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Improving the efficiency of production wells at the final stage of gas field development

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Abstract

Purpose is to improve the efficiency of extraction of remaining hydrocarbons within the oil and gas fields at the final stage of their development while optimizing operational conditions of the production wells.

Methods. Software package PipeSim by Schlumberger has been applied to improve the efficiency of the current well stock under the conditions complicated by liquid accumulation within a bottomhole. A hypothetic well has been used.

Findings. The basic operational parameters of a production well have been calculated for different values of water coefficient (i.e. 50; 100; 150; 200; 250; 300; 350; 400 and 450 l/th.m^3). The research has helped identify that increase in the water coefficient results in the increased rate of liquid as well as decreased gas rate. A nodal analysis method has been applied to identify the following: at the level of 450 l/th.m^3, a production well stops flowing. The results of the studies support the idea that to activate a well efficiency at the level of 18 th.m^3/day, it is required either to replace 62.0 tubing string with 50.3 mm one or reduce wellhead pressure from 10.16 down to 9.88 MPa or develop gas lift injection at the level of 1.9 th.m^3/day. In addition, the results give the evidence of engineering efficiency as for the method implementation. However, expediency of the application depends upon the processing limits of industrial facilities as well as upon the ratio between the water-free and wet deposit areas.

Originality. The correlation dependencies have been determined to forecast operational indices of highly watered wells. The research results help substantiate promptly the methods intensifying hydrocarbon output depending upon different types of geological and engineering limitations.

Practical implications. Implementation of the results will help optimize operation of production wells under active edge and bottom water inflow into the productive pools and increase their hydrocarbon extraction respectively.

Keywords: *field, deposit, well, water drive, water influx, accumulation of liquid, gas lift, increase in hydrocarbon extraction*

1. Introduction

To some extent, the majority of natural gas field in Ukraine are exhausted passing normally to the final mining stage. The stage demonstrates selective inundation of productive deposits which complicates operation of production wells due to liquid accumulation within a wellhead when velocity of gas-liquid flow is lower than critical one [1]-[3].

Under the conditions of the water drive, inundation of gas as well as gas condensate fields results in the drop of gas-saturated share of productive section stipulating loss of production well efficiency [4], [5]. As a result, a need arises to perform large-scale activities to restrict local water inflow, and use different procedures dewatering bottomholes of production wells [6].

Generally, natural gas fields are characterized by complex geological structure and inhomogeneous nature of productive formation in terms of its area and thickness [7]. Industrial practices of hydrocarbon reservoirs point to the fact that selective inundation of productive deposits takes place within highly permeable layers and interlayers [8], [9].

As a rule, operations as for the water shutoff are far from being efficient. Useful shutoff activities should involve knowledge of nature, reasons, and regularities of water inflow into productive pools and production wells. The abovementioned helps control efficiently the inundation nature of productive gas saturated layers as well as production wells [10]. Foaming surfactants [11], optimization of wellhead pressure, lifting etc. [12]-[14] are applied to remove gas-liquid mixture from the bottomholes of gas wells and gas condensate wells.

A number of methods and inventions, widely used by gas industry, are applied for operation of production wells under intensive edge and bottom water inflow into productive pools [5], [15]-[18]. Authors of invention [19] have proposed to produce gas by means of periodic removal of gas-liquid mixture from a bottomhole using a gas ejector.

Such well-known researchers as L.S. Chugunov, A.I. Berezniakov, and V.I. Shadrin [20] come up with the idea of continuation of productive well operation while gas controlling within a wellhead by means of choke valves. However, the technique is less than effective if two or more wells operate in

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one pipeline since their technological parameters differ. As a result of pressure redistribution, a flow slows down stipulating liquid accumulation within the well bottomholes.

Intensification of gas influx to a well bottomhole is also practised while low-pressure gas ejecting by means of high pressure gas [21]. Low efficiency and gas temperature drop behind the ejector, resulting in hydrating, are disadvantages of the technique. Nevertheless, the device helps increase gas output, and decrease gas losses while blowing.

Basing upon experiments, I.L. Konovalov and colleagues [22] made an invention for the automated support of boundary waterless rate of a well penetrated a seam with bottom water. The proposed system supports the specified boundary allowable bottom water cone by means of changes in the gas rate.

Mainly, seam anisotropy as well as rate of gas withdrawal determines the velocity of water cone formation and bottom water breakthrough into a gas well bottomhole. It is recommended for wells, penetrating seams with bottom water, to be operated while supporting the boundary waterless rate. In the context of such cases, it is expedient not to penetrate lower 15-20 meters of gas saturated seam, i.e. develop deliberately inadequacy of wells in terms of the seam penetration degree [23].

