PORTABLE PROPERTIES OF THE RESERVOIR WATERS USED IN POWER SYSTEM

Vagif Hasanov[1], Jeyhun Naziyev[2], Leyla Hasanova[1], Aqil Omarov[1],
İrada Aliyeva[1], Gulshan Akhundova[1]

•

[1]Azerbaijan State Marine Academy
[2] Azerbaijan State Oil and Industry University
vgasanov2002@yahoo.com
j_naziyev@yahoo.com
aqil.omarov@asco.az
leyla.hasanova.75@mail.ru
iradealiyevakerim@gmail.com
gulakhundova@gmail.com

Abstract

In comparison with the sea shipping, systematic pollution of the sea by oil seems insignificant under oil-and-gas field engineering. Measurements of the viscosity of reservoir waters by remote capillary in the temperature interval of (298.15 to 598.15) ºK and the pressure of (0.1 to 40) MPa are reported. The relative uncertainty in the viscosity does not exceed ± 1.8 %. An equation describing viscosity of the studied reservoir waters and the dependence with the mineralization, pressure and temperatures is given.

Keywords: equation, measurements, liquid, viscosity, thermodynamic

I. Introduction

In comparison with the sea shipping, systematic pollution of the sea by oil seems insignificant under oil-and-gas field engineering. But within drilling and oil extraction in Azerbaijan it's possible the hit if high-toxic drilling fluid and chemical reagents of the reservoir and insipid refinery waters.

Rigid norms of sea disposal of the waters of production and as well as inconsistency among the norms and corresponding methods of cleaning and neutralization of the sea disposal require

The decision of this important problem on the sea fields, where together with oil reservoir waters are extracted, is necessity of desalination of the water by thermal method [2].

Designing effective methods of desalination of the sea water, salty and salty waters, demands awareness of thermal properties of the solution n of the water salt systems under increase characteristics of condition.

Experimental studying of thermal properties in the reservoir waters and its desalination will represent possibility by usage of the thermal method of drilling of the oil and water and increasing of recoverable oil.

Viscosity concerns to the main thermal properties of the liquids and gases.

II. Experimental

Samples for researches of reservoir waters have been taken from the Quintile- sea field. The

Chemical composition of the reservoir waters and the number of the well are given in Table 1.

Experiments have been held on the installation based on the method of remote capillary in the relative variant of changes [3].

The theoretical grounds of this method is the equation for laminar stream of Gagen-Puazey:

$$\mu = \frac{\pi(p_1 - p_2)r^4}{8\upsilon\ell} \quad (1)$$

where r radius of capillary and υ volume of gases flowing thragh capillary and $p_1 - p_2$ change of pressure at the end of capillary and ℓ length of capillary.

According to the equation (1), the accuracy of calculation of the coefficient of the viscosity depends on the accuracy of determination of geometric measure of the capillary, the significance of change of pressure at the end of the capillary, the volume of gases and liquid, flowing through the capillary at the unit of time.

This method was realized in different variants of authors [4-9] for research of both gases and liquid in large spheres of state parameters, where both the basic advantages and disadvantages of the method were noted.

The scherue of the experimental installation of measuring of viscosity is presented in the Fig.1. The main element of the installation is capillary 5 from stainless steel with diameters 0.22 mm and length 195 mm, which in joint to the lengthening 6. With the help of this lengthening the stream analysing the liquid is directed to the cold zone. The lengthening joint to the flange 7, combined with mobile cylinder 9, which in its turn, communicates with still cylinder 11 with the help of the joint tube 10.

