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# THE RESULTS OF HYDRODYNAMIC STUDIES ON STATIONARY AND NON-STATIONARY FILTRATION MODES ON THE EXAMPLE OF THE KRUK DEPOSIT

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# THE RESULTS OF HYDRODYNAMIC STUDIES ON STATIONARY AND NON-STATIONARY FILTRATION MODES ON THE EXAMPLE OF THE KRUK DEPOSIT

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***Abstract.*** *The article presents the results of gas-hydrodynamic studies at the Kruk field, using methods of steady selection and pressure recovery based on stationary and unsteady modes, which were carried out according to the well research methodology, which prescribes the separation into phases of the entire productive flow of the gas-liquid mixture in the separator, in which, under various separation modes, the amount of liquid phase, namely gas condensate and formation water, was separated and measured.. A mobile full-flow separation installation was used as a separator. The condensate output was measured in a calibrated container using a measuring ruler, which made it possible to record the level of separation of condensate and water. Gas condensate studies were carried out in one well operating mode using a 6 mm choke with 3 separation modes. At each separation mode, samples of separated gas, stable and unstable condensate were taken for laboratory research. An assessment of the conditions for fluid removal from the bottom of the well and an assessment of the conditions of corrosion of downhole equipment were carried out, and recommendations were given for choosing the optimal operating mode of the well based on the obtained flow rates.*

***Keywords:*** *stationary mode, non-stationary mode, liquid removal, corrosion.*

***AnnotatsiY.*** *Maqolada Kruk konida gaz-gidrodinamik tadqiqotlar natijalari, statsionar va nostatsionar rejimlarga asoslangan barqaror holatdagi qazib olish va bosimni tiklash usullaridan foydalangan holda, quduqlarni fazalarga ajratishni nazarda tutuvchi quduqni tadqiq qilish metodologiyasi bo‘yicha amalga oshirilgan. separatordagi gaz-suyuqlik aralashmasining butun mahsuldor oqimi, bunda turli xil ajratish rejimlarida suyuqlik fazasi miqdorini, ya’ni gaz kondensati va qatlam suvini ajratish va o‘lchash. Separator sifatida mobil to‘liq oqimli ajratish moslamasi ishlatilgan. Kondensat chiqishi xajmi belgilangan idishda o‘lchov o‘lchagich yordamida o‘lchandi, bu kondensat va suvning ajralish darajasini qayd etish imkonini berdi. Gaz kondensatini o‘rganish bir quduq ish rejimida 3 ta ajratish rejimiga ega 6 mm chok yordamida amalga oshirildi. Har bir ajratish rejimida laboratoriya tadqiqotlari uchun ajratilgan gaz, barqaror va beqaror kondensat namunalari olindi. Quduq tubidan suyuqlikni olib tashlash shartlarini baholash va quduq uskunasining korroziyasi sharoitlarini baholash amalga oshirildi va olingan oqim tezligidan kelib chiqqan holda quduqning optimal ish rejimini tanlash bo‘yicha tavsiyalar berildi.*

***Kalit so‘zlar****: statsionar rejim, nostatsionar rejim, suyuqlikni olib tashlash, korroziY.*

***Аннотация.*** *В статье приведены результаты газогидродинамических исследований на месторождении Крук, применяя методы установившихся отборов и восстановления давления на основе стационарных и нестационарных режимов, которые выполнялись по методике исследования скважин, предписывающей разделение на фазы всего продуктивного потока газожидкостной смеси в сепараторе, в котором при различных режимах сепарации осуществлялось отделение и замеры количества жидкой фазы, а именно газового конденсата и пластовой воды. В качестве сепаратора использована передвижная полнопоточная сепарационная установка. Выход конденсата замерялся в оттарированной ёмкости при помощи мерной линейки, позволяющей фиксировать уровень раздела конденсата и воды. Газоконденсатные исследования выполнены на одном режиме работы скважины на штуцере 6 мм при 3-х режимах сепарации. На каждом режиме сепарации отобраны пробы отсепарированного газа, стабильного и нестабильного конденсата для лабораторных исследований. Проведены оценка условий выноса жидкости с забоя скважины и оценка*

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*условий коррозии скважинного оборудования, а также даны рекомендации по выбору оптимального режима эксплуатации скважины на основе полученных дебитов.*

***Ключевые слова:*** *стационарный режим, нестационарный режим, вынос жидкости, коррозия.*

## Introduction

Administratively, the Kruk deposit is located on the territory of the Karaulbazar district of the Bukhara region of the Republic of Uzbekistan (Fig.1). Tectonically, the deposit is located in the Central part of the Chardzhou tectonic stage, which complicates the eastern on-board zone of the Amudarya depression. The main structural elements of the area are the Ispanli-Chandyr and Dengizkul shaft-shaped uplifts and the Kushab trough separating them.

