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Production Performance Analysis of Chang 2 Reservoir in W Oilfield

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Abstract

Oil and gas field development geology is a branch of petroleum geology, which is gradually formed along with oil and gas field development. Oil and gas field development geology refers to the geological research work of the whole process from evaluation of exploration to the end of oil and gas field development after oil and gas field exploration and development. 2) Study the influence and interaction of reservoir characteristics on oil, gas and water performance during development;3) Provide geological data and optimize tertiary oil recovery methods. By studying the production data of Chang 2 reservoir in W oilfield, reservoir evaluation, reservoir development evaluation and reservoir development plan compilation are understood. Based on the experimental results, the evaluation results of the study area are obtained by overall analysis and evaluation of the data of the study area, which provides scientific basis for reasonable reservoir development, reserve evaluation and production performance prediction. Complete the production performance analysis of Chang 2 reservoir in W Oilfield, comprehensively process the actual geological data of the oilfield and analyze and solve the actual problems of exploration and development.

Keywords

Oil and Gas Field Development; Evaluation Exploration; Gas-Water Dynamic; Dynamic Prediction.

1. Introduction

Through actual data analysis and map compilation, understand reservoir geological characteristics, master reservoir analysis, data processing and map compilation methods, and put forward comprehensive suggestions for Chang 2 reservoir development in W oilfield. Draw the petrographic cross section of Chang 2 reservoir in W Oilfield, the cross section of Chang 2 reservoir in W Oilfield and the schematic diagram of development small layer division, and analyze the sedimentary time unit division, sedimentary microfacies type, section shape and phase change, continuity and connectivity change, sedimentary cycle period and vertical overlapping superposition condition of Chang 2 sandstone reservoir, oil and water distribution condition of reservoir and oil-water interface characteristics by using the well cross section[1].

Production optimization method based on reservoir performance understanding mainly relies on empirical reservoir development technology policy summarized from reservoir performance understanding to screen "problem wells," and guides injection-production adjustment in combination with specific injection-production optimization strategy [2]. Based on statistical arrangement of experimental analysis results, relevant maps are drawn,

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permeability heterogeneity parameters are calculated, and reservoir physical property characteristics and intra-layer heterogeneity and their impacts are analyzed. Understand the reservoir production performance, basic parameters and development indicators, and master the reservoir production performance. Reservoir production curve drawing, analysis of W oilfield long 2 reservoir production performance, production and water cut change rule, water injection development effect, etc., roughly divided into production stage, analysis of the distribution of reservoir pressure change characteristics, derived from the known conditions of oil-water interface depth and pressure calculation formula, determine the reservoir pressure analysis and oil-water interface, understand the concept of reservoir pressure and pressure system, understand the reservoir pressure distribution characteristics and the physical significance of oil-water interface, for W oilfield long 2 reservoir development, Reserve evaluation and production performance prediction to provide scientific basis.

2. Evaluation of Geological Characteristics of Reservoir and Reservoir Development

From Figure 1 and Figure 2 above, it can be seen that the reservoir is dominated by Chang 1 and Chang 2 strata, the lithology is dominated by sandstone, the non-reservoir is dark argillaceous rock and partial tight sandstone interlayer, and the sedimentary microfacies is delta distributary channel sedimentary microfacies.(mainly composed of sandy sediments, with sequence characteristics gradually thinning upward, which is elongated sand body in plane, symmetrical lenticular in cross section, thickest and coarsest in middle, thinning and thinning toward both ends) and interdistributary bay sedimentary microfacies (As can be seen from Figure 1, it is wedge argillaceous sedimentary body in the cross section, mainly clay sediment, containing a small amount of silty sand and fine sand, tapering out to the middle, showing thin lens shape); for delta distributary channel sedimentary microfacies, its lithology and thickness change have certain rules [3]: thick sandstone in the middle becomes coarse, both ends become thinner and finer, and the thickness of sedimentary microfacies layer in interdistributary bay changes greatly; It is preliminarily judged that the sedimentary cycle is Grade III.(cyclic deposition composed of different sand layer groups), vertical superposition is superimposed sand body; oil-water interface is as shown in Figure 2, cap rock is mainly argillaceous rock, oil layer and water layer are continuously distributed in large area, oil layer is thick distributed in middle, mainly located in upper oil layer, lower oil layer is aquifer, S4, S3, S5-5 and S5-6 are mainly water layer, oil layer contains many tight interlayer, its vertical continuity is poor, and oil-water layer interface is clear.

