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NEW APPROACH FOR TWO-PHASE FLOW CALCUATION OF ARTIFICAL LIFT

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Abstract

The article develops a method for adjusting design pressure of bellows gas lift valves in deviated gas lift wells based on research and calculations and provides a method for the arrangement of gas lift valves along tubing. As a result of the calculations, the valve opening pressure of the first gas lift valve was taken equal to the initial gas pressure, the valve opening pressure of the following valves was 0.05-0.175 MPa lower than that of the previous gas lift valve, and the pressure difference between the last valve and the second from the last valve was 0.28-0.35 MPa.

Keywords:

Gaslift valve;
Vertical and deviated gaslift wells; Pressure;
Pressure gradient;
Special gas consumption;
Gas-liquid mixture;
Tubing; Inclination angle.

Nowadays, the oil recovery from the mature fields became more significant topic than exploration of a new field. The great majority of the discovered fields are being exploited for several years. As a result the decrease in reservoir pressure, bypassed oil and several other issues are observed in these fields. Researchers put great effort to enhance oil recovery in these mature fields [1-6]. Reservoir pressure depletion makes application of artificial lift systems compulsory, as reservoir pressure is no more enough to lift the reservoir fluid to the surface.

Flow of the gas-liquid mixture in the tubing is accompanied with a continuous change in the thermodynamic and hydrodynamic parameters [7-10].

In the hydraulic calculations on flow in pipes, the important challenge is to determine its pressure drop. The pressure drop depends on the mixture density and the hydraulic friction coefficient, so it is necessary to determine the dependence of these parameters on the flow rate, geometry and pipeline position.

As a rule, deep water, cluster drilled well bores are randomly oriented in space: well bore highly differs from the design position, it forms an angle «α» with a vertical plane, and its azimuth angle «β» changes. At the same time, the well bore rotates around the axis «n» times. Therefore the gas-liquid mixture flow direction in the tubing differs from the direction of gravitational forces.

A number of laboratory and field experiments, and theoretical works were performed to study the gas-liquid mixture motion in hilly terrain pipeline [11-13]. However, it is impossible to run some processes that may occur under field conditions in laboratory practices and/or take all of them into account in theoretical studies. Therefore, the researchers studied only few of individual issues of this complex process, and the solutions are not efficient in practice. Since the processes in a two-phase flow are complex and are affected by various factors over time, there is still no universal analytical equation for the multicomponent flow motion in a pipe.

According to the researches, it is possible to record liquid-gas mixture motion with a mathematical differential equation, however the integration of these equations is either impossible or technically extremely difficult [14].

Thus, the equation of the liquid-gas mixture flow can only be obtained by applying a statistical method or the theory of similarity and measurements to field data in laboratory conditions [15-17]. The pressure drop value caused by gravitational forces has high proportion among total pressure drop, when the liquid-gas mixture flows in hilly terrain pipelines. Generally, the gas-liquid mixture motion in a non-horizontal pipeline is characterized by certain parameters.

As mentioned earlier, in total pressure drop gravitational losses are great in gas-liquid mixture motion in the hilly terrain pipe. Determination of the real gas capacity - φ is extremely important: this is the main determining factor of gravitational losses in the case of random orientation of the pipeline in space. This issue is being studied in two directions. One of them is the drift model developed by Zuber [18-20]. In this model, it is assumed that bubbles rise rate (ω_α) in liquids in inclined pipes depends on the angle of inclination (α) of the pipes to the horizontal plane. According to the Zuber model,

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the relationship between the actual gas capacity and the bubbles rise rate in a liquid can be written as follows:

$$\varphi = \frac{Q_2}{c_1(Q_1+Q_2)+c_2 s\omega_\alpha} \quad (1)$$

Generally, the bubbles rise rate in a liquid can be determined by the following equation:

$$\omega_\alpha = kp_1^{\frac{1}{2}}\left[g\left(P_1-P_2\right)^{\frac{1}{2}}\right] \quad (2)$$

here: k - is a coefficient, that takes into account the physical properties of the mixture components and the inclination angle of the pipe.