The geological structure of the described deposit includes dislocated rocks of Pre-Jurassic age and sedimentary cover deposits represented by rocks of the Jurassic, Cretaceous, Paleogene, Neogene and anthropogenic systems.

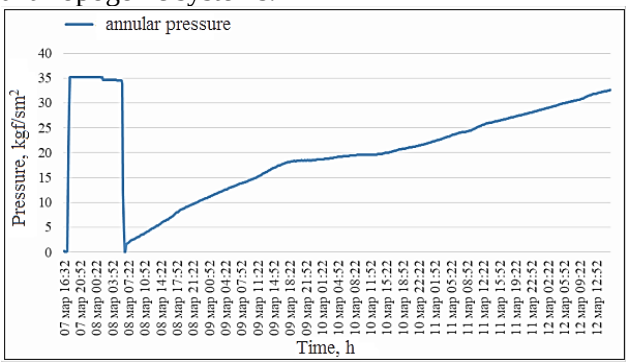


**Fig.1. Measurement of annular pressure**

Hydrodynamic studies of the object were performed by recording the level recovery curve and annular pressure using an echo sounder (level gauge). In Fig.1, you can see sharp stepwise jumps in the level of liquid and annular pressure in a stopped well. This is most likely due to the leakness of the wellhead equipment, which in the future will have an impact on the recalculation of bottomhole pressure (Fig. 2). It is possible to calculate the estimated reservoir pressure parameters in the process of interpreting the data.

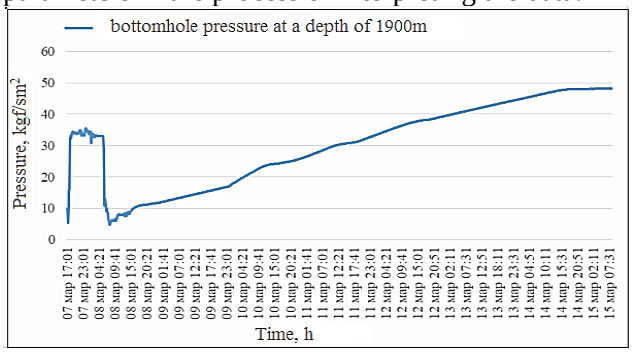


**Fig.2. Measurement of bottomhole pressure at a depth of 1900 m**

The well was investigated using a single stationary direct flow filtration mode without a union. The study on the stationary filtration mode was carried out by supplying gas to the annular space (gas lift). Upon completion of the study of the well in a stationary filtration mode, a study was conducted using the method of recording pressure recovery curves. The research was carried out by direct measurements at a depth of 1900 m (Fig.2).

In the Saphir module of the integrated KAPPA-Workstation platform (v 5.30), the interpretation of the level recovery curves has been performed. In the interpretation, the effective power was assumed to be 5.1 m and porosity 8% according to the geological model. The main interpretation results obtained during the processing of level recovery curves are shown in Table 1.

Table 1

**Results of Hydrodynamic studies**

| | | | |
|---|---|---|---|
| **1.The main results of the interpretation** | | | |
| 1.1 | Stratum pressure at the manometer level, $P_{man}$ | - | MPa |
| 1.2 | Pressure on upper perforation holes, $P_{uph}$ | 3,45 | MPa |
| 1.3 | Stratum pressure at the level of the middle of the perforation interval,$P_{mpi}$ | 3,50 | MPa |
| 1.4 | Stratum pressure at the depth of the oil-water contact, $P_{owc}$ | 4,2 | MPa |
| **2.Conclusion** | | | |
| 2.1 | Research quality | evaluative character | |
| **Reliability of interpretation results** | | | |
| 2.2 | $P_{stratum}$ on the upper perforation interval | Satisfactorily | |

Hydrodynamic studies on non-stationary filtration modes. Well investigations by the pressure recovery curves method were carried out after the well was put into operation.