The porosity distribution frequency of Chang 2 reservoir in W Oilfield is the most in the interval of 16%-18%, that is, the average porosity of this reservoir is between 15%-20%, and the pore size is relatively uniform, and the overall porosity of the reservoir is good; it can be seen from the figure that the cumulative frequency is affected by the porosity distribution frequency, and the slope of the cumulative frequency curve increases first and then decreases with the increase of porosity interval.

Reservoir permeability heterogeneity parameter: breakthrough coefficient (heterogeneity coefficient)

$$K_{\text{Sudden leap}}=K_{max}/K$$

K_{max}-Maximum permeability value; K-Average permeability value

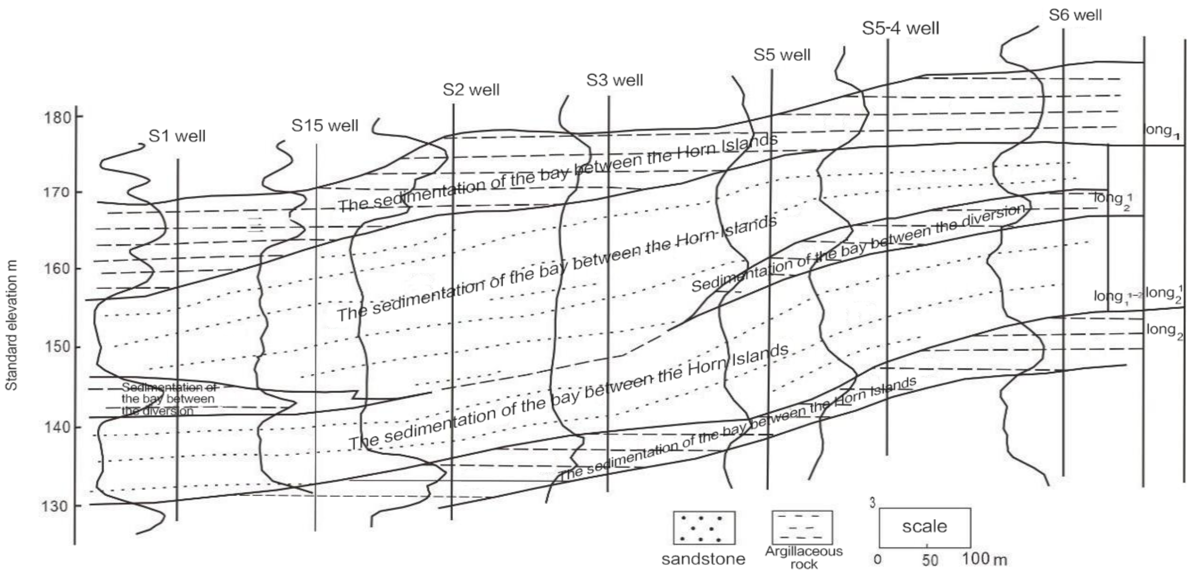

Fig 1. Lithofacies Cross Section of Chang 2 Reservoir in W Oilfield

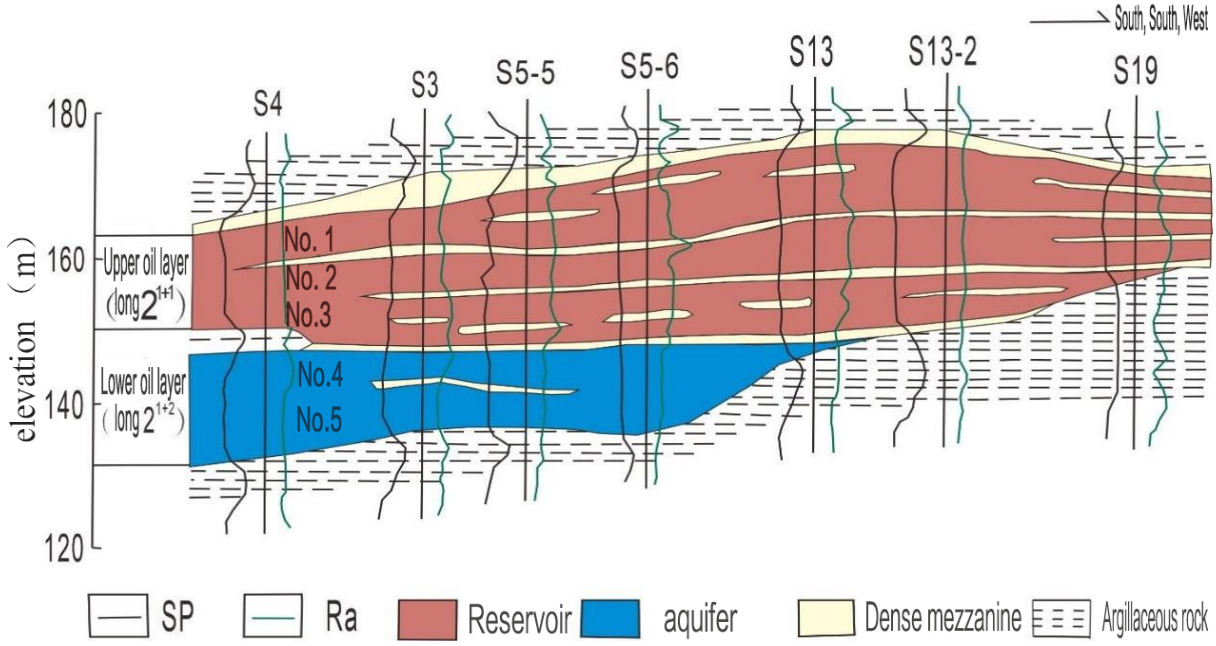

Fig 2. Schematic Diagram of Cross Section and Development Subzone Division of Chang 2 Reservoir in W Oilfield

The permeability distribution frequency of this reservoir is the largest in 0mD-5mD, most of the permeability values are less than 10μm2, and the size distribution is uneven, so it is preliminarily judged that the permeability of this reservoir is poor. Through calculation, $K_{Sudden\ leap}$=4.02>1, further indicating that the permeability of this reservoir changes greatly, the injectant is easy to rush along the highest permeability section, and the oil displacement effect is poor. Permeability is the fundamental reason for causing the heterogeneity in this reservoir. Porosity is usually used to express the ability of reservoir fluid and permeability is used to express the permeability of reservoir. Reservoir affects the amount of reservoir reserves, and permeability directly affects the productivity of oil and gas[4].Experimental results show that porosity and permeability of reservoir have certain correlation; in medium and high permeability reservoir, porosity and permeability have good correlation; In the low permeability reservoir, the correlation between porosity and permeability is low, and with the decrease of permeability, the correlation between porosity and permeability decreases continuously, or even has no correlation. It can be seen from the figure that the larger the permeability, the larger the porosity. There is a linear relationship between porosity and permeability, and this reservoir may be a low permeability reservoir.

As shown in Figure 3, oil saturation and water saturation vary greatly with depth, indicating poor homogeneity. The depth is 1223m-1235m, which can be roughly divided into five small sections from top to bottom. Oil saturation increases from bottom to top, which is compound antirhythm. The overall development effect of compound rhythm is between positive rhythm and antirhythm [5]. (Positive rhythm oil layer thickness sweep coefficient is small, oil well water breakthrough is early, water cut rises quickly, water flooded characteristics are bottom flooded type, development effect is poor; reverse rhythm oil layer water flooded thickness is large, water flooding is much more uniform than positive rhythm, development effect is better).

