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RESEARCH OF THE DENSITY OF THERMAL WATERS OF THE KHACHMAZ DISTRICT OF THE REPUBLIC OF AZERBAIJAN

MAHIR BASHIROV [1], NOFAL NABİYEV [2], AYTAN NAMAZOVA [3]

[1] Baku Engineering University, Department of "Mechanical Engineering"

mbashirov@beu.edu.az

[2] Baku Engineering University Department of "Logistics and Transport Technology"

nnabiyev@beu.edu.az

[3] Technical Humanitarian High School

aytan_bashirova@yahoo.com

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ABSTRACT

During the measurement of (p, ρ, T) dependences, in order to obtain high-accuracy values of density by means of graphical extrapolation at atmospheric pressure in each case of equilibrium, efforts were made to create the lowest possible values of pressure, the obtained values were compared with the values of density measured on the DMA 5000M device. The experimental values of the density of the "4th section " thermal water of Khachmaz district of Azerbaijan at different pressures and temperatures were measured. First, in order to check the measurement accuracy of the experimental device, the results obtained for water and toluene were compared with the information given in various literature. The obtained experimental results are shown in the table and expressed by the equation of state.

1. Introduction:

Currently, extensive measures are being taken both within the Republic and internationally to reduce the amount of carbon dioxide emitted into the atmosphere. Great work is being done in this direction in Azerbaijan (including at the Department of Mechanical Engineering of Baku Engineering University). In accordance with the "State Program on the Use of Alternative and Renewable Energy Sources in the Republic of Azerbaijan" approved by the decree of the President of the Republic of Azerbaijan dated October 21, 2004, the Ministry of Industry and Energy of the Program the implementation coordinator has been determined (Decree of the President of the Republic of Azerbaijan, 10 november 2009). In the State Program, the main directions for the implementation of measures related to the use of the potential of wind energy, as well as solar energy, the hydropower of geothermal waters, mountain rivers and water channels, as well as the energy of biomass, as the most efficient energy sources for our Republic, have been defined.

In addition to the regional fracture in the zone of thermal water distribution, there is also a zone of tectonically disturbed rocks with a branched system of sharply falling (descending) cracks covering the entire Mesozoic layer. The velocity of water is higher in the main drainage channels, i.e., where the transfer of water heat to the surrounding rocks is the least, thus the water has the maximum temperature, and in the zones with many cracks. This is confirmed by the outputs of geothermal sources in the erosion depressions of the intersection of the main water collection zones (Namazov, 2017; Ibragimova I.Sh., Babaev, 2000; Tagiyev et al., 2001; Babayev, Ibrahimova, 2004).

The hydrogeological parameters of the discharge zone of thermal waters directly depend on the degree of cracking and the character of the hydrous rocks. The abundance and abundance of gryphons in natural outcrops indicates a well-developed rift.

Geothermal energy resources of the studied region (Khachmaz district) are particularly valuable. Thus, the colorful chemical composition, high healing properties, favorable geographical position of the area create a good basis for their treatment purposes and wide application in various fields of the national economy (Namazov, 2017; Bashirov et al., 2013).

2.Research objective

The analysis of the chemical composition of thermal water of Khachmaz district "4th section" was measured in atomic emission spectrometer with IRIS Intrepid II Optical Emission Cheomotograph inductively coupled plasma (Bashirov et al., 2013; Nabiev, 2011). The results show that the majority of chemical elements are sodium (Na). Na constitutes approximately 72.41 ÷ 90.12% of all chemical substances in the thermal water of the Khachmaz district of Azerbaijan. In the tables 1-2 shown below, the geographical coordinates of the thermal water of the "4th section" station located in Khachmaz district of Azerbaijan, the temperature at the time of exit from the source and the amount of minerals in the chemical composition are given (Bashirov et al., 2013; Nabiev, 2011).

Geographical coordinates of Khachmaz district "4th section" thermal water and its temperature at the moment of exit from the source

Table 1

Name of source	Geographical coordinates	Temperature at exit
4th section	North $41^0 36' 17''$ East $48^0 41' 54''$	T = 317,15 K

Chemical composition of thermal water of "4th division" of Khachmaz region of Azerbaijan

Table 2

The name of Thermal water	Name of the mineral	Amount of the mineral, ml/lt
4th section	Al1670	<0,01
	As1890	<0,01
	B2089	1.87
	Ba2304	0.11
	Ca3181	158.0
	Cd2288	<0.01
	Co2286	<0.01
	Cr2055	<0.01
	Cu3247	<0.01
	Fe2599	0.02
	Hg1849	<0.02
	K7664	18.30
	Li6707	0.16

	Mg2790	28.20
	Mn2939	0.11
	Mo2045	0.02
	Na8183	832
	Ni2316	<0.01
	P2136	<0.01
	Pb2203	<0.01
	S1820	37.40
	Sb2175	<0.02
	Se1960	<0.02
	Si2124	3.09
	Sr4077	9.28
	Ti3349	<0.01
	Tl1908	<0,05
	V2924	<0.01
	Zn2062	<0.01
	Total:	**1088.56**

Taking into account the fact that the vibrating tube densimeter device needs to be calibrated with at least two substances for the study of the density of liquids after checking the device's performance, for this purpose, water, toluene are used as the main calibrator. standard) were selected as substances. The results obtained for water and toluene were compared with the information given in the literature (Wagner, Pruss, 2002; Lemmon, Span, 2006). As a result of the comparison, the difference between the obtained values for the density of water and toluene and the information in the literature shows that the estimated errors of the measurements in the device are very small. Obtaining results with a small error and close to each other shows the high accuracy of the created experimental device (Nabiev, 2011; Bashirov et al., 2009).