Authors of papers [14], [24] have proposed a method of automated well blowing. Its idea is as follows: periodically, liquid rises from a bottomhole owing to the automated system to control consumption (ASCC). The technique has been successfully applied by Orenburg GF for gas lift automation.

Leading world companies analyze problems of low pressure well operation and generate innovative procedures intensifying hydrocarbon extraction to redevelop exhausted watered fields. The best practices of the top experts are adopted actively and produce good results [25].

To control inundation of productive deposits and production wells, common equations and dependencies are used making it possible to evaluate the bottomhole zone condition as well as the condition to bring bottomhole liquid to the surface. Domestic practice uses an idea of critical velocity characterizing gas velocity when liquid phase particles and solids are suspended. Minimum required velocity of a gas-liquid mixture at the tubing shoe inlet should not be less than 5 m/s [26], [27].

Common methods of liquid lifting and control of a productive deposit inundation are not efficient. Hence, it is required to upgrade the available ones and create new procedures to develop the exhausted oil and gas fields at the final stage.

Numerous studies show that more complete coverage of the gas-saturated area to be developed, it would be desirable to prevent formation water movement into the reservoirs. However, the problem has not been solved yet [28].

The problem how to avoid formation water getting into productive pools as well as operation of the water wells within Ukrainian deposits becomes more and more urgent. Its solving is one of the tendencies to provide energy independence of the state.

The purpose of the study is the improved efficiency of oil and gas field development at its final stage under heavy water content of the product being developed and the increased ultimate factors of hydrocarbon production.

End of the purpose should involve accomplishment of the tasks:

1. Systemization of the available procedures optimizing operation of oil and gas wells under different geological and engineering conditions.

2. Improvement of the developed methods forecasting the efficiency of oil and gas wells in terms of high water factors to take quick decisions.

2. Research methods

To intensify further the development of the exhausted natural gas deposits at its final stage, complicated by edge and bottom water inflow into productive pools, the available techniques and methods for hydrocarbon extraction have been systemized; their efficiency for different geological and engineering conditions have been studied.

Recovery of the well efficiency needs providing conditions under which gas-liquid mixture will be removed from a bottomhole to the surface, i.e. generating the required velocity of upwardly moving gas flow at the tubing shoe inlet. The abovementioned may result from pressure drop within a wellhead; replacement for smaller diameter tubing; and well transfer to a gas-lift way of operating.

While using PipeSim software by Schlumberger Company, calculations were performed for a hypothetic gas condensate well with following parameters: 3870 m depth; 3700 m tubing lowering; 62 mm tubing diameter; 19.7 MPa current reservoir pressure; 10.16 MPa wellhead pressure; 354 K reservoir temperature; 45 th.m^3/day natural gas rate; 0.64 kg/m^3 gas density; and 1024 kg/m^3 water density.

Figure 1 demonstrates standard design of a gas well where gaslift valve is at 3500 m depth.

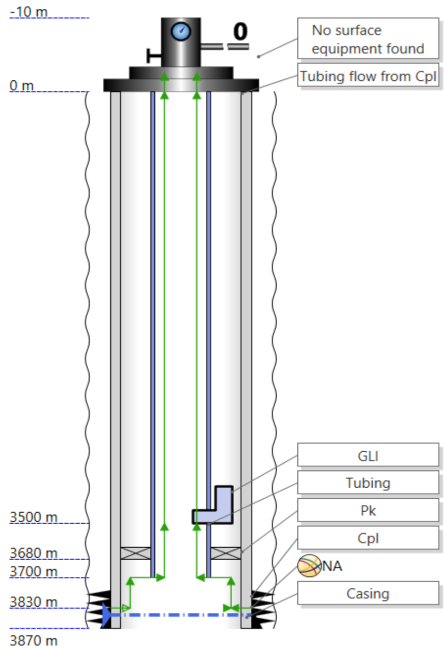

Figure 1. Standard design of a gas well where a gaslift valve is at the depth of 3500 m

Operational parameters of a production well have been defined for the following geological and technological environment:

– 62; 50.3; 40.89; 35.05; and 26.4 mm tubing diameters at the specified level of a water factor being 450 l/th.m^3;

– 5; 6; 7; 8; 9; and 10 MPa for wellhead pressure in terms of the specified level of a water factor being 450 l/th.m^3;

– for wellhead pressure at the level of the specified water factor being 450 l/th.m^3;

– for a gaslift method of a well operational if a gaslift valve is at 3500 m depth.