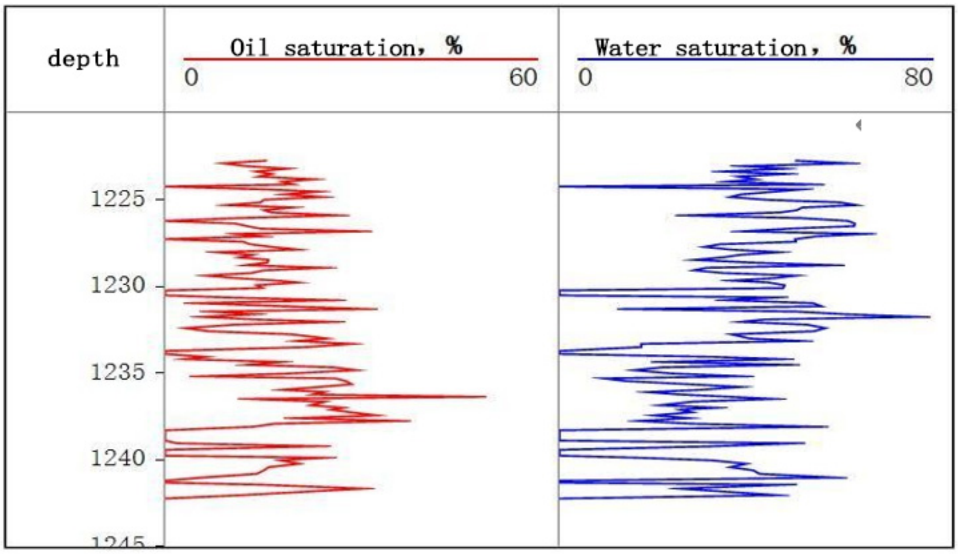

Fig 3. Profile Diagram of Oil and Water Saturation Change with Depth

According to Figure 4, Chang 2 reservoir top elevation contour map, it can be seen that wells s5-1 and s1 - 4 -1 are located in the highest stratum in the nearby area, surrounded by contour lines in this area, which is a good reservoir structure; Good thick sandstone distribution area can be found from sandstone thickness contour map, thick sandstone is favorable area for reservoir. From contour map, it can be seen that wells s5-1, s5-5 and s5-6 are located in thick sandstone with thickness up to 34- 38m. In addition, wells s3, s3-1 and s5-2 are also located in thick sandstone. The reservoir effective thickness contour map can analyze the reservoir thickness. From the outside of the reservoir to the inside, the reservoir effective thickness gradually increases, reaching the maximum value in the area surrounded by s3, s5-5, s5-6, s13 and s13-2. The reservoir effective thickness reaches 17-19 meters, and reaches 14 meters on the contour line where s5, s5-2, s5-3 and s14-2 are located. Porosity contour map analysis results play an important role in reservoir recoverability, physical property analysis of oil and gas field development and selection of oil displacement mode. Analysis shows that S5-5 and S5-6 areas are the largest porosity areas in this reservoir area, reaching 17% to 20%. From the outside of this area to the inside, oil saturation increases, and in the areas where S5-5 and S5-6 wells are located, oil saturation is the highest, reaching 60%-65%. permeability determines the reservoir exploitation drive mode and oil and gas flow connectivity. as shown in the figure, permeability increases gradually from the periphery of the reservoir area to the area where wells s5-5, s3, s3-2, s4 and s2 are located in the middle of the reservoir. permeability of wells s13, s12-1 and s5-6 in the middle of the reservoir is about 12% to 16.2%, which is relatively good in this area.

Comprehensive analysis results show that the sandstone layers with good reservoir properties are s5-1, s5-5, s5-6, etc. The oil reservoirs are distributed in the areas where wells s5-5, s5-6, s12-1 and s13 are located. Oil and gas are mainly accumulated in this area, and water layers are distributed outside the areas surrounded by s1, s6, p3 and s5-4.