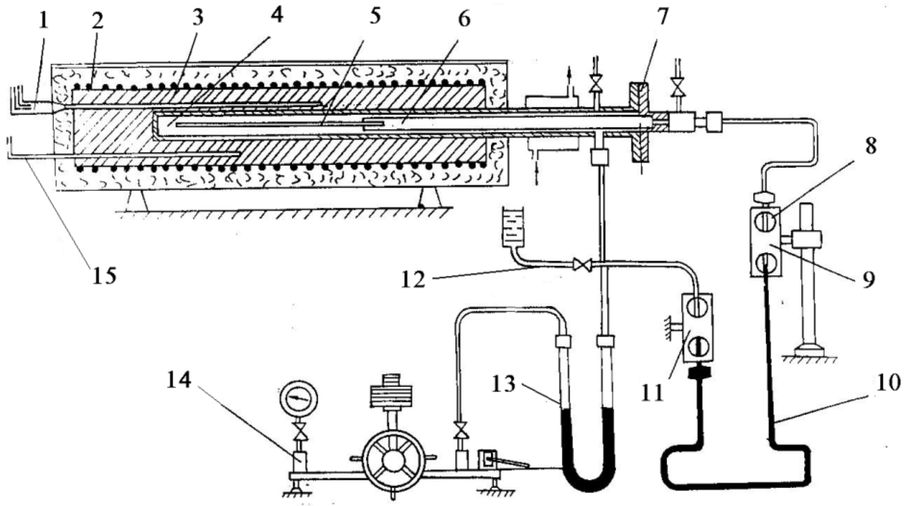

Fig. 1: *The scheme of experimental installation for determination of viscosity of the substance during large interval of temperature and pressure: 1- resistance thermometer; 2- electric heaters; 3- copper block; 4- autoclave; 5- capillary; 6- lengthening; 7- flange; 8- peep-holes; 9 and 11 - cylinder; 10- tube; 12- valves; 13- mercury manometer; 14- pressure gauge; 15- thermocouple.*

The widen caintainess are envisaged for the preliminary stabilization of regime of the liquid stream through the capillary. The still cylinder 11 is combined with the autoclave 4. The entrance and exit sections of the measuring capillary have small conic expansion. The number Re does not exceed 400 in all experiences. During the motion of the mobile cylinder 9 to the upward the mercury flows from this cylinder to the still cylinder 11, with this playing the role of the liquid piston of measuring instrument’s pump with the help of which the liquid flow through the capillary is realized.

The cylinders 9 and 11 having the same volume are supplied with both peep-holes 8 from orgglass with interal diameters 1 mm and taken a risk for them cutting off the volume of the cylinders. Details of the installation contacting with the analysing liquid are made from stainless steel.

Massive copper block 3 from red copper on the surface of which two electric heaters 2 winded along all length are pressed on the autoclave 4. There is a heat –insulation layer from asbestos, basaltic cotton and glass material on upward of the heater.

Filling the installation the analysing liquid is made thourgh valve 12. The cylinders were filled with the weighed quality thourghly puled from the wixed mercury. All experiences were held with constant mercury.

Temperature was measured with a platinum resistance thermometer with an accyracy of 0.01 ^{0}K. The temperature of the magnetic suspension was measured with mercury-in-glass thermometers with a precision of 0.1 ^{0}K.

Pressures were generated and measured with a dead weight gauge at pressures greater than 0.1 Mpa while a differential manometer was used for atmosphere pressure. In accordance with the recommendations of [10], the experimental uncertainties are for temperature ±3 mK, pressure greater than 0.1 $\pm 5 \cdot 10^{-2}$ Mpa and $\pm 5 \cdot 10^{-4}$ Mpa for atmospheric pressure, and $\pm 3 \cdot 10^{-4}$ $kg \cdot m^{-3}$ for density.

The time of flow of the liquid through the capillary was measured with the help of the stop-watch SW-50 with the value of division 0.1 s, and arithmetical mean from several changes was used in calculations.

Uncertains gained values of dynamic viscosity on condition of the mistakes concerning the pressure, mineralization and temperature does not exceed ± 1,8 %.

There are examples, gained value of the viscosity of the reservoir waters have been given in the Tables 2,3,4.

III. Results

For convenience of practical usage of the data's concerning the viscosity should access the equation of the viscosity [11-15].

This equation describing the coefficient of the viscosity in dependence with the mineralization, pressure and temperature, which describe as:

$$\eta_{p.w} = 1537 + (1 + 0.0115 \cdot C^{1.25}) \eta_{water}, \qquad (2)$$

where η_{water} - waters viscosity and C- mineralization of the reservoir water.

New given equation for viscosity, which keeps an interval of the temperatures (298.15 to 598.15) ^{0}K. Equations (2) describe the experimental results of tables 2 to 4 within less then 0.8 %.

IV. Conclusions

The experimental data's concerning the viscosity of the reservoir waters in the range diapason of the condition parameters have been given in this work.

Real research of the reservoir waters takes the temperature interval (298.15 to 598.15) ^{0}K and by the pressure of (0.1 to 40) MPa.

The viscosity of the reservoir waters has been measured by determined method of remote capillary.

Defect of the measures of the viscosity is ± 1,8 %.