In the Saphir module of the integrated KAPPA-Workstation platform (v 5.30), the interpretation of the pressure recovery curves is performed. The analysis was carried out at a reservoir thickness of 21 m and a porosity of 11.06%.

Based on the result of the analysis of the pressure derivative, a well model with a linear influence of the Hegeman well bore was adopted, the reservoir model is homogeneous. The filtration parameters of the collector obtained during the processing of pressure recovery curves are shown in Table 2.

Table 2

**Pressure recovery curves processing results**

| Parameter | Parameter designation | Parameter value | Dimension |
|---|---|---|---|
| Stratum pressure | $P_{str}$ | 78,07 | kg/sm$^2$ |

| Parameter | Parameter designation | Parameter value | Dimension |
|---|---|---|---|
| Bottom-hole pressure | $P_b$ | 5,1 | kg/sm$^2$ |
| Depression | ΔP | 72,97 | kg/sm$^2$ |
| Productivity | Q/ ΔP | 0,16 | (m$^3$/day)/ (kgs/sm$^2$) |
| Permeability | k | 0,15 | md |
| Conductivity | kh | 3,15 | md*m |
| Skin factor | S | 34,77 | dimension less. |
| Exploration radius | $R_{ex}$ | 97,54 | m |
| Debit | Q | 12,6 | m$^3$/day |

Table 3

**The main results of research on the modes**

| Types and № of control and measuring devices | Stand-alone digital pressure gauge-thermometer-6 №6438 | |
|---|---|---|
| Measurement/research ⌀ of union (mm) | Gaz lift<br>- | Pressure Recovery Curve<br>- |
| Start date of work | 07.03.2021 | 08:03.2021 |
| Start-up time | 17:30 | 07:30 |
| Date of end | 08:03.2021 | 15:03.2021 |
| Stop time | 06.00 | 09.00 |
| **Pressure** | | |
| Buffer | 8,6 | 36,7 |
| Bottomhole | 5,1 | 42,5 |
| At depth | 1900 | 1900 |
| Gas temperature Buttomhole | 92,6 | 96,4 |
| **Debit** Liquid thousand m$^3$/day | 12,6 | |

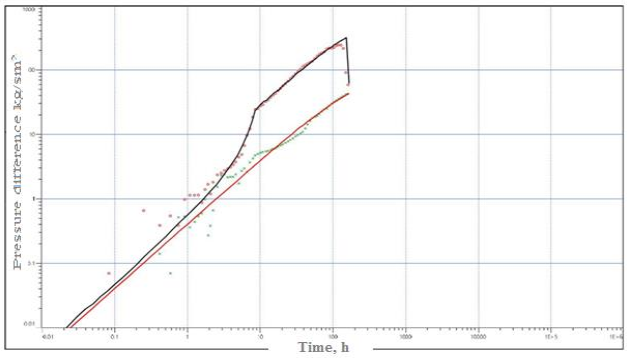


**Fig.3. Diagnostic graph of the KVD**

## Conclusion

A full range of gas dynamic and gas condensate studies was performed in the well of the Kruk field.

The above interpretation results are evaluative character. Based on such data, it is impossible to reliably estimate reservoir pressure and well productivity. The difficulty lies in the reliability of the level measurement and the absence of sound velocity measurement. The speed of sound depends on the composition of the gas, pressure and temperature. The level recovery curves method is outdated and is practically not used for oilfield practice, only for the diagnosis of technological parameters of well operation modes. The duration of registration of the level recovery curves was 101.0 hours. The initial reservoir pressure, taking into account the given history of the well, was 3.45 MPa at the level of the upper perforation interval (2325 m). Due to the incorrect data presented, the interpretation results are evaluative.

To obtain reliable information about the bottomhole zone of the well, it is recommended to measure with a frequency of 5 minutes at a working well for at least two hours. Further, after closing the well at the level recovery curves for two hours – every 10 minutes, the next two hours – every 30 minutes, and thereafter every hour. When solving the problem of determining reservoir pressure and productivity coefficient: the first 12 hours every hour, then for 12 hours – every two hours, then every 4 hours. In wells with a long pressure recovery time, the frequency of measurements after 48 hours of the level recovery curves registration can be reduced to 2 times a day. Before stopping the well in front of the KVU, it is necessary to beat off the level for at least 2 hours with a frequency of 10 to 20 minutes to determine the dynamic level, and then calculate the downhole pressure in the operating mode.

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