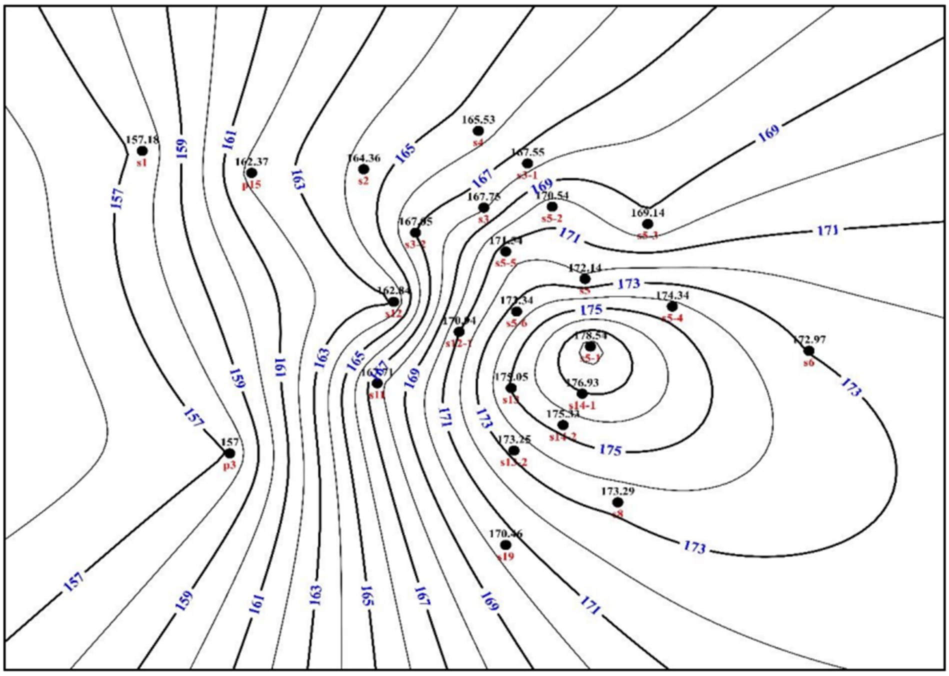

Fig 4. Contour Map of Chang 2 Reservoir Top Elevation (m)

3. Reservoir Development Performance Analysis

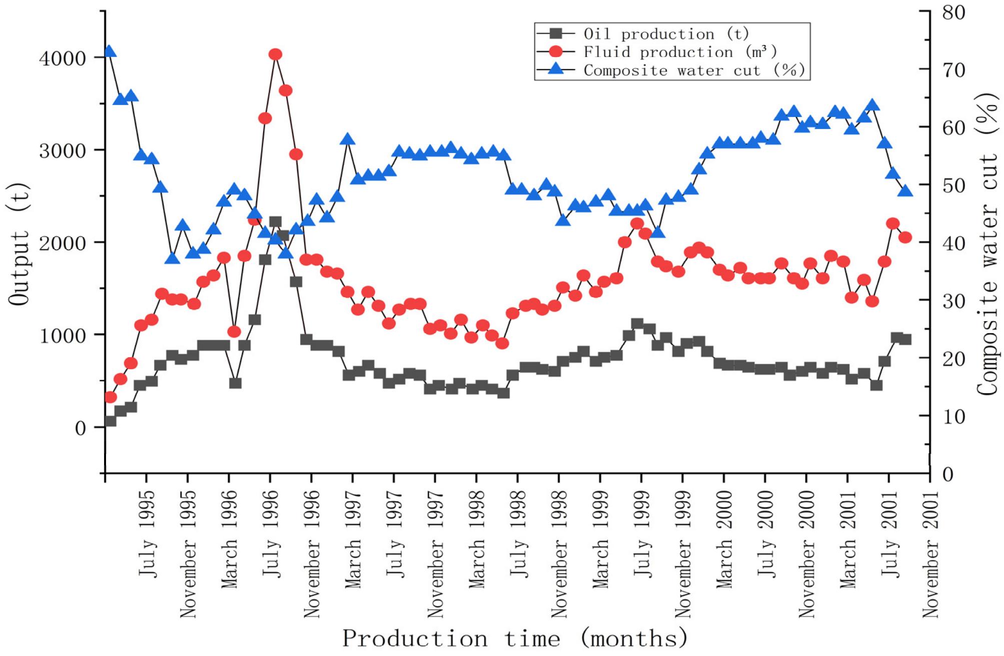

Fig 5. Change Curve of Fluid Production, Oil Production and Comprehensive Water Cut against Time in Chang 2 Reservoir of W Oilfield

It can be concluded from Figure 5 that the comprehensive water cut curve showed a large decline trend in January 1996, the comprehensive water cut of Chang 2 reservoir rose first and then declined in 1996, showed a decline trend from September 1998 to December 1999, and continued to rise thereafter. The liquid production of Chang 2 reservoir showed a decline trend with gentle change; It can be seen from the figure that the oil production of reservoir increases with the decrease of comprehensive water cut in the initial stage, which is a process of water injection. The oil production and liquid production of Chang 2 reservoir of W Oilfield reach the peak in November 1996. Generally speaking, the liquid production and oil production increase with the decrease of comprehensive water cut, and the production decreases with the increase of water cut. In summary, Chang 2 reservoir of W Oilfield can be roughly divided into four production stages: July 1995-November 1996, production increasing stage; Dec. 1996-June 1997, production decreasing stage; July 1997-August 1999, stable production stage; after September 1999, production decreasing stage.

