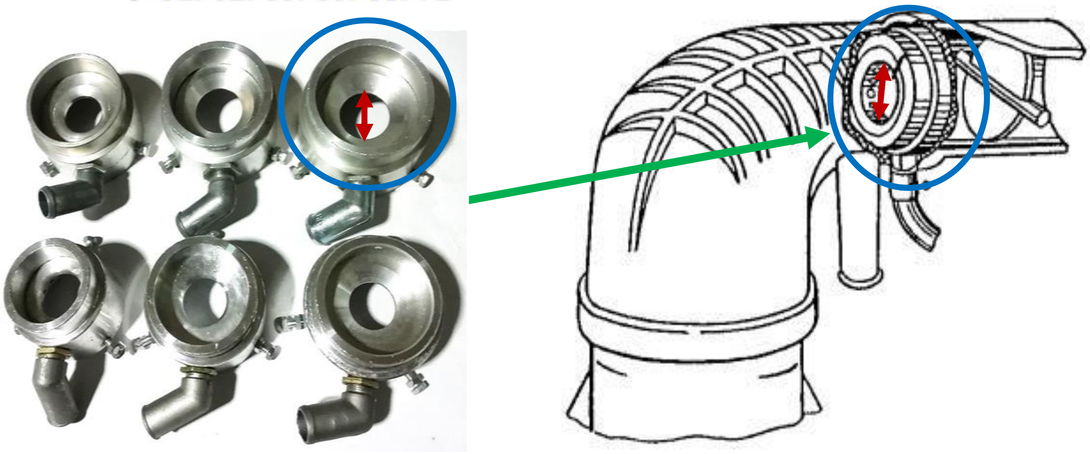

FIGURE 1. Gas air mixing device in the 3rd generation GCE of CNG vehicles

Today, re-equipment of vehicles running on CNG fuel with 4th generation GCE is becoming popular (Fig. 2). This generation GCE can be converted to almost all modern internal combustion engines, is very simple in design, and also very efficient. Unlike the 1st-2nd-3rd generation GCE of CNG vehicles, the 4th generation GCE is equipped with gas injectors that deliver CNG fuel to each cylinder. this is, in turn, leads to increased engine power and significant fuel savings.

In the 3rd generation GCE of CNG vehicles, the gas air mixing device (Fig. 1) mixes fuel with air and introduces it into the cylinder through the inlet manifolds. In this case, the amount of air flow passing through the gas air mixer cannot reach the required level in the engine load mode. The reason for this is the small diameter of the gas mixer hole (Fig. 1), when the gas pedal is pressed, the necessary amount of air cannot enter through the holes for complete combustion of fuel. As a result, a rich fuel mixture is formed in the cylinder and energy efficiency decreases.

