KPU International Journal of Engineering & Technology
Volume 2, Issue2, Dec. 2022
e-ISSN:2790-0819, p-ISSN:2790-0800

Date Received: 2022-10-06
Date Accepted: 2022-12-19
Date Published: 2022-12-30

Determination of A Suitable Operating Method For Gas Wells From Jurassic Reservoir Rocks in The Khwaja Gogerdak Gas Field, Northern Afghanistan

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Abstract

The technological gas exploitation regime (method) from the wells is the determination of an appropriate flow rate for gas wells considering the physical and mechanical properties of reservoir rocks and formation pressure, which can provide normal gas exploitation during well operation. The purpose of this scientific research is to determine an appropriate gas exploitation method for enhancing wells flow. By considering the proposed regime and method in the field, we will be able to predict and stop various problems. These problems include the formation of water and water penetration into the wells, confinement of the gas within the formation, factors that may damage the production intervals and rapid reduction of the formation pressure. Finally, determining and choosing an appropriate gas exploitation method can help us to increase the rate of gas flow and extend the life of the well. This scientific-research is combined of field and library work based on the figures measured in the head and bottom of well No. 3. The measured figures and information collected from this well are: daily gas production, amount of formation, well head pressure and well bottom pressure, Parameters and characteristics of the productive formation, like the gas compression capability coefficient, the filtration resistance coefficient and the permeability coefficient have been determined using formulas and graphs, both analytically and graphically. The question is: Which exploitation regime (method) should we use to minimize the exploitation problems and enhance the amount of gas production? In this article, the problems with the gas exploitation process are well identified and reasonable solutions are proposed. As a result, without determining an appropriate technological exploitation regime, it is not possible to produce gas properly from the wells.

Keywords: Suitable gas exploitation regime, daily discharge, well testing, reservoir rocks, gas mine.

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1. Introduction

To extract gas from mines, it is necessary to determine a suitable technological regime for the exploitation of gas. If a suitable operating regime is not selected, the operating process will face serious problems such as the destruction of the area around the bottom of the well (productive interval), formation of sand barriers, accumulation of water on the bottom of wells, rusting of production equipment, formation of water tabs (uneven progression of the gas contour), entrapment of gas in reservoir rocks, etc.

To avoid the problems mentioned previously during the process of exploiting Jurassic reservoir rocks, we must determine an appropriate exploitation regime for well No. 3 and all other wells drilled in the Khwaja Gogerdak Gas Field. Hydrodynamic testing has incredible scientific and economic value. We can select a suitable technological gas exploitation regime by analyzing, interpreting test results, and obtaining various productive layer parameters.

The main purpose of this research paper is to determine the maximum permissible and favorable gas flow rate from the Jurassic formation of the Khwaja Gogerdak Gas field based on the formation pressure, the pressures at the head and bottom of the well, and well discharges under different operating regimes.

Furthermore, parameters such as porosity, permeability, saturation, and thickness of the gaseous layers are determined with the help of field studies, comprehensive calculations, and analyses using formulas, graphs, figures, and tables. Finally, the necessary parameters are arranged, and appropriate technological gas exploitation regimes are chosen for the exploitation of gas from wells.

In this study, we are focusing on the following point.

1. Determination of an appropriate technological gas exploitation regime (method) for wells.
2. Identification of important parameters of production formation (porosity, permeability, formation pressure, etc.)
3. Determination of an appropriate operating regime for gas production to maximize the allowable flow rate (discharge rate) of wells.
4. Evaluation of the productivity of wells and associated fluids.

2. The structure map of the Jurassic

The structure of the Khwaja Gogerdak Mines field is located in the north part of Afghanistan, 23 kilometers east of the city of Sheberghan, Jawzjan, Afghanistan. This is one of the most gas-rich parts of northern Afghanistan. In the Khwaja Gogerdak Gas Mining field, gas reservoirs are proven in upper Jurassic limestones, dolomite, sandstones, and, to some extent, Cretaceous calcareous sediments. Gas production started from this mine with the cooperation of the Soviet Union in October 1967 (2.6 billion cubic meters per year). Until now, most of the gas reserves have been depleted from the Getrif, Albian, and Aptian reservoirs in the Khwaja Gogerdak gas field. The extracted gas

was then transported by pipeline to the former Soviet Union and Mazar-e-Sharif fertilizing and the electric planet. Currently, gas is depleted from the Getrif sediments of the Khwaja Gorgerdak Mining field. However, the reserve of Jurassic sediments, which amounts to about 10.6 billion cubic meters, is still intact and has been completely opened by wells No. 3, 41, and 43. In this mining field, no gas has been extracted from the Upper Jurassic mine, because of its location at a greater depth and the sourness of its gas (containing hydrogen sulfide). Preventing future exploitation problems requires determining optimal exploitation regimes and maximum allowable flow rates from these wells.