Analysis of the mechanized production of natural gas involved two stages. Stage one studied minimum consumption of the gaslift gas (i.e. 0.2; 0.4; 0.6; 0.8; 1.0; 1.2; 1.4; 1.6; 1.8; and 2.0 th.m^3/day) required for a well to start operating. Stage two studied different ranges (maximum ones) of the gaslift gas consumption, in terms of which the greatest gas rates were achieved (i.e. 25; 50; 100; 125; 150; 200; 225; 250; 275; 300; and 325 th.m^3/day), and different values of a water factor (i.e. 450; 500; 600; 700; 800; 900; and 1000 l/th.m^3).

3. Results and discussion

A nodal analysis method has been applied to study conditions of the production well flowing for such water factors as 50; 100; 150; 200; 250; 300; 350; 400; and 450 l/th.m^3. The study has helped define that a production well operates consistently until the water factor achieves 450 l/th.m^3. If water content within the well production exceeds the specified value then flowing well operation terminates.

The calculation results testify that the water factor increase brings about liquid rate growth, and gas rate drop, respectively. Figure 2 demonstrates dependencies of liquid and gas rates upon different water factor values.

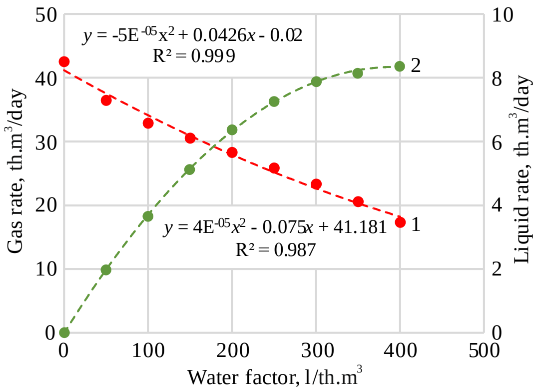

Figure 2. Dependencies of gas (1) and liquid (2) rates upon different water factor values

The research results have helped define that in terms of a water factor, dependencies of gas and liquid rates are described by means of regression equations with 0.987-0.9998 correlation coefficient. If a water factor is 450 l/th.m^3 then the well efficiency recovery is possible when wellhead pressure drops. In turn, it stipulates increase in pressure drawdown as well as provision of liquid movement to the surface. Figure 3 explains depen-dencies of gas and liquid rates upon different wellhead pressure if a water factor is 450 l/th.m^3.

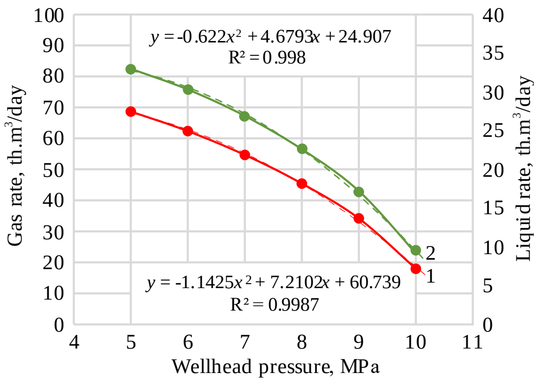

Figure 3. Dependencies of gas (1) and liquid (2) rates upon different wellhead values if a water factor is 450 l/th.m^3

Analysis of a dependence, shown in Figure 3, has made it possible to define that under similar conditions, 10 MPa down to 5 MPa wellhead pressure drop results in 17.95 th.m^3/day up to 68.68 th.m^3/day increase of a gas rate; and liquid rate increase is 9.15 th.m^3/day up to 33 th.m^3/day. The results of the studies demonstrate high technological efficiency as for the wellhead optimization in terms of production wells. Nevertheless, the method implementation at the final stage of gas field development has numerous engineering limitations preventing from the wellhead pressure drop due to the necessity to treat the produced gas, and support its conditions in accordance with the industrial specifications.

Decrease in tubing diameter is the promising procedure to recover efficiency of highly watered wells. Figure 4 represents the findings concerning optimization of tubing diameter in the form of dependencies of gas and liquid rates upon different values of tubing diameter if a water factor is 450 l/th.m^3.