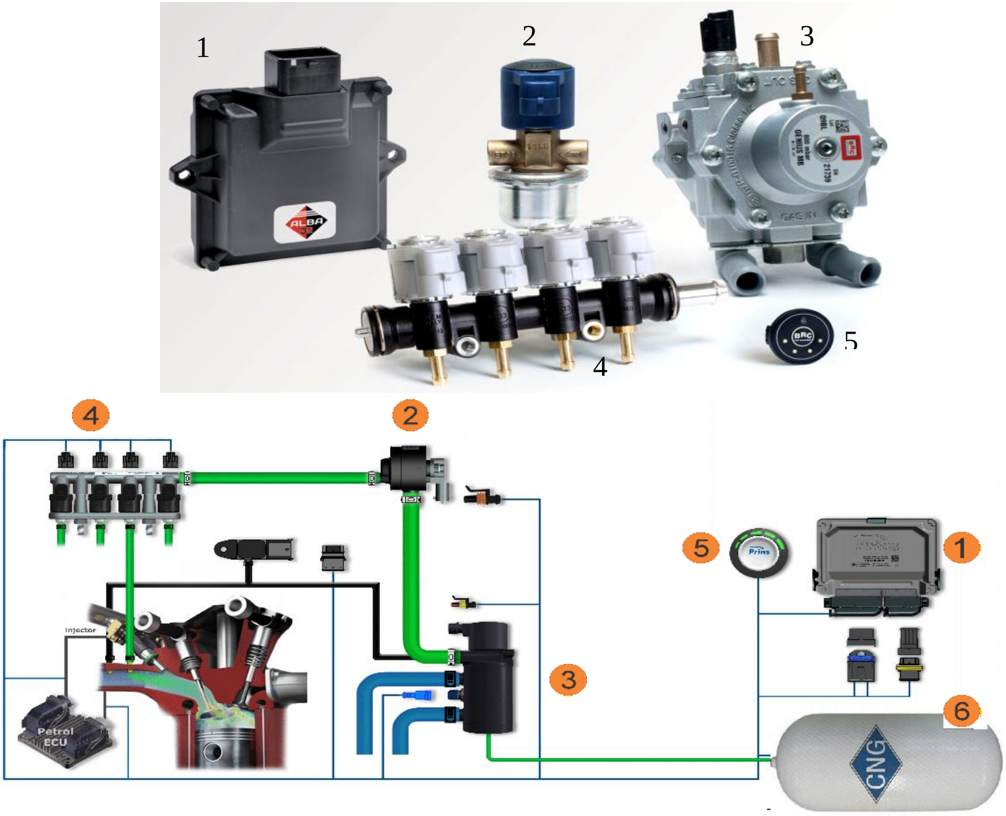

FIGURE 2. *4th generation GCE of CNG vehicles 1- ECU (Electronic Control Unit); 2- Filter; 3- Injectors; 4- Evaporator (eVP-500); 5- Switch; 6- CNG-tank*

In the 4th generation CNG vehicles, the above deficiency is eliminated and separate gas injectors are installed in each intel manifolds for gas transfer (Fig. 2 (4)), and an electronic control unit (ECB) of CNG (Fig. 2 (1)) that optimally manages the process is installed. After equipping vehicles with 4th generation GCE, the gas ECU is programmed on the computer in the appropriate program (Fig. 3). Today's popular Stage, Digironic, Europegas, Prins, Autogas system, BRS, Autogaz AC and others can be mentioned among these programs.