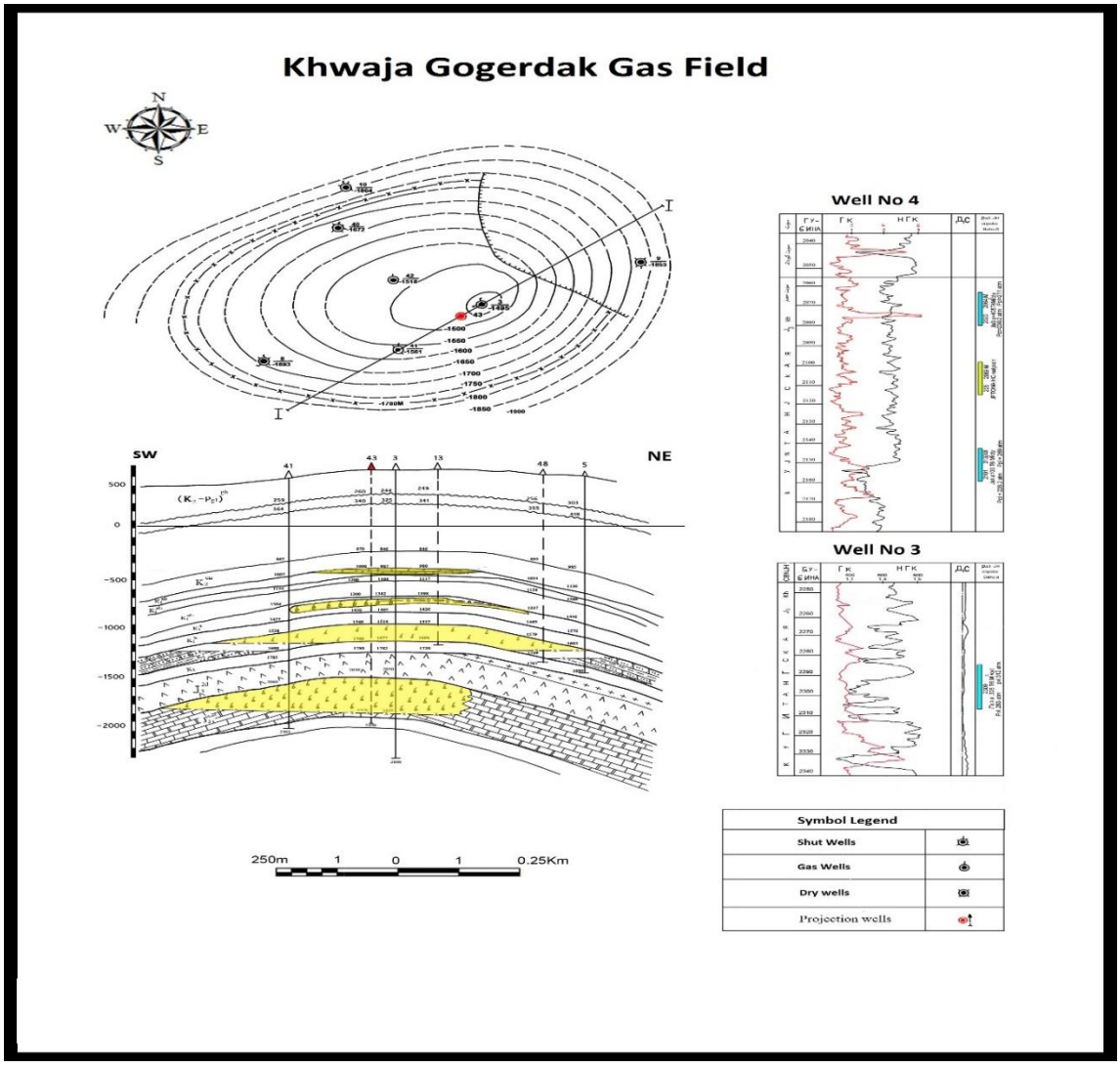


Figure 1: The structural map of the Khwaja Gogerdak gas field

Well No.3

Well, No.3 is drilled on the top of the anticline for evaluation and exploitation of the Khwaja Gogerdak gas field. The depth of the well is 2800 m.

The characteristics of the well according to the basic information Measured in the field:

- The average depth of wells — L_{av} = 2309m
- Relative density of gas — $\bar{\rho}$ = 0,66
- Stratum heat — $T_{lay} = 368k^{\circ}$
- Stratum pressure — P_{lay} = 318 atm
- The diameter of exploitation column — D = 127mm
- The thickness of the productive layer — h = 51m
- Gas viscosity — μ= 0,02CPz
- Feed meter radius — $2\delta = 750, Rk = \frac{750}{2} = 375m$
- Depression — ΔP=54at

3. Methodology

The current research was done through both library-based methods and field surveys. The first part was performed by reviewing the existing literature, but the second part was carried out with a distributed questionnaire along the studied route.

The data used in this research paper are collected from wells during gas production and other scientific research reports from the Jawzjan Hydrocarbon Survey Directorate and the Afghan Gas Directorate. Subsequently, information and field data were analyzed and evaluated by reliable scientific sources and international scientific experiments. Based on that, an appropriate method for gas production from the wells, layer filtration resistance coefficient, the permeability coefficient of the layer, physical-mechanical characteristics of the rocks, pressure, and temperature of the upper Jurassic production interval of the Khwaja Gogerdak gas field was determined.

In this research, gas well number (3) of the Khwaja Gogerdak gas field was tested with the constant regime method. And the well was debited by the DUKT CTDM consumption meter, and the figures were measured. Pressure and temperature under different working regimes are written in table 1.

Table 1: The price of gas exploitation parameters that are measured in the wellhead

Gas heat in the wellhead $T_{mou,}$ k^o	Choke coefficient C	Static pressure $P_{mou.\ st}$, atm	Dynamic pressure P_{mou}, atm	Choke diameter in mm	Regime Number
315	62.244	105	100	19.05	1
320	46	125	120	15.85	2
321	35.44	138	128	12.7	3
322	25.245	169	145	11.13	4
318	16.917	175	170	9.51	5

4. Determination of an appropriate operating system for the Khwaja Gogerdak Jurassic wells:

The wells are tested using different gas-producing methods. There are two common methods to test oil and gas wells:

1. Well testing during constant operation (constant fluid flow rate).
2. Well-testing in static operation (variable fluid flow rates).