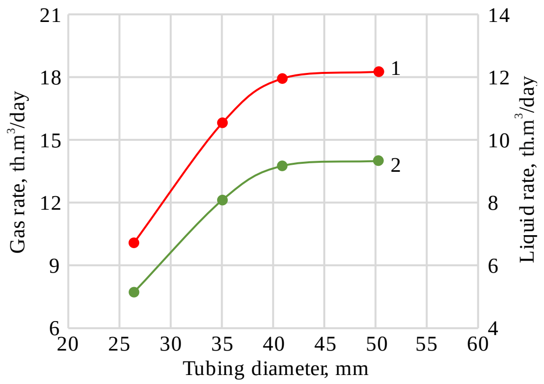

Figure 4. Dependencies of gas (1) and liquid (2) dependencies upon different values of tubing diameter if a water factor is 450 l th.m^3

The analysis of dependence of gas and liquid rates upon different values of tubing diameter has helped understand that 50.3 mm down to 26.4 mm decrease of tubing diameter factors into 18.26 th.m^3/day down to 10.08 th.m^3/day reduction of gas rate as well as 9.33 th.m^3/day down to 5.15 th.m^3/day liquid rate.

The calculations have helped identify that if a water factor is 450 l/th.m^3 then 50.3 mm should be the maximum tubing diameter value in terms of which the well will operate. The research results speak for technological efficiency of the procedure optimizing operation conditions of production wells in the context of high water factors.

Figure 5 shows the results of stage one of the studies concerning the efficiency of gaslift operation of highly watered wells. The results are represented in the form of bottomhole pressure and gas rate dependencies upon the gaslift gas consumption.

The calculation results support the idea that the increase in gaslift gas consumption factors into the decreased bottomhole pressure; however, actual rate of natural gas grows up. The findings show that 0.2 up to 2 th.m^3/day increase of gaslift gas flow results in 13.21 up to 17.95 th.m^3 of a gas rate/day; in this context, liquid rate experiences 7.86 up to 10.68 th.m^3/day growth.

Moreover, it has been defined that sustainable operation of a wet well (if a water factor is 450 l/th.m^3) can be provided owing to 0.2 th.m^3 of gaslift gas/day and one gaslift valve mounted at 3500 m depth.

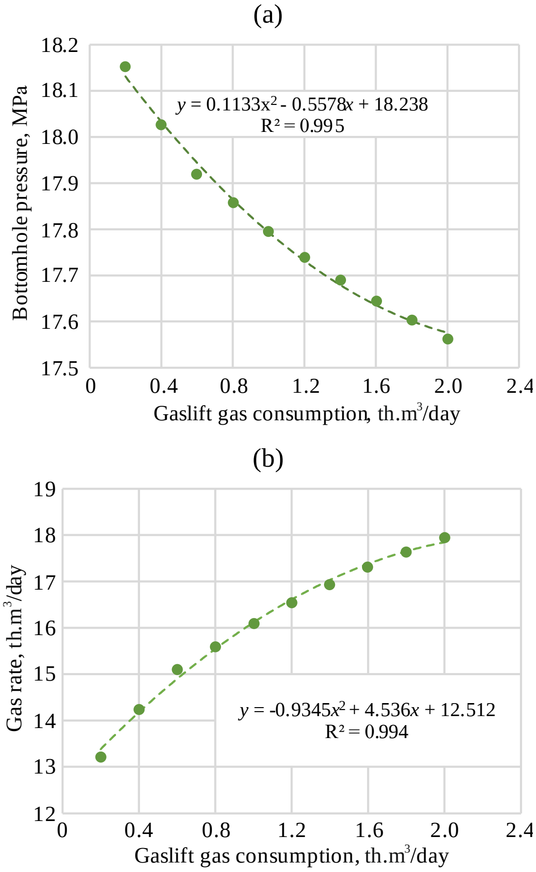

Figure 5. Dependencies of bottomhole pressure (a) and gas rate (b) upon the gaslift gas consumption in terms of 450 l/th.m³ water factor (for stage one of the research)