According to the laboratory experiments conducted by Runge, the inclination angle of the pipe has a great influence on the bubble rise rate in the liquid, and this rate can be expressed in the following general formula:

$$\frac{\omega_\alpha}{\omega_0} = \frac{k_1(N_F\cdot N_{E0},\alpha)}{k_1(N_F\cdot N_{E0},0)} \quad (3)$$

here: ω_α, ω_0 – respectively, the bubble rise rate in the static liquid in inclined and vertical pipes.

It should be noted that, calculation of the actual gas capacity from the bubble rise rate in a liquid according to Eq. (1) is not unambiguously. C1 and C2 coefficients depend on the flow regime, shape of the channel and the physical properties of the components of the mixture. Therefore, the influence of α and φ in such process is not clearly shown in different regimes.

Studies show that the bubble rise rate in pipes with 1° inclination to the horizontal plane at low liquid velocities is 1.5 times lower than the bubble rise rate in vertical pipes [14, 21-23].

Matte and Gregor studied the impact of the inclination angle on the characteristics of an oil-gas flow, forming a plug in inclined pipes with a diameter of 25.4 mm. The inclination angle of the pipes was changed between 0-10° [20].

The results show that the inclination angle of pipes affects the rise velocity of gas in the liquid and frequency of oil plug formation in the flow, but in calculations this effect can be neglected.

Singh and Griffith also came to a similar conclusion by varying the inclination angle between 0÷20° in pipes with different diameters [24].

The second direction of the study is characterized by the investigation of the actual gas capacity dependence on the inclination angle $\varphi = f(\alpha)$.

Fleningen was one of the first experts who studied this dependence. However, his experiments do not fully answer the posed question. The main conclusion he made from the experiments is that the inclination angle has no effect on the actual gas capacity at high gas velocities. Sevigni came to an analogical conclusion by implementing extensive experimental works on pipes with a diameter of 20.9 mm and inclination angle of 5, 10, 15, 30, 60 and 90°. It was impossible to systematize the dependence of «α» on «φ» in the processing methodology of the experimental results.

The necessity of this study was exposed with observation of large pressure drops within pipes during liquid-gas mixture transportation via main pipelines from geographical areas with rugged relief. It is related to the fact that in the geometric lower part of the area, liquid accumulates in the lower part of pipes, while gas bubbles are formed in its higher parts.

The equilibrium condition between air accumulated in inclined pipes and its movement within the water flow was considered by L. Conti in the mid-20s of the XX century [25, 26]. Later, this issue was studied more perfectly by different researchers. Among these works, I.A. Charni's study deserves more attention [20, 27]. The study provides an analytical solution for hydraulic pressure drop, live section shape of the flow, transportation conditions of liquid and gas accumulated in the rising and falling parts of an area.

The results of these theoretical works have been verified by laboratory studies. Experiments show that while liquid and gas flows downward, gas accumulates in the uppermost part of the pipeline at values below the critical value of the flow rate. Once gas leaves its accumulation area, it moves as separate streams within pipes, and gas travels at lower velocity than liquid, covering the most part of the pipeline and it has a high velocity.

At higher elevations, gas moves faster within a pipeline. Liquid which moves at lower velocity accumulates in pipes. As the amount of liquid accumulated within pipes increases, friction pressure losses increase.

These results of laboratory experiments were confirmed in the process of liquid- gas mixture transportation via main pipelines in the United States.

Later, Gallyamov performed laboratory experiments to study movement of two-phase liquids within inclined pipes [25, 26].

The results of the laboratory experiment are graphically represented using the following non-dimensional parameters:

$$Fr = \frac{\vartheta_q}{\sqrt{gd}};\quad \frac{P}{\gamma_m\cdot\Delta z} = \bar{P};\quad \frac{\Delta z}{L} = k;\quad Sh = \frac{2\pi L}{T\vartheta_q} \quad (4)$$

where: Fr - Froude number;

d - pipe diameter;

P - dimensionless pressure;

Sh - Strouhal number;

Δz - difference in geometric heights;

P - pressure at the beginning of a pipe;

T - flow time of a gas or liquid plug.

1-k = 0.0254, 2-k = 0.0204, 3-k = 0.017, 4-k = 0.0122, 5-k = 0.0068, 6-k = 0.0088, 7-k = 0.0054

when Fr = const, the amount of liquid in pipes remains unchanged, and wavy movement of liquid and gas occurs in pipes. As the Froude number increases, pressure amplitude changes. Then neither pressure variation nor complete clogging of pipe cross section in this zone does occur.