The hydrodynamic testing of the well involves determining the necessary parameters for the well, and the production layer during the filtration of the gas from the bottom of the well and from the bottom of the well to the surface. Research on the hydrodynamics of oil and gas wells and the analysis and interpretation of their results are important parts of the oil and gas production process. [3]

Gas wells were tested during constant operation in this study, and the good flow rate was measured several times by installing and removing different chokes into the X-mass tree outlet line. At each flow rate, wellhead and bottom pressures were measured. The equipment used in the data collection of this research is illustrated in the figures below.

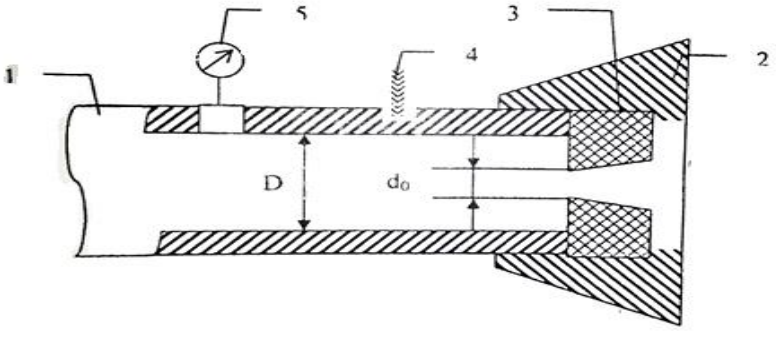


Figure 2: Critical flow rate diaphragm measuring tool

During the investigations, a special gas consumption measurement device (wellhead monitor and critical flowmeter) is installed on the wellhead outlet lines. The structure of this device is illustrated in Fig (4). This device is composed of a body (1) and a choke (2), which is connected to the body through a joint (3). The choke has cone-shaped canals with specific diameters. In addition, in the unit of measurement, special channels are installed for connecting the manometer, the duck (5), and the thermometer. [3] [2]

In the study of gas wells, the gas passes through the measurement device and is released into the atmosphere. Simultaneously, the gas pressure in the measuring device (dynamic pressure), the pressure in the back space of the tubing (static pressure), and the gas temperature are measured. Subsequently, the operating regime of the well is changed by changing the diameter of the choke. For this purpose, the well is shut down for a short period (10-15 minutes) and the valves are measured by the instruments. After installation of the new choke, the good flow rate changes, causing pressure changes at the wellhead after a period of (2-3) hours or more. Pressure and temperature are measured twice.

4.1.Basic formulas for performing calculations:

Gas compressibility coefficient calculation formulas:

$Z = F(P_{acou}, T_{acou})$…… ……..…..……..1

$P_{cri} = 49.5\text{-}3.7 \cdot \bar{\rho}$ ……..…...2

$T_{cri} = 93+176 \cdot \bar{\rho}$ …….3

$P_{acou} = \frac{P}{P_{cri}}$…….4

$T_{acou} = \frac{T}{T_{cri}}$…….……..5

c. The formula to determine a gas well's 24-hour flow rate:

$Q = \frac{C_1 \cdot P_{m \cdot din}}{\sqrt{Z_1 \cdot T \cdot \bar{\rho}}}$ $m^3/24h$……6

d. Formula to determine the pressure at the bottom of the well concerning the static pressure of the well.:

$P_w = P_{m \cdot st} \cdot e^s$……..…7

e. Formula to determine the pressure at the bottom of the well using the dynamic pressure of the wellhead.:

$P_w = \sqrt{P_{m \cdot din} \cdot e^{2S} + \theta q^2}$, KGF/cm2……..8

f. The gas flow equation of the downhole production interval.:

$P_{lay}{}^2 - P_w{}^2 = Aq + Bq^2$……..9

g. Formula for the determination of the permeability factor of the production film.:

$$K = \frac{116 \cdot mg \cdot z \cdot P_0 \cdot T_{lay} \cdot \ln \frac{K_k}{R_w}}{\prod \cdot K \cdot h \cdot T_0} \text{.....10}$$