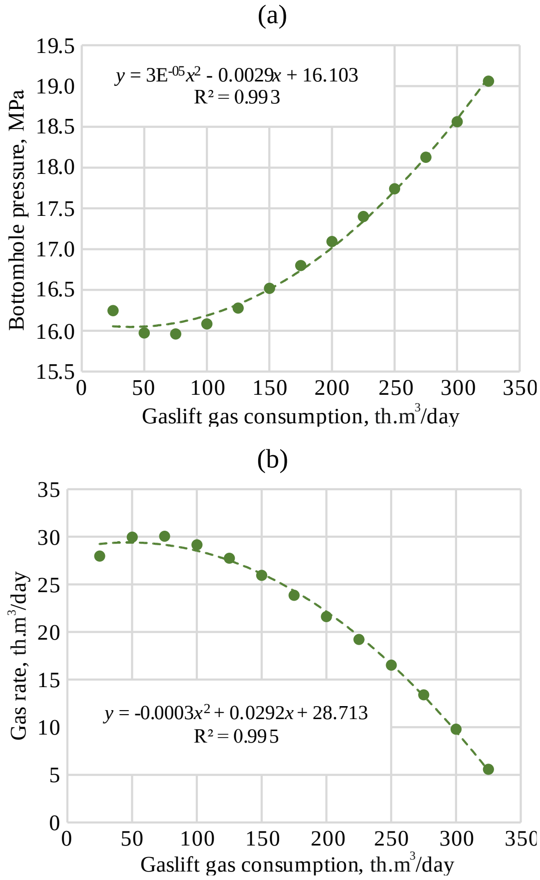

Figure 6. Dependencies of bottomhole pressure (a) and gas rate (b) upon the gaslift gas consumption in terms of 450 l/th.m³ water factor for stage two of the research

The studies have helped derive dependencies of bottomhole pressure and gas rate upon the gaslift gas consumption; the dependencies are described with the help of regression equations. The correspondences make it possible to assess values of bottomhole pressure and reservoir gas rate in terms of different minimum amounts of the gaslift gas consumption.

Figure 6 demonstrates dependencies of bottomhole pressure and gas rate upon the gaslift gas consumption for stage two of the research.

The calculations have helped conclude that maximum gaslift gas consumption for the analyzed geological and technological environment is 325 th.m^3/day in terms of 450 l/th.m^3 water factor. If the value is exceeded then a well will not operate since the bottomhole pressure is quite higher than the reservoir pressure.

Analysis of the dependencies, shown in Figure 6 speaks for the idea that increase in the gaslift gas consumption first results in gas rate growth, achieveing its peak value, and starts decreasing. Reverse situation is observed as for the bottomhole pressure. Dependencies of the bottomhole pressure and gas rate upon the gaslift gas consumption are described by means of quadratic equations with 0.993-0.995 correlation coefficients.

Equations of dependencies in Figure 6 make it possible to identify both maximum value of reservoir gas rate and minimum value of bottomhole pressure in terms of the specified gaslift gas consumption. Hence, in this context, maximum gas rate is 30.06 th.m^3/day and minimum bottomhole pressure is 17.828 MPa if the gaslift gas consumption is 48.7 th.m^3/day.

The results of the studies, concerning gaslift gas use for different water factor values speak for the idea that reservoir gas rate decreases if a water factor increases; reverse situation is observed with the liquid rate. Figure 7 demonstrates dependencies of the liquid and gas rates upon the gaslift consumption for different water factor values.

Dependencies in Figure 7 are described with the help of quadratic equations which solution helps assess optimum value of the gaslift gas consumption for each amount of a water factor where it is possible to obtain both maximum value of reservoir gas rate and minimum value of bottomhole pressure.

Figure 8 demonstrates dependence of the optimum gaslift gas consumption upon a water factor.

Dependence in Figure 8 makes it possible to assess the predicted values of the gaslift gas consumption in terms of any water factor values.

Quadratic Equiation 1 has been derived according to the research results:

$$q_{g.l.} = -0.00004F_w^2 + 0.1625F_w - 17.154. \quad (1)$$

Equation 1 helps define optimum gaslift gas consumption for different water factor values in terms of which it is possible to achieve peak values of the reservoir gas rates.

A promising tendency of future research to improve the efficiency of reasonable hydrocarbon resources while using the available well stock at the final development stage is upgrading of the current methods of machine mining; among other things, it concerns gaslift applying electric centrifugal pumps. Currently, hydrocarbon fields, considered as the key ones in terms of extraction and remaining reserves, are associated with the Dnieper-Donets Depression.