Figure 1 illustrates this process schematically.

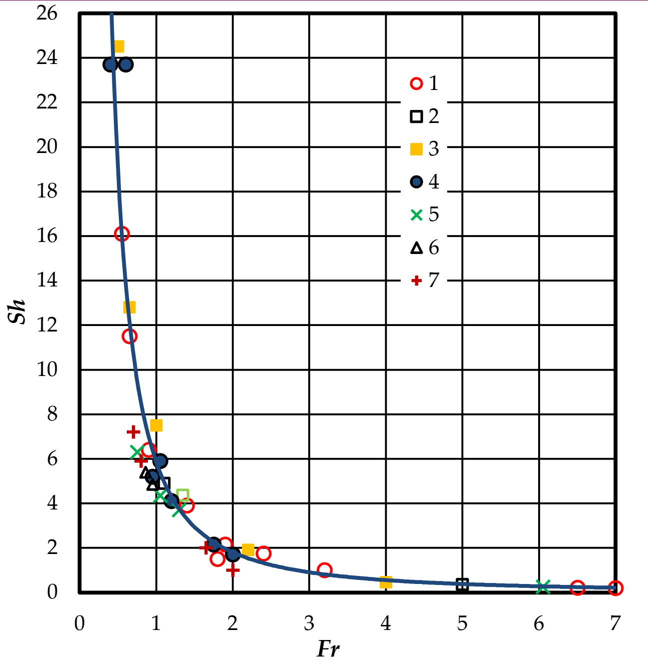

Fig.1. Relation between the Froude number (*Fr*) and Strouhal number (*Sh*)

Field experience shows that in gas-lift wells with randomly oriented wellbores , flow of liquid-gas mixture and multicomponent liquid is subjected to more complex processes. The flow is under the influence of controlled and uncontrolled factors (independent of us), therefore it turns into a disordered (chaos) event.

There is certain regularity in this disorder. Large field and laboratory studies are required to find this regularity.

A flow in a hilly terrain pipeline is a complicated process. Because liquid flow direction in the curved areas of pipes is not parallel to the curved axis of pipes, but it has velocity summands in the cross-section direction. Actually, if the liquid particles move in a curved line, they are subjected to a side force under the influence of pressure gradient.

Within a pipe, pressure is higher in the concave part of the pipe than that in the convex part. So, different velocities appear in a flow direction, as a result, flow is separated from pipe walls and stream line sometimes shrinksorexpands. In the result «second closed flow» phenomena occurs, which gives rise to additional hydraulic resistance. If the angle formed by a pipe on a vertical plane is less than 15°, «second closed flow» is not observed [27, 28].

With regard to large-scale development of oil and gas fields on ocean shelve in the second half of the XX century, specialists carried out comprehensive laboratory and field experiments to study regularity of liquid-gas mixture movement in hilly terrain pipes [18, 19, 29].

Beggas and Brill studied liquid-gas mixture movement based on the energy conservation law [24]

$$dp + \rho_{qar}\,\vartheta_{qar}\,d\vartheta_{qar} + \rho_{qar}\,d\rho_{qar} \qquad (5)$$

Based on this formula, the researchers obtained a relation that help to determine the pressure gradient using the hydraulic friction and inertia forces of the mixture. The calculation method allows to estimate the hydraulic pressure loss in horizontal and vertical pipes. The study analyzes the flow of the liquid-gas mixture in the pipes and identifies four flow regimes: split flow (stratified and stratified wavy flow), annular, mixed flow (clogged and wavy), and dispersion (emulsion-shaped, bubble-layered).

Specialists have created a diagram to determine these regimes in Fr_{qar} - β_m coordinates [24]. Similar studies were conducted in [18, 19]. It is possible to approximate the flow regimes from the diagram constructed in the Frqar - β_m plane. However, the inaccuracy of this method does not give the required result. In general, equation (5) assumes the average values of the parameters of the multiphase fluid flow and shows its average characteristic.

This problem concerns the mechanics of the whole environment, and its solution is associated with great difficulties.