Given equation, describing experimental data's by the viscosity with exact accuracy.

Table 1: *Chemical compound reservoir waters*

No of the Oil well	PH	Bome	Hardness	Na+K g.	Ca g.	Mg g.	Cl g.	SO_4 g.	CO_3	HCO_3 g.	NT g.	HB_4O_7 g.	Total	S_1	S_2	A	a
176	6.5	2.01	27.02	6.2	0.3	0.12	7.3	2.8	0	1.2	0.1	0.08	18.1	82.1	0	16.36	1.54
81	6	2.43	52	8.4	0.6	0.27	11.4	2.5	0	0.7	1	0.9	25.77	69.58	0	27.69	2.26
158	7	3.82	22	12.1	0.24	0.12	18	0.021	0	0.2	0.77	1.1	32.55	64.14	0	34.08	0.8

Table 2: *Experimental values of dynamic viscosities of pore waters consist of* $C = 18.11$ *g/l*

	T/K												
p/MPa	298.15	323.15	348.15	373.15	398.15	423.15	448.15	473.15	498.15	523.15	548.15	573.15	598.15
	$\eta \cdot 10^7 (Pa \cdot s)$												
0.1	9128.04	5667.61	3910.42										
5	9128.65	5680.20	3921.38	2954.33	2350.29	1941.62	1646.09	1426.72	1257.61	1119.90			
10	9129.79	5693.17	3934.17	2966.85	2363.78	1954.55	1660.13	1439.24	1268.28	1148.46	1023.58	934.23	
15	9130.80	5698.77	3947.22	2979.18	2373.47	1967.01	1673.20	1452.99	1282.92	1148.46	1040.30	952.12	846.72
20	9131.75	5721.10	3960.27	2991.50	2388.15	1979.46	1686.14	1466.73	1297.55	1164.09	1057.02	970.01	871.91
25	9132.57	5727.56	3967.34	2999.23	2396.51	1988.24	1695.78	1477.02	1308.49	1175.70	1069.29	982.97	890.17
30	9133.38	5734.01	3974.44	3006.95	2404.87	1997.45	1705.42	1487.30	1319.43	1187.30	1081.56	995.93	910.03
35	9133.44	5745.10	3986.57	3018.43	2416.43	2009.71	1717.60	1501.48	1331.37	1198.91	1093.71	1009.41	927.18
40	9135.57	5757.36	3997.38	3030.71	2428.50	2012.56	1729.09	1513.66	1343.79	1210.83	1105.83	1023.30	943.71

Table 3: *Experimental values of dynamic viscosities of pore waters consist of C = 25.77 g/l*

p/MPa	T/K 298.15	323.15	348.15	373.15	398.15	423.15	448.15	473.15	498.15	523.15	548.15	573.15	598.15
	$\eta \cdot 10^7 (Pa \cdot s)$												
0.1	9219.45	5735.41	3963.57										
5	9219.46	5748.77	3974.60	2999.19	2388.72	1975.56	1679.47	1455.23	1281.29	1144.61			
10	9219.47	5761.59	3987.66	3011.22	2401.98	1988.29	1690.55	1467.15	1294.32	1157.50	1047.32	957.42	
15	9219.48	5767.24	4000.89	3023.72	2414.36	2000.96	1703.79	1481.65	1309.26	1173.75	1064.43	975.75	870.35
20	9219.49	5789.85	4014.11	3036.24	2426.74	2013.63	1717.03	1495.18	1324.19	1189.45	1081.53	994.08	895.98
25	9225.52	5796.38	4021.29	3044.08	2435.24	2022.79	1726.85	1505.67	1335.35	1201.30	1094.09	1007.60	914.80
30	9231.53	5802.91	4028.47	3051.92	2443.73	2031.94	1736.67	1516.15	1346.51	1213.15	1106.65	1020.65	931.75
35	9231.54	5816.06	4040.03	3063.61	2456.42	2043.57	1748.48	1528.07	1358.40	1244.68	1118.52	1032.46	946.56
40	9231.55	5828.41	4052.31	3075.50	2468.34	2056.92	1760.53	1540.66	1370.09	1257.31	1130.74	1044.86	961.36

Table 4: *Experimental values of dynamic viscosities of pore waters consist of C = 32.55 g/l*