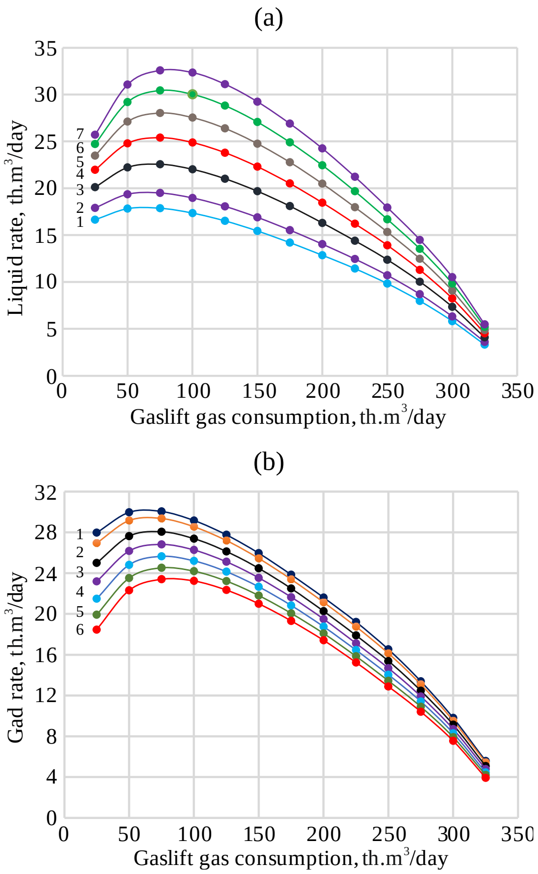

Figure 7. Dependencies of liquid (a) and gas (b) rates upon the gaslift gas consumption for different water factor values: 1 – 450; 2 – 500; 3 – 600; 4 – 700; 5 – 800; 6 – 900; 7 – 1000 l/th.m³

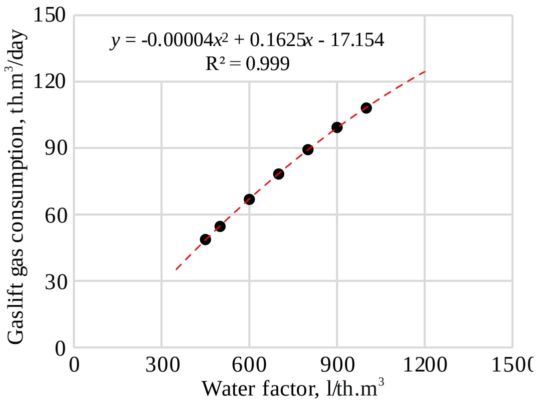

Figure 8. Dependence of the optimum gaslift gas consumption upon a water factor

They are characterized by complex geological structure, deep productive pools, and abnormal reservoir pressure and temperature. The abovementioned supports the idea that popular global procedures for oil and gas production cannot be applied within the majority of Ukrainian deposits. That is why a need arises to do additional studies with the use of the basic digital modelling tools in light of the global practices of hydrocarbon field design to adapt the world procedures to the geological conditions of oil and gas fields within the Dnieper-Donets Depression.

4. Conclusions

Critical analysis of numerous experiments and theoretical studies have been involved to systemize various procedures and methods intensifying hydrocarbon extraction at its final stage under the conditions complicated by edge and bottom water inflow into gas-saturated levels.

The research, carried out using PipeSim software by Schlumberger Company, has helped define that various techniques may be applied to improve the production well efficiency under liquid accumulation within a bottomhole. However, gaslift turned out to be both multifunctional and and efficient method.

The findings point to the fact that increase in the gaslift gas consumption first results in gas rate growth, achieveing its peak value, and starts decreasing. Reverse situation is observed as for the bottomhole pressure. The results of the simulation have helped understand that maximum consumption of gaslift gas is 325 th.m³/day under the analyzed geological and technological conditions, and if a water factor is 450 l/th.m³. If the injected gaslift gas consumption exceeds the specified value then a well will not operate since the bottomhole pressure is quite higher than the reservoir pressure.

A statistical analysis of the analytical data has helped identify optimum values of the gaslift gas consumption for different water factor values in terms of which maximum efficiency of wells is achieved as well as minimum amounts of bottomhole pressure.

The research has made it possible to derive the correlation dependence to forecast efficiency of highly watered wells.

The dependence provides a way to make prompt decisions while selecting the operating schedules for highly watered gas wells as well as gas-condensate ones depending upon their geological and technological conditions.

Broadly speaking, implementation of the system to optimize oil and gas field development will help improve final hydrocarbon extraction and go global in the solution of this problem.

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References

[1] Kondrat, R.M., & Khaidarova, L.I. (2017). Enhanced gas recovery from depleted gas fields with residual natural gas displacement by nitrogen. *Naukovyi Visnyk Natsionalnoho Hirnychoho Universytetu*, (5), 23-29.