By analyzing the results of Beggas and Brill laboratory experiments with certain mathematical transformations, the following expression is given for the average value of the pressure gradient of the liquid-gas mixture in inclined pipes:

$$\frac{dp}{dz} = \frac{\left[\rho_{qar}\cdot g\cdot \sin\alpha + \dfrac{2\lambda_{qar}\cdot M_{qar}\cdot \vartheta_{qar}}{\pi d^3}\right]}{1-\dfrac{\rho_{qar}\vartheta_{qar}\vartheta_q}{\rho}} \qquad (6)$$

herein: $M\beta_m$ – volume consumption of liquid-gas mixture;

ϑ_q – specific velocity of gas;

α – the angle of inclination of the wellbore from the vertical plane.

The assumption of (6) formula is that the mass consumption of the liquid-gas mixture in the pipes equals to the multiplication of its velocity and density.

The calculation algorithm of the formula (6) is given in the technical literature [29].

Other extensive researchs in this field were carried out by A.A.Mamayev, Q.E.Odshariya, O.V.Klapchuk [18]. Studies have shown that clogged and annular flow regimes are observed in inclined and vertical pipes.

In general, it has been proven that in inclined pipelines, stratified, clogged and annular flow types are mainly possible. In the upstream along the arbitrary spatial curve, congested and annular motion is mainly observed. The angle of inclination in the vertical plane has a drastic effect on the change of the separation boundary of the flow regimes in the Frqar and βq coordinates. The inclination angle of the wellbore in the upstream flow has a greater effect on the smaller values of the Frud number. Because, in such conditions, the flow velocity is small and the force of gravity is large. It is important to know the actual fluid capacity in the flow in inclined wells. Because these parameters are the main hydrostatic addends of the pressure gradient in the tubing.

However, each flow regime has its own specific equation. The equation of «clogged» motion of a liquid-gas mixture:

$$-\frac{dp}{dz}=\lambda_{qar}\frac{\vartheta_{qar}^2}{2D}\left[\frac{\beta^2}{\varphi}\rho_q+\frac{(1-\beta)^2}{1-\varphi}\rho_m\right]+\rho_{qar}\cdot g\cdot\sin\alpha$$

herein: $\rho_{qar} = \varphi_q\rho_q + (1 - \varphi)\rho_m$ – is the density of the mixture.

$$\frac{\vartheta_{qar}^2}{2D}\left[\frac{\beta^2}{\varphi}\rho_q+\frac{(1-\beta)^2}{1-\varphi}\rho_m\right]$$ – is a real dynamic pressure.

The expression on the right side of the above equation is the loss due to gravity and friction.

To solve this equation, it is necessary to know the dependence of the actual gas capacity (φ) and the hydraulic friction coefficient on the flow and physical characteristics of the mixture. The actual gas capacity (φ) in clogged motion is determined experimentally. Studies show that the actual gas capacity (φ) depends on the exhaust gas capacity (β), the Froud criterion (Frqar), the angle of inclination (sin α) created by the vertical flow in the pipes, the viscosity of the liquid () and the Weiber criterion (We). Then we can write the following parametric relation for the actual gas capacity:

$$\varphi=\varphi(\beta,Fr_{qar},\bar{\mu},We,\sin\alpha)$$

From the above parameters, β and Fr_{qar} are the main parameters that affect φ. The results of A.A. Tochigi's experiments with air-water mixture in horizontal pipes are given in the set of curves $\varphi = f(\beta, Fr_{qar})$ in figure 2.

It can be seen from the graph that when $0 < \beta < 1$, the actual gas capacity (φ) of the flow is less than the exhaust gas capacity ($\varphi < \beta$), ie the relative velocity