According to the water injection volume and production trend of each well, it can be seen that when water injection well S13-2 is used for oil displacement, the oil production of Well S-13 increases most obviously, the oil layer is obviously affected, and the reaction of oil layer water injection is faster; the water injection and oil displacement of Well S14-2 is second only to Well S-13, and the oil layer is better affected; the water injection and oil displacement effect of Well S-14 is the worst, and the oil layer is the worst affected among the three oil wells. To sum up, the water injection effect and main water injection direction are shown in Figure 6.

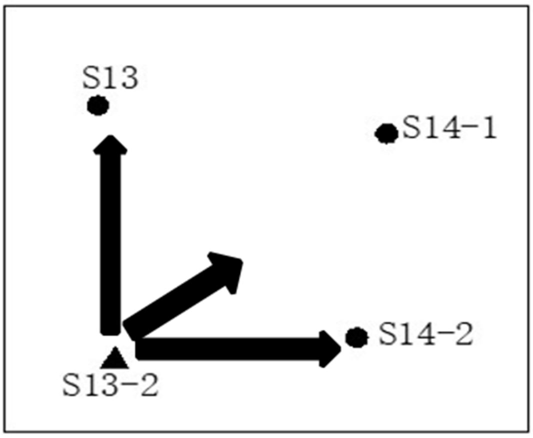

Fig 6. Well Location Distribution of S13 -2 Injection-Production Well Group

Production characteristics of oil and water wells: According to the analysis of the figure, it can be seen that increasing the monthly water injection rate ensures the increase of oil production. Generally speaking, the monthly oil production of well groups changes with the change of water injection rate, with the increase of water injection rate and the increase of oil production; with the decrease of water injection rate, the oil production decreases. In September 2000, the opposite change trend occurred, and the water injection effect was not obvious.

Effect of water injection: In the initial stage, oil production increases with increasing water injection volume, and the effect is obvious, reflecting that oil production increases with increasing water injection volume; in the middle stage, the effect of water injection begins to slow down; in the later stage, the effect of water injection decreases, curve intersection occurs, and oil production changes become small. Analysis of cumulative water injection and cumulative oil production curve in the figure shows that, with the passage of time, the slope of cumulative water injection curve deviates obviously from cumulative oil production curve upward, cumulative water production is equal to oil production in early stage, and gradually cumulative water injection is obviously greater than cumulative oil production, and the difference is larger and larger, which also indicates that the effect of water injection is decreasing.

The main geological factors affecting the waterflooding effect are reservoir heterogeneity: interlayer injection-production difference, plane injection-production difference; reservoir permeability and productivity coefficient; reservoir fracture; reservoir mineral composition and rock surface wettability, underground crude oil viscosity and oil-water ratio.

According to the analysis in Figure 7, the monthly liquid and oil production curves of Chang 2 reservoir in W Oilfield showed a stable trend before September 1997, with small variation amplitude, then showed a sharp increase trend, and showed a relatively stable variation trend after January 1998; the monthly oil production increased with the increase of monthly liquid production, and the daily oil production capacity remained within a small variation range, with gentle curves; At the inflection point in September 1997, oil production increased rapidly, which may be affected by the decrease of water cut, and reached its peak in December 1997. The decrease of water cut may be due to the need of water injection and pressure displacement in the early stage of oilfield development, which caused more water to be injected into the reservoir. At the inflection point, due to the decrease of oil production pressure, the formation of channels may be caused by capillary pressure or surface extraction pressure, resulting in the decrease of water cut.