[2] Matkivskyi, S., & Kondrat, O. (2021). The influence of nitrogen injection duration at the initial gas-water contact on the gas recovery factor. *Eastern-European Journal of Enterprise Technologies*, *1*(6(109)), 77-84. https://doi.org/10.15587/1729-4061.2021.224244

[3] Burachok, O., Kondrat, O., Matkivskii, S., & Khaidarova, L. (2020). Application of CEOR optimization method for gas-condensate reservoir below dew-point: Synthetic case study. *Oil Gas European Magazine*, *46*(IV), 41-49. https://doi.org/10.19225/201209

[4] Doroshenko, V.M., Yeger, D.O., Zarubin, Y.O., & Kondrat, R.M. (2007). Directions for solving problems of development of depleted oil and gas fields. *Exploration and Development of Oil and Gas Fields*, (4), 108-110.

[5] Ancell, K.L., & Trousil, P.M. (1990). Remobilization of natural gas trapped by encroaching water. *Proceedings of the 65th Annual Technical Conference and Exhibition of Society of Petroleum Engineers held in New Orleans, Louisiana*, 375-381. https://doi.org/10.2118/20753-MS

[6] Boyko, V.S., Boyko, R.V., Keba, L.M., & Seminskyi, O.V. (2006). *Flooding of gas and oil wells*. Kyiv, Ukraine: International Economic Foundation, 791 p.

[7] Romi, A., Burachok, O., Nistor, M.L., Spyrou, C., Seilov, Y., Djuraev, O., Matkivskyi, S., Grytsai, D., Goryacheva, O., & Soyma, R. (2019). Advantage of stochastic facies distribution modeling for history matching of multi-stacked highly-heterogeneous field of Dnieper-Donetsk Basin.

Petroleum Geostatistics, (2019), 1-5. https://doi.org/10.3997/2214-4609.201902188

[8] Matkivskyi, S., & Kondrat, O. (2021). Studying the influence of the carbon dioxide injection period duration on the gas recovery factor during the gas condensate fields development under water drive. *Mining of Mineral Deposits*, *15*(2), 95-101. https://doi.org/10.33271/mining15.02.095

[9] Kondrat, R.M., & Kondrat, O.R. (2017). Improving the efficiency of further development of depleted natural gas fields. *Oil and Gas Industry of Ukraine*, (3), 15-20.

[10] Matkivskyi, S., Kondrat, O., & Burachok, O. (2020). Investigation of the influence of the carbon dioxide (CO_2) injection rate on the activity of the water pressure system during gas condensate fields development. *Global Trends, Challenges and Horizons*, 1-10. https://doi.org/10.1051/e3sconf/202123001011

[11] Rauf, O., Gerdes, N., & Lummer, R. (2013). Foam and scale inhibitor squeeze with natural gas: A lifeline for water flooded and damaged gas well. *SPE European Formation Damage Conference & Exhibition*. https://doi.org/10.2118/165098-MS

[12] Zaikin, K.M. (2012). Technology of operation of flooded gas condensate wells of Orenburg OGCF and recommendations for elimination of flood consequences. *Gas Industry*, (4), 35-39.

[13] Lee, J., Nickens, G., & Wells, M. (2008). *Operation of flooded gas wells*. Moscow, Russian Federation: LLC "Premium Engineering", 384 p.

[14] Kapusta, E., Rymarenko, K., Nukhaev, M., Grishenko, S., Aitkaliev, G., Minin, D., Kabanov, V., Galkin, D., Karamysheva, T., Ulyanov, V., & Dadakin, N. (2019). Complex approach for gas lift wells optimization for Orenburgskoe field. *SPE Russian Petroleum Technology Conference*. https://doi.org/10.2118/196818-MS

[15] Long, L.C. (1963). Experimental research on gas saturation behind the water front in gas reservoirs subjected to water drive. *Proceedings of the 6th World Petroleum Congress*, 483-498.

[16] Calgle, T.O. (1990). Performance of secondary gas recovery operations: North Alazan H-21 Reservoir. *Proceedings of the 65th Annual Technical Conference and Exhibition of Society of Petroleum Engineers held in New Orleans, Louisiana*, 508-513. https://doi.org/10.2118/20771-MS

[17] Hower, T.L., Bcrgeson, I.E., Lewis, D.R., & Owens, R.W. (1992). Recovery optimization in a multi-reservoir offshore gas field with water influx. *Proceedings of the 65th Annual Technical Conference and Exhibition of the Society of Petroleum Engineers held in Washington*, 9-15. https://doi.org/10.2118/24865-MS

[18] Matthew, J.D., Hawes, R.I., & Lock, T.P. (1988). Feasibility studies of water flooding gas condensate reservoir. *Journal of Petroleum Technology*, *40*(08), 1049-1056. https://doi.org/10.2118/15875-PA

[19] *Method for removing liquid from gas wells and loops*. (1994). Patent #2017941, Russian Federation.