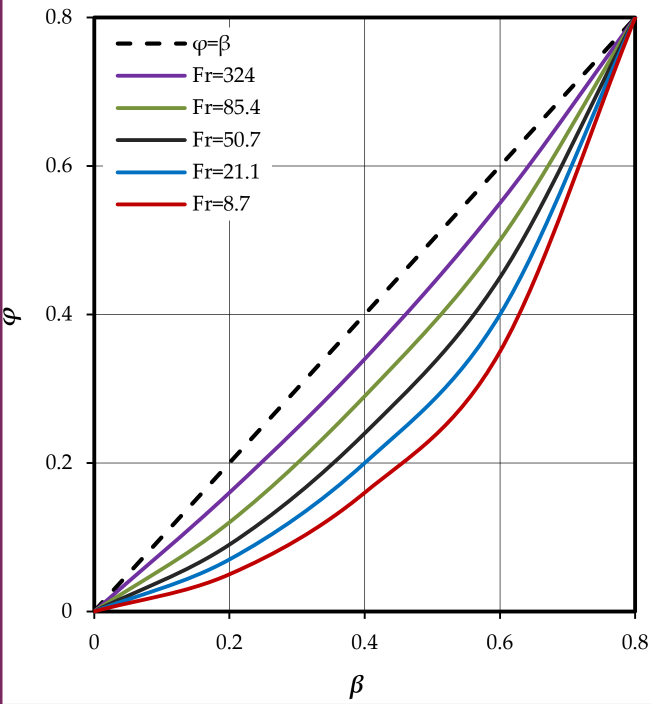

Fig.2. Relation between actual gas capacity and exhaust gas capacity

of air is positive and moves faster than liquid.

The graph shows that as Fr_{qar} increases, actual gas capacity increases. After $Fr_{qar} > 4$, φ depends only on β.

It has been found that the actual gas capacity (φ) is directly propotional to, the exhaust gas capacity (β) and the Frqar in the upward movement of the liquid-gas mixture is subject to.

This dependence is described in figure 3.

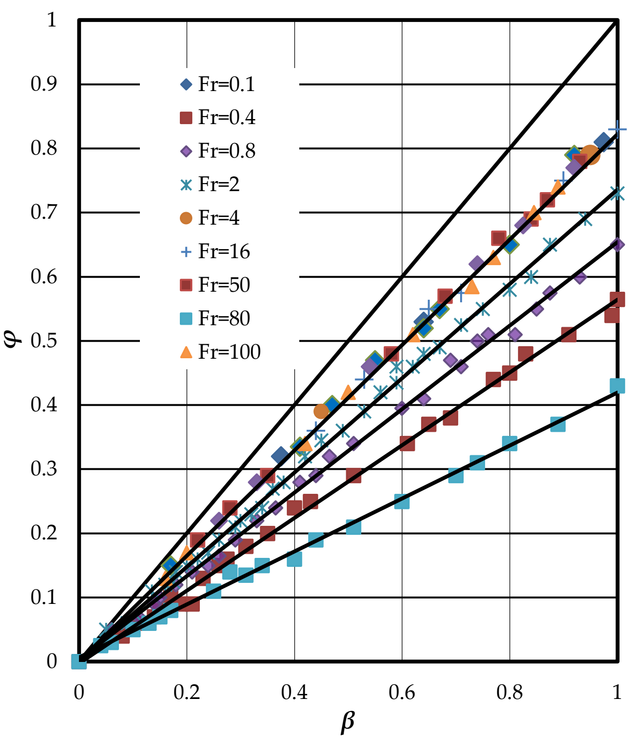

Fig. 3. Actual gas capacity dependence on exhaust gas capacity and Frud's criterion in the rising flow of water-air mixture

The model area starts after $Fr_{qar} > 4$ and when $\beta = 1$, then $\varphi < 1$.

The following expression is obtained for the actual gas capacity in the upper clogging motion of the water-air mixture:

$$\varphi=0.81\left(1-e^{-2.2\sqrt{Fr_{qar}}}\right)$$

As the viscosity of the lifted liquid increases, the value of *Fra* and $k1 = \varphi / \beta$ decreases.

As a result of the full impact of viscosity, φ is defined by the following expression:

$$\varphi=k_1\left(1-e^{-4.4\sqrt{\frac{Fr_{qar}}{Fr_a}}}\right)\beta$$

In the 1980s technological parameters of the inclined wells and the factors determining the form of wellbore (angle formed by the vertical plane of the body «α», azimuth «β», as well as the number of rotations of the well bore around its axis «n») was studied at the Azerbaijan Institute of Petroleum and Chemistry by applying mathematical-statistical methods on field data and results of field experiments [30]. The following relationship was obtained based on the survey data of the wells at the «Oil

Rocks» and «Palchiq Pilpilesi» fields according to the proposed method:

$$\alpha = 8.588 \cdot l^{0.607} \cdot e^{0.0022}$$

where: l - total deviation of the wellbore from a vertical plane.