3.Discussion of the research work and its results:

After the verification experiments on the properties of water and toluene (p,ϱ,T) were carried out, the density of the thermal water of Khachmaz district "4th section" of Azerbaijan was measured at high pressure and different temperatures in the experimental facility that works with the vibrating tube densimeter method. . During the measurement of (p,ϱ,T) dependences, in each case of equilibrium, an effort was made to create the lowest possible values of the pressure in order to obtain high-precision values of the density by means of graphic extrapolation in the atmospheric pressure, and the obtained values are the DMA of the density It was compared with the values measured in the 5000M device. The values obtained by different methods agree well within ± 0.02% (Bashirov, et al., 2013; Nabiev, 2011; Bashirov et al., 2009). Researches for thermal water of Khachmaz district "4th division" were conducted at temperatures T=(278.15÷373.15) K and pressures up to p=40 MPa. Experimental indicators obtained on (p,ϱ,T) dependencies are given in table 3.

Experimental values of the density of the "4th section " thermal water of Khachmaz district of Azerbaijan at different pressures and temperatures

Table 3

$\frac{p}{MPa}$	$\frac{\rho}{kq/m^3}$	$\frac{T}{K}$	$\frac{p}{MPa}$	$\frac{\rho}{kq/m^3}$	$\frac{T}{K}$
0.201	1007.44	278.15	0.214	991.53	328.15
5.006	1009.65	278.15	5.006	993.57	328.17
10.006	1011.92	278.16	10.301	995.81	328.16
15.214	1014.26	278.14	15.921	998.17	328.15
20.004	1016.39	278.15	20.152	999.93	328.14
25.301	1018.72	278.16	25.008	1001.94	328.15
29.986	1020.76	278.15	30.102	1004.03	328.13
35.114	1022.97	278.13	35.026	1006.03	328.15
39.997	1025.04	278.15	39.996	1008.03	328.15
0.690	1006.06	288.16	0.302	983.52	343.15
5.061	1007.95	288.11	5.014	985.64	343.17
10.162	1009.96	288.10	10.006	987.85	343.15
15.166	1011.85	288.13	15.308	990.14	343.16
19.942	1014.07	288.11	20.410	992.30	343.15
24.996	1016.13	288.13	25.008	994.21	343.16
30.010	1018.40	288.11	29.998	996.23	343.16
34.744	1020.45	288.13	35.047	982.30	343.15
40.002	1022.67	288.13	39.995	1000.14	343.15
0.798	1002.95	298.19	0.304	974.18	358.15
5.132	1004.77	298.19	5.008	976.40	358.14
9.979	1006.82	298.19	10.009	978.69	358.16
14.879	1009.03	298.14	15.308	981.04	358.15
20.098	1011.23	298.13	20.008	983.07	358.15
25.123	1013.33	298.13	25.021	985.18	358.16
30.022	1015.38	298.12	29.987	987.20	358.17
34.932	1017.28	298.13	35.030	989.19	358.15
39.846	1019.24	298.14	39.994	991.08	358.15
0.385	997.61	313.07	1.393	963.97	373.08
5.158	999.87	313.08	5.416	965.99	373.08
10.079	1002.12	313.08	10.407	968.36	373.08
15.112	1004.32	313.08	15.587	970.77	373.09
19.962	1006.44	313.06	0.420	972.95	373.09
25.287	1008.74	313.06	25.274	974.97	373.09
29.992	1010.62	313.07	30.049	977.01	373.09
35.037	1012.69	313.06	35.201	978.99	373.09
40.130	1014.69	313.08	39.745	980.72	373.10

The obtained experimental results are expressed by the following equation of state:

$$p = A\rho^2 + B\rho^8 + C\rho^{12} \qquad (1)$$

Here, coefficients A(T), B(T) and C(T) depend on temperature in polynomial form:

$$A(T) = \sum_{i=1}^{3} a_i T^i,\ B(T) = \sum_{i=0}^{2} b_i T^i,\ C(T) = \sum_{i=0}^{2} c_i T^i \qquad (2)$$

Values of coefficients a, b and c in equation (2) are given in table 6.

Table 4

a_1 = -1.2533813	b_0 = 736.75489731	c_0 = -488.2859137
a_2 = $-0.339952 \cdot 10^{-2}$	b_1 = -3.43166265	c_1 = 3.2130145
a_3 = $0.96906297 \cdot 10^{-5}$	b_2 = $0.87206243 \cdot 10^{-2}$	c_2 = $0.61334197 \cdot 10^{-2}$

The equation (1) allows us to express the experimental values of the dependence (p, ϱ, T) ofhermal water with an error of 0.007%, taking into account the values of the coefficients A (T), B (T) and C (T).

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