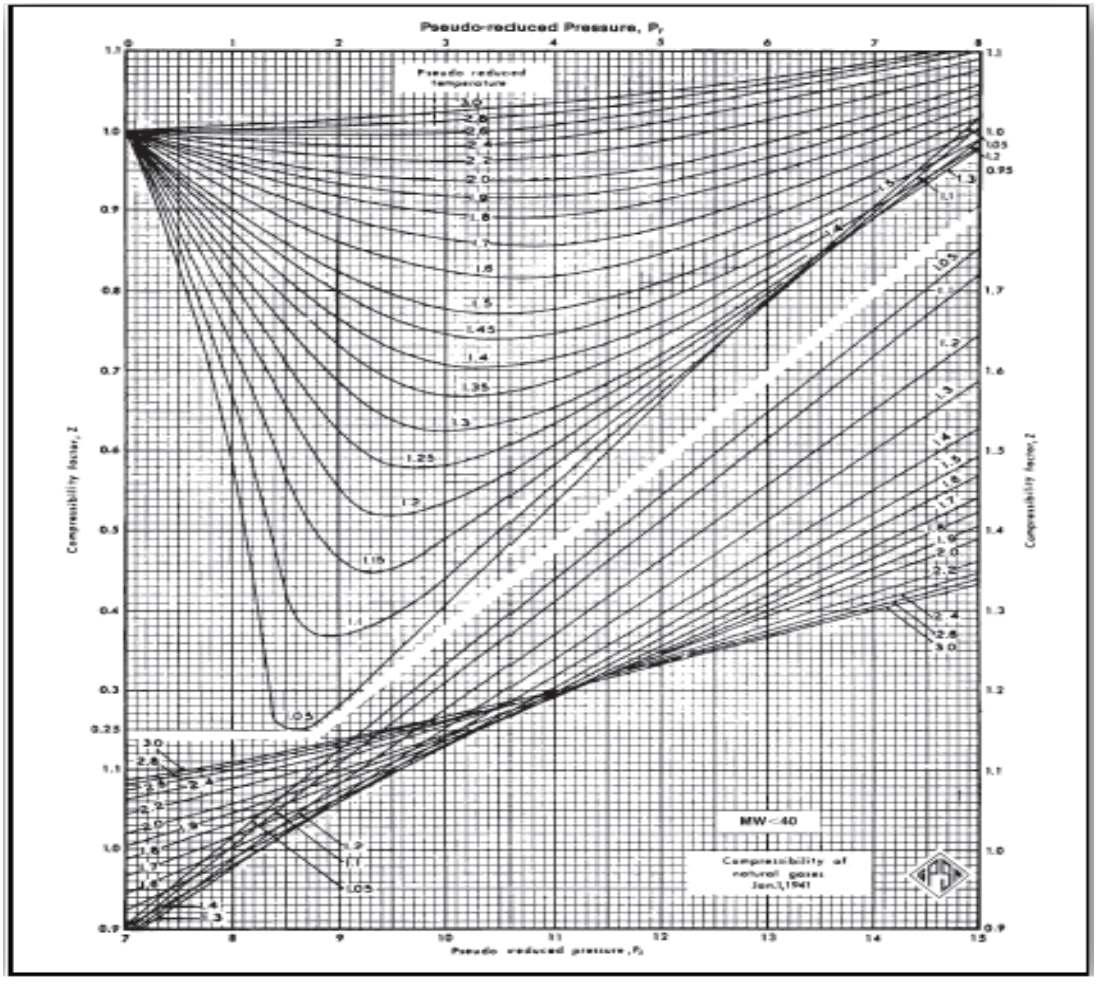


Figure 3: Determination of the gas compressibility coefficient based on the calculated pressure and heat.

4.2.The sequence of calculations:

Well Flow Rate Calculation: After testing the well, we calculate the flow rate of the well in each gas extraction regime as follows:

$$Q = \frac{\mathrm{C} \cdot P_{m \cdot din}}{\sqrt{\mathrm{Z} \cdot T \cdot \bar{\rho}}} \qquad \mathrm{m3/24h}$$

Here: $P_{m \cdot din}$ dynamic pressure before choke, Z gas compressibility coefficient, T Gas temperature in Kelvin, $\bar{\rho}$ relative density of gas and C is the choke coefficient.

To obtain the flow rate, the coefficient of compressibility for each regime is defined. First, the value of the critical pressures P_{cri}, critical temperature T_{cri}, calculated pressure P_{acou}, calculated temperature T_{acou}, and the value of the compression coefficient is defined using the above diagram.

Regime 1:

T_{cri}=93+176$\bar{\rho}$ =93+176·0,66=93+116,6=209,160k

P_{cri}=49,5-3.7$\bar{\rho}$ =49,5-3,7·0.66 =47,06at

$T_{acou1}=\frac{T_{mou1}}{T_{\text{cri}}}=\frac{315}{209,16}=1,5$

$$P_{acou1}=\frac{P_{m\cdot din1}}{P_{\text{cri}}}=\frac{100}{47,06}=2,12$$

$$Z_1=0,84$$

Using the above prices and formulas, the well debit will be calculated as follow:

$$Q_1=\frac{C_1\cdot P_{m\cdot din}}{\sqrt{Z_1\cdot T\cdot\bar{\rho}}}=\frac{62,244\cdot 100}{\sqrt{0,84\cdot 315\cdot 0,06}}=\frac{6224,4}{13,2}=471,5T\cdot M^3/24h$$

Regime 2:

$T_{acou2}=\frac{T_{mou2}}{T_{\text{cri}}}=\frac{320}{209,16}=1,53$ $P_{acou2}=\frac{P_{m\cdot din2}}{P_{\text{cri}}}=\frac{120}{47,06}=2,55$

$$Z_2=0,82$$

$$Q_2=\frac{C_2\cdot P_{m\cdot din}}{\sqrt{Z_2\cdot T\cdot\bar{\rho}}}=\frac{46\cdot 120}{\sqrt{0,82\cdot 320\cdot 0,62}}=\frac{5520}{13,16}=419,45T\cdot M^3/24h$$

Regime 3:

$T_{acou3}=\frac{T_{mou3}}{T_{\text{cri}}}=\frac{321}{209,16}=1,53$ $P_{acou3}=\frac{P_{m\cdot din3}}{P_{\text{cri}}}=\frac{128}{47,06}=2,72$

$$Z_3=0,8$$

$$Q_3=\frac{C_3\cdot P_{m\cdot din}}{\sqrt{Z_3\cdot T\cdot\bar{\rho}}}=\frac{35,44\cdot 128}{\sqrt{0,82\cdot 321\cdot 0,66}}=\frac{4536.3}{13.18}=344,1T\cdot M^3/24h$$

Regime 4:

$T_{acou4}=\frac{T_{mou4}}{T_{\text{cri}}}=\frac{322}{209,16}=1,54$ $P_{acou4}=\frac{P_{m\cdot din4}}{P_{\text{cri}}}=\frac{145}{47,06}=3,08$

$$Z_4=0,8$$

$$Q_4 = \frac{C_4 \cdot P_{m \cdot din}}{\sqrt{Z_4 \cdot T \cdot \bar{\rho}}} = \frac{25{,}245 \cdot 145}{\sqrt{0{,}79 \cdot 322 \cdot 0{,}66}} = \frac{3660.5}{12{,}95} = 282.6T \cdot M^3/24h$$

Regime 5:

$T_{acou5} = \frac{T_{mou5}}{T_{cri}} = \frac{318}{209{,}16} = 1{,}52 \quad P_{acou5} = \frac{P_{m \cdot din5}}{P_{cri}} = \frac{170}{47{,}06} = 3{,}6$