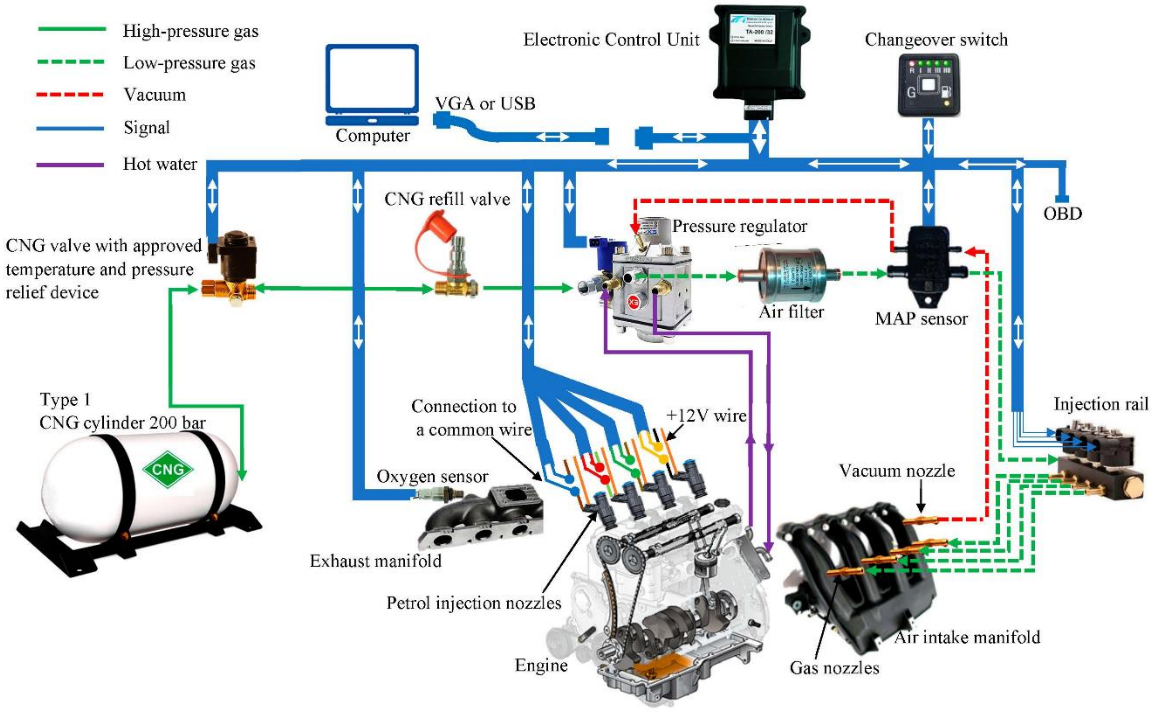

FIGURE 3. *The arrangement of CNG components in petrol-fueled vehicles [14]*

Through the above programs, the "gas-gasoline" fuel exchange mode in the engine supply system can be changed in relation to the specific temperature of the fuel or the number of crankshaft revolutions. We can change this process by installing a program by connecting a computer to the gas ECU (Fig. 3-4).

During the operation of vehicles equipped with 4th generation GCE, it is possible to reduce gasoline consumption by reducing the time of transition from gasoline mode to gas, and this, in turn, provides an opportunity to save fuel costs and improve the environmental safety of vehicles.

In order to effectively control the "gas-gasoline" modes of vehicles equipped with a universal fuel supply system running on CNG, the optimal program is selected for the gas mode control ECU, and the main indicators of the control of the "gas-gasoline" mode are changed. These indicators are the engine temperature and the frequency of crankshaft revolutions. The ECU uses gasoline fuel to reach the optimal temperature in the cooling system during the initial start-up of the vehicle engine in gasoline mode, and this temperature is 30° C for gas mode operation, which is determined by the computer, depending on the temperature after reaching, it automatically switches to gas mode, i.e. starts using CNG fuel.We can control this task in the "Switch-over temp" function of the program (Fig. 4).

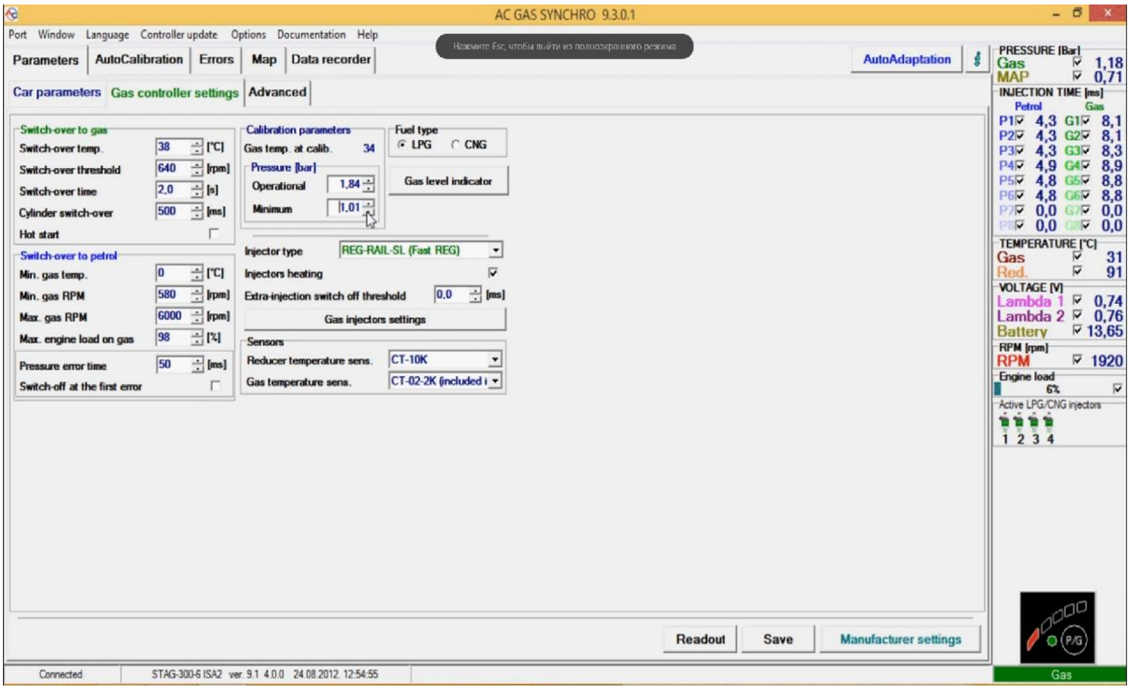

FIGURE 4. *"Gas controller settings" section of the AC GAS SYNCHRO 9.3.01 program that changes the gas - gasoline mode*

Based on the above, the experts of the Department of "Transport Energy Devices" of the Tashkent State Transport University will vehiclery out an analytical experiment-test practice on improving the operational indicators and environmental safety of CNG vehicles equipped with the 4th generation GCE.