The following dependence was obtained between gas consumption in the wells and the number of rotations (n) of the wellbore around its axis:

$$V_0 = 302.89 - 0.782l + 0.0034l^2$$

The analysis of well-known models reveals that the mathematical expressions obtained by VNIIGaz and Beggas-Brill for estimating the actual gas capacity «φ_Γ» are more reliable. Therein, the second case is more reliable in practice, since in this calculation technique the actual gas capacity is higher. It means that the pressure drop is greater than the hydrostatic component of the flow.

In recent years, the complexity of creating an arbitrary profile of liquid-gas mixture and a true mathematical model of flow in pipes has prompted researchers to refer to statistical and adaptive methods. One such effective method is the group method of data handling (GMDH) [31]. The idea of GMDH is based on a self-organizing approach.

In biological systems, the process of natural selection of the best individuals to continue the next generation from the excrescent population is called self-regulation.

The practical significance of the GMDH method lies in the fact that it allows to determine the pressure gradient distribution of the liquid-gas mixture in the tubing based on small amount of experimental data.

According to field data, the interval measurement of pressure in thetubing refers to gaslift wells operating the Fasila strata of the central tectonic block of the Gunashli field.

In general, a subject that depends on more than two arguments can be written with the following functional relation:

$$F = f(x_1, x_2, \dots x_3) \quad (7)$$

The function (7) of the model is replaced by equations consisting of 2 functions. In the first stage, a possible solution is sought in the form of the following expression [24]:

$$Yij = a_0 + a_1 x_1 + a_2 x_i + a_2 x_j + a_3 xi x_j + a_4 x_2 + a_3 x_{j2} \quad (8)$$

The following model was selected according to the field data:

$$dP/dl = f(Q, R, P) \quad (9)$$

It should be noted that the angle formed by wellbore of the selected wells with a vertical plane is more than 15°.

The following expression for the pressure drop was obtained as a result of processing the field data and the results of interval pressure measurement in the tubing by the GMDH method:

$$dP/dl = 0.0017 + 0.0002P \cdot R^{-5} + 2.1 \cdot 10^{-6} P^2 q^{-0.5} \quad (10)$$

where: R – is specific consumption of working agent, m^3/day;

q – is well production, m^3/day;

P – is well working pressure, MPa.

The following average value is obtained for the dynamic pressure gradient based on the abovementioned equation:

$$dP/dl = 0.002 \div 0.0022 \quad (11)$$

Knowing the dynamic pressure gradient, it is possible to place silphone gas lift valves in deviated gas lift wells along the tubing and adjusting them to the design pressure.

The deployment depth of the 1st valve (regardless of type) from the wellhead is determined depending on the maximum gas pressure and the static fluid level.

If the well is filled with fluid, deployment depth of the 1st gaslift valve from the well head is determined by the following expression:

$$l_1 = (P_{ib} - P_{qa}) / (\Delta P / \Delta l) \quad (12)$$

where: P_{ib} – is initial opening pressure, MPa;

P_{qa} – is wellhead pressure, MPa;

$\Delta P/\Delta l$ – is statistic pressure drop, $\Delta P/\Delta l$ = 0.01 MPa/m.

If the fluid level in the well is low, then the deployment depth of 1st valve in the wellhead is determined by the following equation:

$$l_1 = l_{st} + \frac{P_{ib} - P_{qa}}{\left[1 + (S_{ba}/S_b)(\Delta P/\Delta l)\right]} \quad (13)$$

where: S_{ba}, S_b – are cross-sectional areas of annulus andtubing, respectively, m^2.

The deployment depth of the 2nd valve from the well head is determined by the following equation:

$$l_2 = l_1 + \frac{\left[P_i' - \left(P_{qa} + l_1 \frac{dP}{dl}\right)\right]}{\left[1 + \left(\frac{S_{ba}}{S_b}\right)\frac{\Delta P}{\Delta l}\right]} \quad (14)$$

where: P'_1 –is regulating pressure of the 1st valve, MPa.

dP/dl - is dynamic pressure differential, MPa/m.