$Z_5 = 0{,}78$

$$Q_5 = \frac{C_5 \cdot P_{m \cdot din}}{\sqrt{Z_5 \cdot T \cdot \bar{\rho}}} = \frac{16{,}917 \cdot 170}{\sqrt{0{,}78 \cdot 318 \cdot 0{,}66}} = \frac{2875{,}89}{12{,}9579} = 255T \cdot M^3/24h$$

4.3.Calculation of bottom-well pressure P_w: For each gas regime, we determine the bottom-hole pressure P_w with the help of the following formula:

$$P_w = P_{m \cdot st} \cdot e^s$$

Here: $P_{(m \cdot st)}$ is static pressure on the back of the tubing, e, the base of the natural logarithm which is equal to 2.7182, and the price of S can be obtained from the following formula:

$$S = \frac{L_{av} \cdot \bar{\rho}}{T_{av} \cdot Z_{av}}$$

In this formula: L_{av} is the average depth of the well, $\bar{\rho}$ is the relative density, and T_{av} and Z_{av} are the average temperature and compressibility coefficient of the gas. The average temperature in the good column is obtained as follows:

$$T_{av} = \frac{T_{lay} + T_m}{2}$$

$$P_{av} = \frac{P_{lay} + P_w}{2} \ atm$$

In the above formula, the bottom well pressure value is not known, so its price is estimated to be higher than the static pressure.

Regime 1:

95+273=3680k $\quad T_{av} = \frac{T_{lay} + T_m}{2} = \frac{368+315}{2} = 341,5 \quad {}^0k$

$T_{acou1} = \frac{T_{av}}{T_{cti}} = \frac{341{,}5}{209{,}16} = 1{,}63 \qquad T_{cri} = 209{,}16$

$P_{av} = \frac{105 + 113}{2} = 109 \qquad P_{cri1} = \frac{P_{av}}{P_{cri}} = \frac{109}{47{,}06} = 2{,}3$

$Z_{av1} = 0{,}88$

$$\frac{L_{av} \cdot \bar{\rho}}{T_{av} \cdot Z_{av}} = \frac{2500 \cdot 0{,}66}{341{,}5 \cdot 0.88} = 5{,}5 \qquad e_1^s = 1{,}2066$$

$$P_{w1} = P_{m \cdot st \cdot 1}.\, e_1^s = 100 \cdot 1{,}2066 \; = 126{,}7at.$$

Regime 2:

$$T_{av2} = \frac{368 + 320}{2} = 344 \qquad P_{av2} = \frac{125 + 133}{2} \; = 129$$

$$T_{acou2} = \frac{344}{209{,}116} 1{,}64 \qquad P_{acou2} = \frac{129}{47{,}06} = 2{,}74$$

$$Z_{av2} = 0{,}87$$

$$\frac{L_{av} \cdot \bar{\rho}}{T_{av} \cdot Z_{av}} = \frac{2500 \cdot 0{,}66}{344 \cdot 0.87} = 5{,}5 \quad e_2^s 1{,}2066$$

$$P_{w2} = P_{m \cdot st \cdot 2}.\, e_2^s = 125 \cdot 1{,}2066 \; = 150{,}8at.$$

Regime 3:

$$T_{av3} = \frac{368 + 321}{2} = 344{,}5 \qquad P_{av3} = \frac{138 + 146}{2} \; = 142$$

$$T_{acou3} = \frac{344{,}5}{209{,}16} = 1{,}65 \qquad P_{acou3} = \frac{141{,}5}{47{,}06} \; = 3$$

$$Z_{acou3} = 0{,}86$$

$$\frac{L_{av} \cdot \bar{\rho}}{T_{av} \cdot Z_{av}} = \frac{2500 \cdot 0{,}66}{344{,}5 \cdot 0.86} = 5{,}57 \quad e_3^s = 1{,}2107$$

$$P_{w3} = P_{m \cdot st \cdot 3} \cdot e_3^s = 138 \cdot 1{,}2107 \quad P_{Z3} = 167at$$

Regime 4:

$$T_{av4} = \frac{368 + 322}{2} = 345 \qquad P_{av4} = \frac{169 + 177}{2} \; = 173$$

$$T_{acou3} = \frac{345}{209{,}16} = 1{,}65 \qquad P_{acou3} = \frac{173}{47{,}06} \; = 3{,}67$$

$$Z_{acou4} = 0{,}86$$

$$\frac{\bar{\rho} \cdot L_{av}}{Z_{av4} \cdot T_{av4}} = \frac{0{,}66 \cdot 2500}{0{,}86 \cdot 344{,}5} = 5{,}56 \quad e_4^s = 1{,}2066$$

$$P_{w4} = P_{m \cdot st \cdot 4}.\, e_4^s = 1{,}2066 \cdot 169 = 204at$$

Regime 5:

$$T_{av5} = \frac{368 + 318}{2} = 343 \qquad P_{av5} = \frac{175 + 183}{2} = 179$$

$$P_{acou5} = \frac{179}{47{,}06} = 3{,}8 \qquad T_{acou3} = \frac{343}{209{,}16} = 1{,}64$$

$$Z_{acou5} = 0{,}85$$

$$\frac{\bar{\rho} \cdot L_{av}}{T_{av5} \cdot Z_{av5}} = \frac{0{,}66 \cdot 2500}{343 \cdot 0{,}85} = 5{,}68 \qquad e_5^s = 1{,}2107$$

$$P_{w5} = P_{m \cdot st} \cdot e_5^s = 175 \cdot 1{,}2107 = 211{,}87at$$

4.4.Calculation of good pressure and flowrate parameters:

The function between good pressure and flow rate is: $f(Q) = P_{lay}^2 - P_w^2$. If the line for this function crosses the point where the two lines of the above graph intersect, the calculations are performed using the following formula: [8]

$$f(Q) = \frac{P_{lay}^2 - P_w^2}{Q}$$

If this line does not cross the intersection point of the above graph, then the next function is used for calculations:

$$f(Q) = \frac{P_{lay}^2 - P_w^2 - C}{Q}$$

$$1)\ \frac{P_{lay1}^2 - P_{w1}^2}{Q_1} = \frac{262^2 - 126{,}7^2}{471{,}5} = 111{,}54$$

$$2)\ \frac{P_{lay2}^2 - P_{w2}^2}{Q_2} = \frac{262^2 - 150{,}8^2}{419.45} = 109{,}4$$

$$3)\ \frac{P_{lay3}^2 - P_{w3}^2}{Q_3} = \frac{262^2 - 167^2}{299{,}7} = 135{,}98$$

$$4)\ \frac{P_{lay4}^2 - P_{w4}^2}{Q_4} = \frac{262^2 - 204^2}{271{,}5} = 99{,}55$$

$$5)\ \frac{P_{lay5}^2 - P_{w5}^2}{Q_5} = \frac{262^2 - 211{,}87^2}{255} = 105{,}6$$

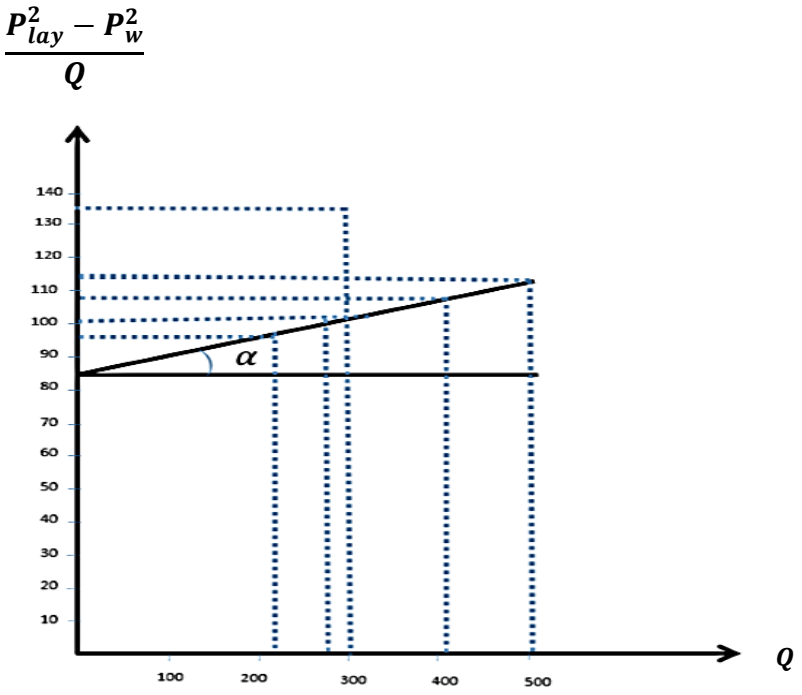


Figure 4: The graph determining the coefficients of filtration power

4.5. Assessment and Finalization of Gas Well Calculations:

The result of the parameters measured for well No. 3 of the Jurassic mines in the Khwaja Gogerdak gas field is illustrated in the figure above. Most of the points take place in a straight line. This status shows that the calculation was performed correctly. We connect the mentioned points and continue the resulting line to the intersection of the order axis. Finally, we will get the price for the coefficient (∝). [3]

$$t_g \propto = \mathrm{B} = \frac{\frac{P_{lay}^2 - P_w^2}{Q}}{Q} = \frac{111.54 - 84}{471.5} = 0{,}058$$

Factors A and B are coefficients of filtration resistance, which are created as a result of the movement of gas from the floor to the well. By placing the coefficients referred to in the gas flow from the reservoir rocks to the well, we obtain the following equation: [1] [3]

$$P_{lay}^2 - P_C^2 = AQ + \mathrm{B}Q^2 = 84Q + 0{,}058Q^2$$

Based on the figures calculated, the permeability coefficient for the stratum (K) is obtained with the following formula.

$$K = \frac{116 \cdot \mu_\Gamma \cdot Z \cdot P_0 \cdot T_{lay} \cdot \ln \frac{R_K}{R_w}}{\Pi \cdot \mathrm{A} \cdot h \cdot T_0}$$

Here: μ_Γ is the gas viscosity in centipoise, h is the stratum diameter on the meter, K is the permeability coefficient, R_K is the radius in meters, and R_C is the radius of the well in meters.

The coefficient of gas compressibility (Z) in productive interval conditions is equal to:

$$T_{acou} = \frac{T_{lay}}{T_{cri}} = \frac{368}{209{,}16} = 1{,}76$$

$$P_{acou} = \frac{P_{lay}}{P_{cri}} = \frac{318}{47{,}06} = 6.75$$

$$Z = 0{,}905$$

According to the above formula, the permeability coefficient is equal to:

$$K = \frac{116 \cdot \mu_\Gamma \cdot Z \cdot P_0 \cdot T_{lay} \cdot \ln\frac{R_K}{R_C}}{\Pi \cdot A \cdot h \cdot T_0} =$$

$$= \frac{116 \cdot 0{,}03 \cdot 0{,}905 \cdot 10^5 \cdot 368\ (\ln\frac{375}{0{,}1})}{3{,}14.84 \cdot 51 \cdot 273} = K = 0{,}70576 darcy$$

$$K = 0{,}70576\ darcy = 705.76\ m\ darcy$$

The permeability coefficient of the stratum indicates the movement of fluids in the stratum which varies from a few millidarcys to a few thousand millidarcys (mD). As much as the permeability factor of the stratum is high, the flow rate of the wells is also higher. [3]

$$A = 84\ \frac{KgF/cm^2 \cdot 24h}{1000m^3}$$

$$B = 0{,}058\frac{KgF/cm^2 \cdot 24h}{1000m^3}$$

Free Debit: The absolute free debit is obtained by the following formula:

$$Q_{ab} = \frac{\sqrt{A^2 + 4B\left(P_{lay}^2 - 1\right)} - A}{2B}$$

$$Q_{ab} = \frac{\sqrt{84^2 + 4 \times 0.058(318^2 - 1)} - 84}{2 \times 0.058} = 781.8\ \times 10^3\ \frac{m^3}{day}$$