	T/K												
p/MPa	298.15	323.15	348.15	373.15	398.15	423.15	448.15	473.15	498.15	523.15	548.15	573.15	598.15
	$\eta \cdot 10^7 (Pa \cdot s)$												
0.1	9309.55	5821.98	4011.51										
5	9309.57	5824.58	4025.49	3055.61	2435.41	2017.45	1716.32						
10	9309.58	5827.18	4038.52	3053.21	2438.01	2020.05	1719.12	1493.33	1318.69	1180.55	1069.44	978.96	
15	9309.59	5841.47	4051.92	3065.90	2450.58	2025.20	1732.59	1507.60	1333.91	1196.84	1086.91	997.70	892.32
20	9309.60	5855.76	4065.31	3078.58	2463.15	2045.79	1746.06	1521.86	1349.13	1213.13	1104.37	1016.44	918.34
25	9310.71	5862.36	4072.59	3086.54	2471.77	2055.09	1756.04	1532.53	1360.50	1225.51	1117.20	1030.01	934.21
30	9321.41	5868.96	4079.86	3094.48	2480.39	2064.39	1766.02	1543.20	1371.87	1237.87	1130.02	1043.61	954.71
35	9321.36	5875.62	4090.53	3106.71	2492.14	2076.41	1778.09	1555.71	1383.04	1248.16	1158.16	1055.40	969.50
40	9322.21	5887.30	4102.47	3118.56	2504.43	2079.58	1790.14	1567.30	1395.33	1260.47	1170.82	1069.06	985.56

References

[1] Kasymov, A.Q. Ecology of the Caspian lake. Baku. 1994, 7-9.

[2] Akberov, R.M. Investigation of influence on layer by water solution of the polymer for increasing oil recovery. *Azerbaijan oil facilities of Baku.* 1998, 7, 36-39.

[3] Akhundov, T.S.; Guseynov, A.T. The viscosity of the water solution of the chloride sodium. *Oil-and-gas*. 1990, 7, 65-68.

[4] Golubev, I.F.; Qnezdilov, N. E. Mixtures of the viscosity of gases. Mockow. 1971, 327.

[5] Golubev, I.F. Mixtures of the viscosity of gases. Mockow. 1959, 375.

[6] Abdullaev, F.G.; Akhundov, R.T. The Experimental research of dynamic viscosity on Benzene and cholorebenzene high temperature. *Oil-and-gas*. 1983, 2, 53-59.

[7] Shatenshteyn, A.A.; Izrailevich, E. A.; Ladijnikova, N. I. Mixtures of the viscosity of gases. Mockow. *JFCh*. 1959, 4, 88.

[8] Pepinov, R.I.; Lobkova, N. B.; Panachov, I. A. On the viscosity of the mixture of water and natrium the stream temperature and pressure. Mockow. 1975**,** 46, 42-48.

[9] Cemenyuc, E.H.; Lvov, C. H.; Zarembo, V. K. The measured reservoir temperature (273 to 670) ^{0}K and pressure (to 200) MPa for the viscosity of the mixture of electrolytes. Mockow. *JPCH*. 1977, 50, 2, 127.

[10] Rivkin, S.L.; Aleksandrov, A. A. The thermodynamic properties of water and water vapor. *Energy*, Moskow. USSR. 1975, 80.

[11] Hales, J.L. Ellender Liquid Densities from (293 to 490) ^{0}K of nine aliphatic alcohols. *Chem.Thermod*. 1976, 8, 1177-1184.

[12] Achundov, T.S.; Iscenderov, A. I.; Tahirov, A. D.; Achmedova, I. N.; Imanova, M. V.; Achundov, R.T.; Ishcanov, Ju; Huseynov, A. G. Termal Properties and viscosity of Aqueous Solutions of Alkaline Metal Halogenides and Alkaline-Earth Metal Nitrates. *11th International conference on Properties of steam*. Prague. 1989, 25.

[13] Stokes, R.H.; Mills, R. Viscosity of Electrolytes and Related Properties. London. *Pergamon Press*. 1965, 110.

[14] Chapman, T.W. The transport properties of consentrated electrolytes solutions. Berkeley. *University of Colifornia*. 1967, 202.

[15] Grimes, C.S.; Kestin, J.; Khalifa, E. Viscosity of aqueous KCl solutions in the temperature range (25 to 150) ^{0}C and pressure range (0 to 30) MPa. *J.Chem. and Eng. Data*. 1979, 24, 2, 121 - 126.