A Chevrolet Cobalt vehicle with an engine working volume of 1485 cm3 produced in 2021 was selected as the experimental test object. This vehicle, produced by the factory, is intended for gasoline fuel, and it is stated by the manufacturer that it consumes 8.4-10 liters of gasoline fuel in the city to cover a distance of 100 km [10]. This vehicle was retrofitted with 4th generation GCEs in June 2022 and has AC GAS SYNCHRO 9.3.01 firmware installed. It is specified that the gas mode starts at 38°C and the frequency of crankshaft revolutions is up to 6000 min-1 times per minute.

When the vehicle engine is started, it switches from gasoline to gas for 5-7 minutes, and in the engine load mode, it switches from gas to gasoline when the constant tachometer reading reaches 6000 min-1. As a result, gasoline consumption increases (Figure 5).

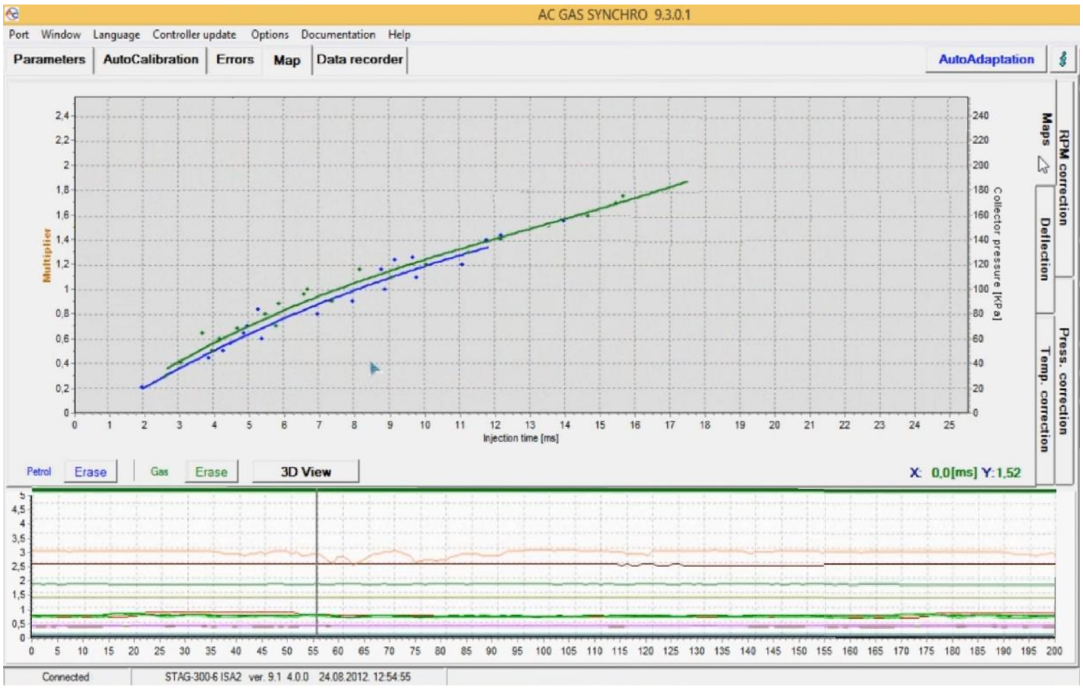

FIGURE 5. The increase in gas consumption was observed in the gas-gasoline mode change graph

The optimal selection of the gas-gasoline mode changing indicators of the above-mentioned gas ECU has a great impact on the improvement of the operational indicators of gas cylinder vehicles and the efficiency of environmental safety indicators.