If the filtration of the production interval is done according to Darcy's Law and there are no barriers in the well. The free flow of the well is equal to $781.8 \times 10^3\ \frac{m^3}{day}$.

The maximum allowable flow rate of the well is the favorable well flow rate which indicates the proper production regime where gas production is constant and with no complications. The favorable well discharge is determined by the following formula: [1]

$$q = \frac{-A + \sqrt{A^2 + 4B.\Delta P\left(2P_{lay} - \Delta P\right)}}{2B}$$

$$q = \frac{-84 + \sqrt{84^2 + 4 \times 0.058 \times 54(2 \times 318 - 54)}}{2 \times 0.058}$$

$$q = 308.4 \times 10^3 \frac{m^3}{day}$$

The favorable flow rate of gas is: $308.4\times 10^3 \frac{m^3}{day}$. By choosing this amount of flow rate, we can avoid the following problems: the destruction of the productive interval, corrosion of installed columns and production pipes, gas entrapment at the production interval, and the formation of water tabs. [7]

$$P_{lay}^2 - P_w^2 = \mathrm{A}Q + \mathrm{B}Q^2 = 84Q + 0{,}058Q^2$$

$$P_{lay}^2 - P_w^2 = 84(308.4) + 0{,}058(308.4)^2$$

$$P_w = 264.0\ atm$$

The bottom pressure of a well is gained 54 atmospheres, which is less than the pressure of the productive layer. The reason for the pressure reduction at the bottom of the well is related to the permeability coefficient of the production interval and its porosity. Based on the calculations of the gas flow rate equation, the favorable flow rate from the well was found to be appropriate. The calculated price for the well bottom pressure corresponds perfectly to the real price obtained by experience.

5. Results and Discussion

After analysis of the data, the physical and chemical properties of the hydrodynamic gas, and study of the geology of the minefield of a good number (3) from the Jurassic mine in the Khwaja Gogerdak mining field, the following results have been achieved:

1. The appropriate flow rate for gas extraction is determined by defining the following parameters: gas compression coefficient, maximum gas flow rate, the quantity of pressure at the head and bottom of the well, and quantity of dynamic and static pressure in the wellhead in different extraction regimes.

2. Using the function graph $f(Q) = \frac{P_{lay}^2 - P_w^2}{Q}$ the filtration resistance factors are obtained (A=84, and B=0.058) which are created when the gases are filtered through the production layer.
3. Based on the calculations, the permeability coefficient of the productive layer is obtained at 705.76 mD(millidarcy)
4. The total daily production of the Jurassic reservoir rocks in the Khwaja Gogerdak gas field is calculated (at $781.8 \times 10^3 \frac{m^3}{day}$), which is the highest flow rate for a gas well.
5. The maximum permissible discharge from well No (3) in the Khwaja Gogerdak mining field is $308.4 \times 10^3 \frac{m^3}{day}$. If the flow rate and pressure difference of this well is adjusted based on our calculations, the gasification coefficient of the production layer will be much higher.
6. The gas should only be extracted via tubing pipes, and the diameter of these pipes should be chosen in which the gas velocity in the wellhead should be received at approximately (10m/s), otherwise, the industrial equipment will rust.
7. To avoid rust in the good casing and other equipment, the inhibitor needs to be pumped at the production interval.

A series of calculations are carried out using data obtained from the test of wells No. 3, 41, and 43 from the Khwaja Gogerdak minefield, using different choke diameters. Finally, the wells debit, the pressure of the wells head and bottom, and the value of the function $\frac{P_{lay}^2 - P_w^2}{Q}$) are obtained which are listed in Tables 2 and 3.

Table 2: Basic parameters of gas exploitation

$\frac{P_{lay}^2 - P_w^2}{Q}$	Gas debit $1000\ M^3/24h$	Downhole (Well bottom) pressure Atm	Protective layer pressure Atm	Choke diameter Millimeter	Regime number
111.54	471.5	126.7	318	19.05	1
109.4	419.45	150.8	318	15.85	2
135.98	344.1	167	318	12.7	3
99.55	282.6	204	318	11.13	4
105.6	255	211.87	318	9.51	5