Subsequent gas lift valves are determined by the following equation:

$$l_n = l_{n-1} + \frac{\left[P'_{n-1} - \left(P_{qa} + l_{n-1} \frac{dP}{dl}\right)\right]}{\left[1 + \left(\frac{S_{ba}}{S_b}\right)\frac{\Delta P}{\Delta l}\right]} \quad (15)$$

The opening pressure of the 1st gaslift valve from top is taken equal to the initial opening pressure, but the opening pressure of the subsequent valves is taken lesser by 0.05-0.175 MPa. The pressure difference between the last and second to the last valve should be 0.28-0.35 MPa.

Conclusion

The methodology has been developed for adjusting the design pressure of silphone gas-lift valves in deviated gas-lift wells and for determining their location along tubing based on investigations and calculations.

References

1. Suleimanov, B. A., Veliyev, E. F., Azizagha, A. A. (2020). Colloidal dispersion nanogels for in-situ fluid diversion. *Journal of Petroleum Science and Engineering,* 193, 107411.

2. Suleimanov, B. A., Latifov, Y. A., Veliyev, E. F. (2019). Softened water application for enhanced oil recovery. *SOCAR Proceedings,* 1, 19-28.

3. Suleimanov, B. A., Veliyev, E. F., Naghiyeva, N. V. (2021). Colloidal dispersion gels for in-depth permeability modification. *Modern Physics Letters B,* 35(01), 2150038.

4. Suleimanov, B. A., Veliyev, E. F., Naghiyeva, N. V. (2020). Preformed particle gels for enhanced oil recovery. *International Journal of Modern Physics B,* 34(28), 2050260.

5. Veliyev, E. F. (2020). Mechanisms of polymer retention in porous media. *SOCAR Proceedings,* 3, 126-134.

6. Veliyev, E. F. (2020). Review of modern in-situ fluid diversion technologies. *SOCAR Proceedings,* 2, 50-66.

7. Suleimanov, B. A. (1997). Slip effect during filtration of gassed liquid. *Colloid Journal,* 58(6), 749-753.

8. Shakhverdiev, A. Kh., Panakhov, G. M., Suleimanov, B. A., Abbasov, E. M. O. (1999). Method for development of oil deposit. *RU Patent* 2125154.

9. Panakhov, G. M., Suleimanov, B. A. (1995). Specific features of the flow of suspensions and oil disperse systems. *Colloid Journal,* 57(3), 359-363.

10. Suleimanov, B. A. (1995). Filtration of disperse systems in a nonhomogeneous porous medium. *Colloid Journal*, 57(5), 704-707.

11. Mirzadzhanzade, A. Kh., Ametov, I. M. (1986). Technique and technology of oil production. *Moscow: Nedra.*

12. Silash, A. P. (1980). Oil and gas production and transportation. Moscow: Nedra.

13. Reference guide for the design of the development and operation of an oil field. Oil production (1983) /Ed. Sh.K. Gimatudinov. *Moscow: Nedra.*

14. Ivakhnenko, A. G., Zaichenko, Y. P., Dimitrov, V. D. (1976). Decision making on basis of self-organizing. *Moscow: Soviet Radio.*

15. Suleimanov, B. A., Ismailov, F. S., Dyshin, O. A., & Veliyev, E. F. (2016, October). Screening evaluation of EOR methods based on fuzzy logic and Bayesian inference mechanisms. SPE-182044-MS. In: *SPE Russian Petroleum Technology Conference and Exhibition. Society of Petroleum Engineers.*

16. Abbasov, E. M., Dyshin, O. A., Suleimanov, B. A. (2008). Application of wavelet transforms to the solution of boundary value problems for linear parabolic equations. Computational Mathematics and Mathematical Physics, 48(2), 251–268.

17. Suleimanov, B. A., Guseynova, N. I., Veliyev, E. F. (2017, October). Control of displacement front uniformity by fractal dimensions. SPE-187784-MS. In: *SPE Russian Petroleum Technology Conference. Society of Petroleum Engineers.*

18. Joachim, I. A. (1968). Oil and gas production. *Moscow: Nedra.*

19. Mamaev, V. A., Odisharia, G. E., Klapchik, O. V., et al. (1978). The flow of gas-liquid mixtures in pipes. *Moscow: Nedra.*

20. Prosviryakov, N. N., Shibanov, V. A. (1982). Calculation features of directional wells. *Proceedings of «Gipromornetegaz»,* 10.