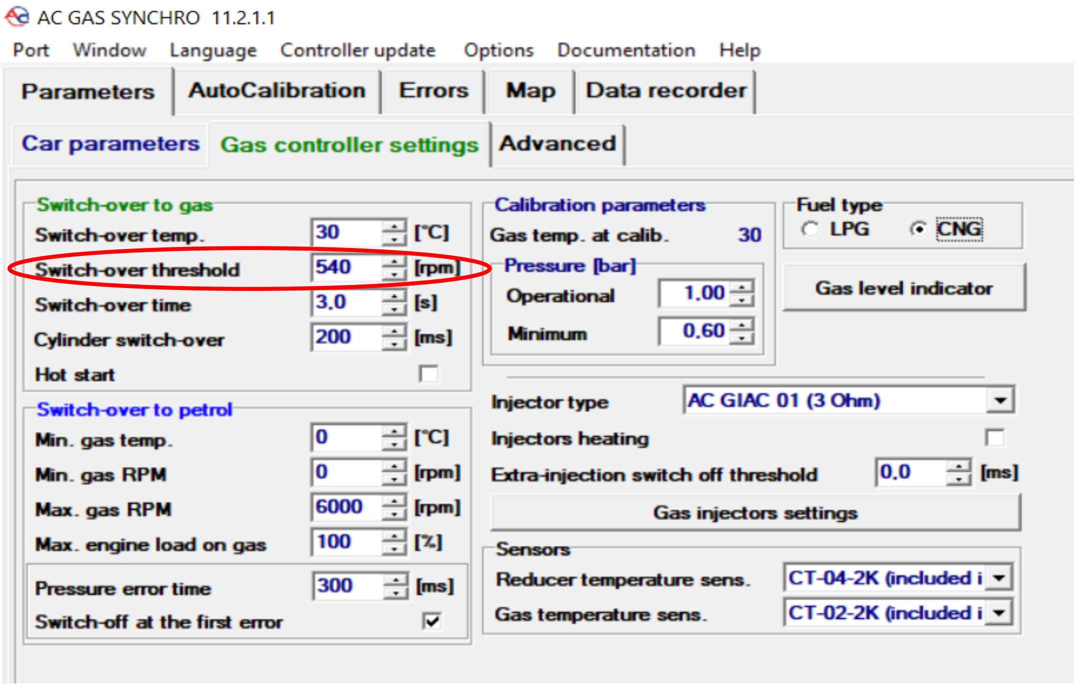

FIGURE 6. Change of "Switch-over time" section of AC GAS SYNCHRO 9.3.01

In this case, from the "Gas controller settings" section of the AC GAS SYNCHRO 9.3.01 program installed in the Chevrolet Cobalt GCE state, we change the "Switch-over time" indicator to

540 min^{-1}. This, in turn, leads to a change in the gas-gasoline mode switching cycle in the engine, i.e. the engine starts to work on gas fuel when the crankshaft reaches the set speed of 540 min^{-1}.

It is very important to choose GCE in accordance with the technical specifications of the car and to set the appropriate program settings in an optimal state in order to improve the performance indicators of gas cylinder cars and ensure their environmental safety.

CONCLUSION

In conclusion, the effective use of modern technologies used in the automobile industry and the operation of cars, which is rapidly developing today, will give high results in the further development of these areas. Making rational changes to the basic program of cars with electronically controlled universal (gas-petrol) supply system, taking into account the operating conditions, leads to improvement of their energetic and environmental indicators.

References:

1. Б.И.Базаров, С.А.Калауов, А.Х. Васидов Альтернативные моторные топлива. Монография. – Ташкент: SHAM SASA, 2014. – 189 с.
2. Б.И.Базаров, Р.Н.Ахматжанов, О.З.Одилов Использование альтернативных энергетических источников и установок на транспорте. Монографияч.-Ташкент: IQTISOD-MOLIYA, 2023. – 257 с.
3. Makarova, Irina & Shubenkova, Ksenia & Sadygova, Gulnaz. (2018). Compressed natural gas as motor fuel: possibilities, problems and solutions. 82. 43-62. 10.14669/AM.VOL82.ART4.
4. Kenedy Aliila Greyson, Gerutu Bosinge Gerutu, Shahzad Bobi, Pius Victor Chombo, "Exploring the potential of compressed natural gas as a sustainable fuel for rickshaw: A case study of Dar es Salaam". Journal of Natural Gas Science and Engineering, Volume 96, 2021, 104273, ISSN 1875-5100 (https://doi.org/10.1016/j.jngse.2021.104273).
5. Yeh, S. (2007). An empirical analysis on the adoption of alternative fuel vehicles: The case of natural gas vehicles. Energy policy, 35(11), 5865-5875.
6. How many vehicles are there in the world? 23 APR 2022. (https://www.which vehicle.com.au/news/how-many-vehicles-are-there-in-the-world).
7. Axborot va ommaviy kommunikatsiyalar agentligi "Gaz balonlaridan noto'g'ri foydalanish oqibatlari, sohada tadbirkorlarga yaratilgan sharoitlar, davlat nazorati va vakolatlari". 10-Yanvar, 2022 (https://www.facebook.com/aoka.uz/ videos/451358343145087/).
8. NGV Global-Natural Gas Vehicle Knowledge Base (http://www.iangv.org/).
9. O'zbekiston Toshkent shahridagi benzin narxi 2023 yil 7 fevral holatga ko'ra 1 litr uchun so'm* (https://www.goldenpages.uz/uz/benzin-cena/)
10. Uzautomotors AJ rasmiy sayti (https://uzautomotors.com/)
11. M.I. Jahirul, H.H. Masjuki, R. Saidur, M.A. Kalam, M.H. Jayed, M.A. Wazed "Comparative engine performance and emission analysis of CNG and gasoline in a retrofitted vehicle engine". Applied Thermal Engineering, Volume 30, Issues 14–15, 2010, Pages 2219-2226, https://doi.org/10.1016/j.applthermaleng.2010.05.037.
12. GVR Report coverAutomotive Natural Gas Vehicle Market Size, Share & Trends Report Automotive Natural Gas Vehicle Market Size, Share & Trends Analysis Report By Fuel Type (CNG, LNG), By Vehicle Type (Passenger, Light-duty & Heavy-duty Buses & Trucks), By Region, And Segment Forecasts, 2021 - 2028 (https://www.grandviewresearch.com/industry-analysis/automotive-natural-gas-vehicles-market)
13. Zawad Abedin, Mousumi Rizia and H M Khairul Enam "COMPARATIVE EMISSION ANALYSIS OF CNG AND OCTANE IN RETROFITTED VEHICLE ENGINES" International Journal of Mechanical

Engineering and Technology (IJMET) Volume 8, Issue 3, March 2017, pp. 123–130 Article ID: IJMET_08_03_014

14. Gerutu Bosinge Gerutu, Kenedy Aliila Greyson and Pius Victor Chombo "Compressed Natural Gas as an Alternative Vehicular Fuel in Tanzania: Implementation, Barriers, and Prospects" Methane 2023, 2(1), 66-85; https://doi.org/10.3390/methane2010006

DEAR AUTHORS!

The journal is divided into sections that reflect the main directions of research in the fields construction of buildings, modern technologies and transport systems:

- Technique;
- Construction;
- Bridge and tunnel;
- Power industry;
- High speed train;
- Transport.

The language of publication is English.

REQUIREMENTS FOR ARTICLES

PRELIMINARY ELEMENTS OF THE ARTICLE (English)

• **Title of the article**. Should briefly reflect the content of the article. It is not recommended to use abbreviations and shortenings.

•**Affirmation**. Specified: surname, name, patronymic of authors, academic degree, title, position, official full name of organizations and the English version of the name, e-mail address of at least one of the authors.

•**Annotation**. It includes: subject, topic, goal, research hypothesis, methods, experiments, main results, their field of application, practical significance, conclusions.

•**Keywords.** From 5 to 15 basic terms.

RECOMMENDED STRUCTURE OF THE MAIN PART OF THE ARTICLE

- Introduction
- Theory, data and research methods, models, technical and technological developments, experiments.
- Research results and discussion.
- References in Russian and English

REQUIREMENTS FOR ARTICLE

• The electronic version of the article Microsoft Word, with the settings of the A4 page margin fields - by default.

• Drawings and photographs of a maximum size of 150x235 mm inserted into an article are made in a format that allows editing and resizing them without additional reference to the authors. Figures made in Microsoft Excel should be duplicated with the source file in * .xls format with the observance of color requirements.

• When preparing a manuscript, one should be guided by the International System of Units SI.

Articles are subject to mandatory scientific review.

The editors reserve the right to reject articles that do not meet the specified requirements.
For publication of articles contact: 100167, Republic of Uzbekistan, Tashkent, st. Temiryulchilar, 1
Phones: *+998 71 299 01 89*; e-mail: nauka@tstu.uz