[20] *Method for operation of cluster gas wells and ejection device for its implementation*. (1998). Patent #2110673, Russian Federation.

[21] Fedorov, A.E., Verbitsky, V.S., & Goridko, K.A. (2016). Experimental studies and analysis of gas-jet device's operation characteristics for oil and gas production in abnormal operating conditions. *Technology Conference and Exhibition*. https://doi.org/10.2118/181956-MS

[22] *A system for automatic control of the flow rate of a gas well that has penetrated a layer with bottom water*. (2007). Patent #2305769, Russian Federation.

[23] Ekeregbe, M.P. (2021). Model prediction of critical gas rate with water-cut reversal effect. *International Conference and Exhibition held in Lagos, Nigeria*. https://doi.org/10.2118/208257-MS

[24] Ulyanov, V., Kuchurin, A., Kibirev, E., Gryzunov, A., Bak, V., Rymarenko, K., Nukhaev, M., & Dadakin, N. (2018). Implementation of the intellectual gas control system for gas lift optimization at Orenburgskoe oil field. *Technology Conference*. https://doi.org/10.2118/191533-18RPTC-MS

[25] *Method for additional development of waterfowl deposits with low-pressure gas reserves*. (2006). Patent #2594496, Russian Federation.

[26] Lea, J.F., Nickens, H.V., & Wells, M.R. (2008). *Gas well deliquification*. New York, United States: Elsevier, 608 p.

[27] Vyakhirev, R.I., Korotaev, Yu.P., & Kabanov, N.I. (1998). *Theory and experience of gas production*. Moscow, Russian Federation: Nedra, 479 p.

[28] Akindele, F., & Tiab, D. (1982). Enhanced gas recovery from water-drive reservoirs – methods and economics, University of Oklahoma. *Proceedings of the 57th Annual Fall Technical Conference and Exhibition of Society of Petroleum Engineers, New Orleans*. https://doi.org/10.2118/11104-MS

Підвищення продуктивності видобувних свердловин на завершальній стадії розробки родовищ природних газів

Р. Кондрат, Л. Матіїшин

Мета. Підвищення ефективності вилучення залишкових запасів вуглеводнів нафтогазових родовищ на завершальній стадії розробки шляхом оптимізації умов експлуатації видобувних свердловин.

Методика. Для підвищення ефективності використання діючого фонду свердловин в умовах, що ускладнюються накопиченням рідини на вибої, використано програмний комплекс PipeSim компанії Schlumberger на прикладі гіпотетичної свердловини.

Результати. Розрахунки основних технологічних параметрів експлуатації видобувної свердловини проведено для різних значень водного фактору (50; 100; 150; 200; 250; 300; 350; 400; 450 л/тис. м^3). За результатами проведених досліджень встановлено, що із збільшенням водного фактору зростає дебіт рідини та зменшується дебіт газу. На основі методу вузлового аналізу встановлено, що за водного фактору на рівні 450 л/тис. м^3 видобувна свердловина припиняє фонтанування. Результати проведених досліджень свідчать, що для відновлення продуктивності свердловини на рівні 18 тис.м^3/добу потрібно замінити колону НКТ з діаметру 62.0 на 50.3 мм, або знизити гирловий тиск з 10.16 до 9.88 МПа або забезпечити нагнітання газліфтного газу з витратою на рівні 1.9 тис.м^3/добу. Результати проведених досліджень свідчать про технологічну ефективність впровадження досліджуваних методів, однак доцільність їх впровадження залежить від технологічних обмежень промислового обладнання та співвідношення необводненої та обводненої площі родовища.

Наукова новизна. Виявлено кореляційні залежності для прогнозування показників експлуатації високообводнених свердловин. Результати досліджень дозволяють оперативно обґрунтувати оптимальні методи інтенсифікації видобутку вуглеводнів залежно від різного роду геолого-технологічних обмежень.

Практична значимість. Використання результатів проведених досліджень дозволить оптимізувати експлуатацію видобувних свердловин в умовах активного надходження законтурних та підошовних вод у продуктивні поклади та, відповідно, підвищити їх вуглеводневилучення.

Ключові слова: *родовище, поклад, свердловина, водонапірний режим, обводнення, накопичення рідини, газліфт, підвищення вуглеводневилучення*