21. Hewitt, G., Hall-Taylor, N. (1974). Annular two-phase flows. *Moscow: Mir.*

22. Guidance for analysis and enhancement of operation efficiency of directional producer wells (1988) /Ed. Mirzadzhanzade, A. Kh. *Baku.*

23. Mirzadzhanzade, A. Kh., Aliev, N. A., Yusifzade, H. B., et al. (1997). Offshore development fragments. *Baku: Elm Publishing House.*

24. Gigiberiya, G. (1956). Hydraulics problems on entrapped air pockets. *Transactions of Institute of Energy, Academy of Sciences of Georgia SSR,* 10.

25. Galyamov, A. G. (1966). Experimental investigations of the two-phase flow resistance in a non-horizontal pipeline. *Oil Industry,* 4, 62-65.

26. Galyamov, A. G., Shammasov, A. M., Sakharova, L. Kh., et al. (1978). The application of a self-organizing model for the hydraulic calculation of gas-liquid flows in pipes. Izvestiya vuzov. *«Oil and Gas»,* 5, 65-67.

27. Teletov, S. G. (1958). Problem of fluid dynamics of two-phase mixtures. Bulletin of Moscow University, 2.

28. Poladov, A. R. (1985). Device for operating of gas lift wells. *Patent SU*1191561.

29. Frangel, I. V., Sivokhina, N. B., Bronzov, A. S. (1968). Allowable wellbore deviation. Moscow: Gostoptekhizdat.

30. Brown, K. E. (1977). The technology of artificial lift methods. Vol. 1. *USA: PPS Tulsa.*

31. Mamaev, V. A., Odisharia, G. E., Semenov, N. I., et al. (1969). Hydrodynamics of liquid-gas mixtures in pipes. *Moscow: Nedra.*

32. Zaitsev, Y. V., Maksutov, R. A., Chubanov, O. V., et al. (1987). Theory and practice of gas lift. *Moscow: Nedra.*

33. Charney, I. A. (1996). The effect of topography and fixed inclusions of liquid or gas to pipeline capacity. *Oil Industry,* 6, 15-20.

Новый подход к расчету двухфазного потока в газлифтных скважинах

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Реферат

В статье на основе проведенных в горизонтальных газлифтных скважинах исследований и расчетов рассматривается метод регулирования силфонных клапанов на расчетное давление и приводится методика определения размещения газлифтных клапанов в насосно-компрессорных трубах. В результате расчетов было предложено принять давление открытия первого газлифтного клапана равным давлению впуска газа, а давление открытия последующих клапанов на 0.05-0.175 МПа меньше, чем у предыдущих газлифтных клапанов, а разность давлений между последним клапаном и предыдущим клапаном равным 0.28-0.35 МПа.

Ключевые слова: газлифтный клапан; вертикальные и горизонтальные газлифтные скважины; давление; градиент давления; расход газа; газо-жидкостная смесь; насосно-компрессорные трубы; угол наклона.

Qazlift quyularında maye-qaz qarışığının axınının hesablanmasına yeni yanaşma

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Xülasə

Məqalədə maili quyularda aparılmış tədqiqatlar və hesablamalar əsasında maili qazlift quyularında silfonlu qazlift klapanlarının hesablanmış təzyiqinə tənzimlənməsi üsulu işləmiş və qazlift klapanlarının qaldırıcı borular boyu yerinin təyini metodikası verilmişdir. Hesablamalar nəticəsində birinci qazlift klapanının açılma təzyiqi qazın işəburaxma təzyiqinə bərabər götürülərək, sonrakı klapanların açılma təzyiqi əvvəlki qazlift klapanlarından 0.05-0.175 MPa kiçik, sonuncu klapanla ondan əvvəlki klapan arasında təzyiq fərqi 0.28-0.35 MPa götürülməsi təklif olunmuşdur.

Açar sözlər: qazlift klapanı; şaquli və maili qazlift quyuları; təzyiq; təzyiq qradienti; xüsusi qaz sərfi; maye-qaz qarışığı; nasos kompressor boruları; meyl bucağı.