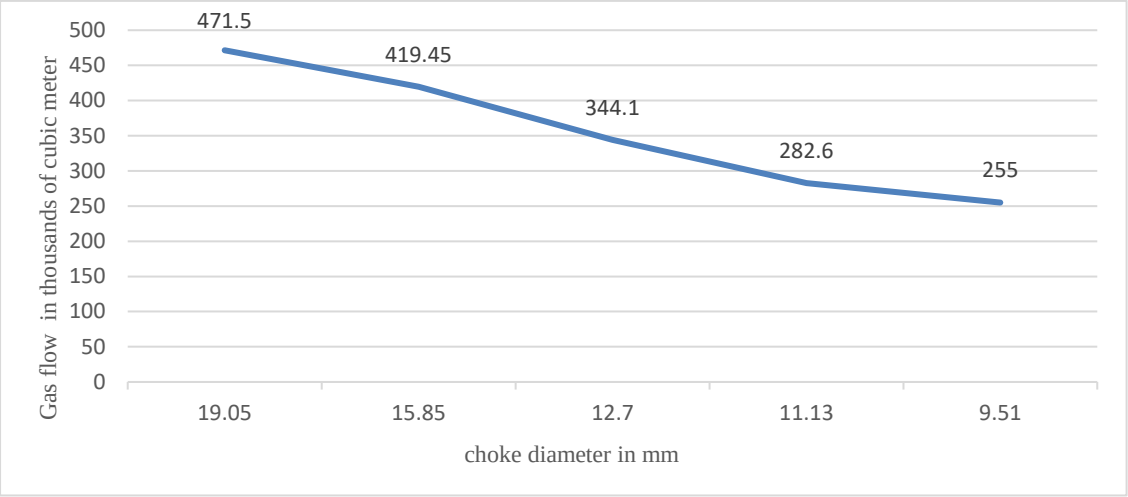


Figure 5: Gas flow graph according to chokes diameters

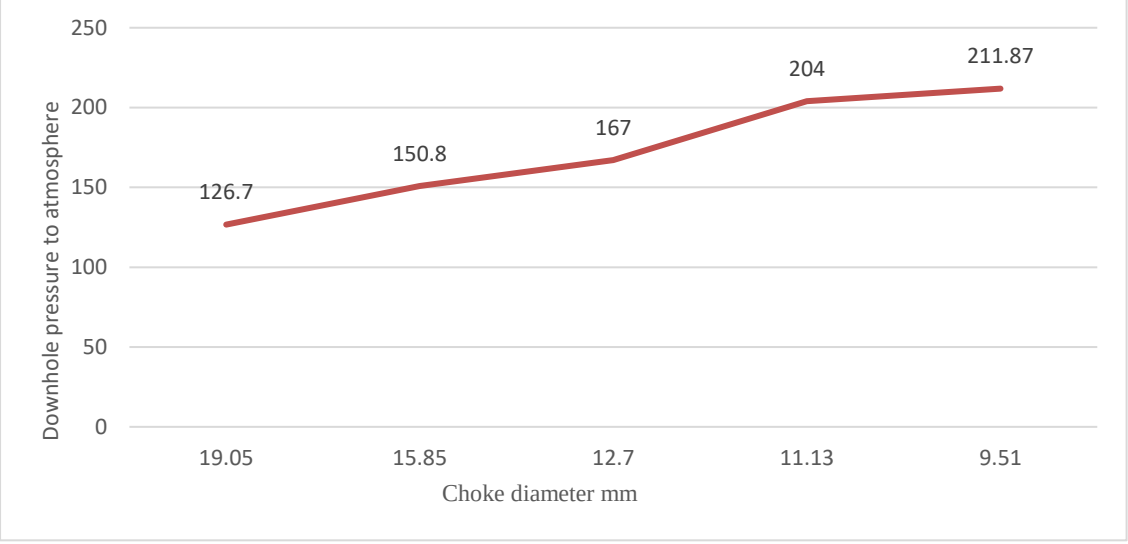


Figure 6: Well bottom pressure graph in different chock diameters.

Based on the above descriptions and results, the following can be suggested:

1. Gas reserves should be calculated through pressure reduction.
2. The acidification of the calcareous production layer is suggested at the beginning of the exploitation process to increase the flow rate.
3. To pump special anti-rust materials (inhibitors), a special valve must be installed at the bottom of the tubing.
4. Anti-rust materials (inhibitors) must be continuously injected into the well at the back of the pipes.
5. The chemical composition of the Jurassic production layer gas of the Khwaja Gogerdak gas field is very different from that of the Heterevien production layer

gas. In this regard, gas extraction should be arranged in separate tubes and transferred to the gas collection points of the Yatim Taq gas field.

6. The packers must be used when installing tubing to separate the two different production intervals from each other.

Table 3: Baic parameters of gas exploitation of well No. 3, Khwaja Gogerdak Mining field

Regime number	$\frac{P_{lay}^2 - P_C^2}{Q}$	The pressure of the bottom of the well (PZ)				Well debit		
		Z_{av}	$\frac{\bar{\rho} \cdot L_{av}}{Z_{av} \cdot T_{av}}$	e^S	Downhole pressure P_W	Coefficient C	Coefficient Z	Well debit $1000M^3/24h$
1	111,54	0,88	5,5	1,2066	126,7	62,244	0,84	471,5
2	109,44	0,87	5,5	1,2066	150,8	46	0,82	419,45
3	135,98	0,86	5,57	1,2107	167	30,44	0,8	299,7
4	99,55	0,86	5,56	1,2066	204	24,245	0,79	271,5
5	105,6	0,85	5,68	1,2107	211,8	16,917	0,78	225

7. Conclusion

Based on data on the upper Jurassic layer in the Khwaja Gogerdak field, and the findings highlighted in this research paper, the following conclusions are drawn:

1. The Jurassic production layer gas in the Khwaja Gogerdak mining field is composed of 3.2% hydrogen sulfide and 7% carbon dioxide. The presence of these gases causes the production equipment to rust at high pressure and temperature, increasing expenses.
2. The good flow rate should be adjusted to $308.4 \times 10^3 \frac{m^3}{day}$ following the technological regime defined for the production of wells.
3. Stainless steel casing must be installed into the well during drilling and completion to avoid rust.
4. During operation, inhibitors must be pumped into the production interval to prevent rust.
5. Special valves for pumping inhibitors into the well shall be installed in the stainless steel tubing with the S-75 marking.

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