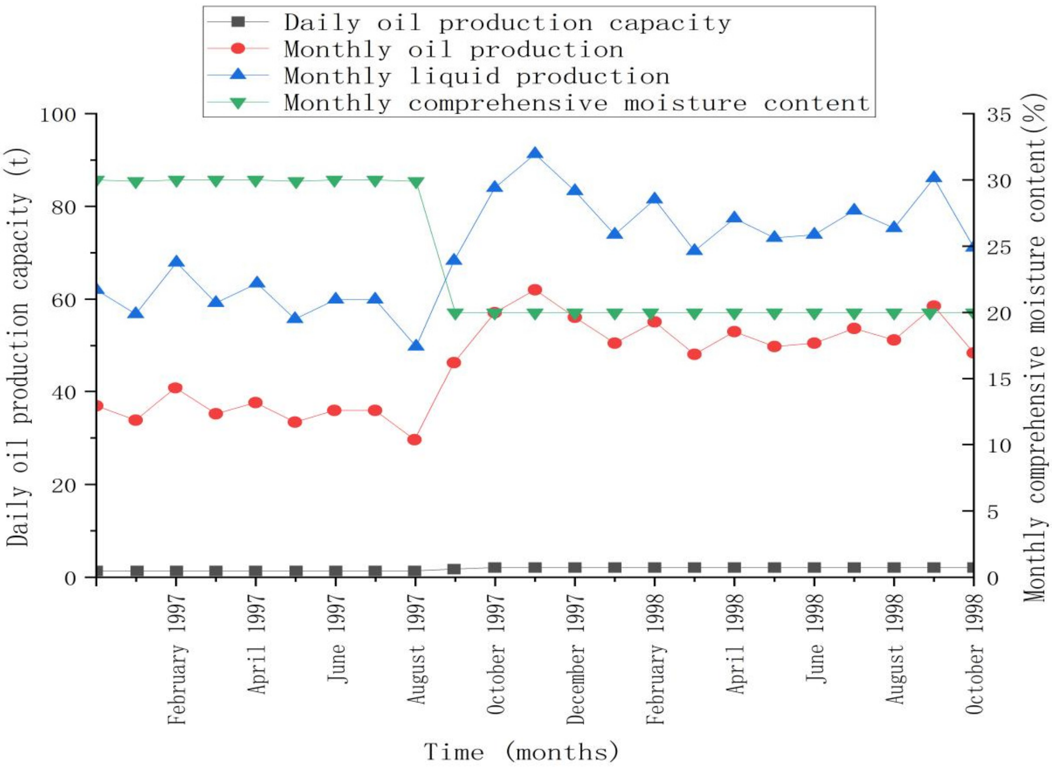

Fig 7. Curve of Monthly Liquid Production, Oil Production, Comprehensive Water Cut and Daily Oil Production Capacity of a Production Well in Chang 2 Reservoir of W Oilfield

4. Reservoir Pressure Analysis and Determination of Oil-Water Interface

Let A be a water well, B be an oil well, and the oil-water interface of the reservoir is between the two wells. It is known that the pressure in the middle of the oil layer measured by well B is P_B, the pressure in the middle of the water layer measured by well A is P_A, the difference in height between the two wells in the middle of the reservoir is H_{AB}, the density of crude oil is ρ_o, and the density of formation water is ρ_w. Calculate the depth h from the middle of the oil layer to the oil-water interface in well B (see Figure 8).

Note: Pressure unit is MPa; depth or height unit such as h and HAB is m; density unit of oil and water is t/m3; hydrostatic column pressure formula P=H×ρ/100 indicates (ρ is fluid density, H is liquid column height)

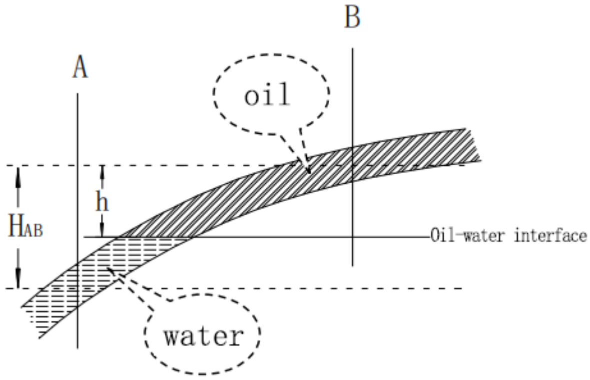

Fig 8. Calculate the depth h from the middle of the oil layer to the oil-water interface in well B

Bottom hole pressure of well A = bottom hole pressure of well B + oil column pressure from bottom hole of well B to oil-water interface + water column pressure from oil-water interface to bottom hole of well A

$$P_A=P_B+h\rho_o/100+(H_{AB}-h)\ \rho_w/100 \quad (1)$$

$$100(P_A-P_B)=h(\rho_o-\rho_w)+H_{AB}\rho_w \quad (2)$$

That is, the height of the oil-water interface is

$$h=(100(P_A-P_B)-H_{AB}\rho_w)/(\rho_o-\rho_w) \quad (3)$$

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