

WU Haibo, LI Junhui and CHEN Hongping, 2015. The reservoir forming characteristics and exploration direction of the condensate gas reservoir in Hailar Basin. *Acta Geologica Sinica* (English Edition), 89(supp.): 363-366.

The reservoir forming characteristics and exploration direction of the condensate gas reservoir in Hailar Basin

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Gas condensate is a special oil and gas resource, and it is a hot spot for geologists and geologists in recent years.. When gas condensate oil content is equal to or greater than 50g/m³, gasoline generally greater than 800m³ -1000m³, called condensate gas reservoir. Condensate gas reservoir phase is more complex, in the original formation condition, natural gas and condensate oil in a single state of the gas phase, and retrograde condensate rule compliance within a certain pressure range, it is a special type that different from the reservoir and gas reservoir. This type is mainly distributed in Western China including Tuha basin and Tarim Basin, it is also found in Bohai Bay Basin and Dongpu depression in the eastern part of the depression^[1-6]. In recent years, with the continuous deepening of exploration of Hailar basin, condensate gas reservoir was found in second segment of Nantun formation of well He10, showing good prospects for exploration.

In this paper, reservoir forming conditions were investigated, the forming model of condensate gas reservoirs was establishment, and favorable exploration area were predicted, the results have important guiding significance.

1 gas condensate reservoir types and genesis

1.1 gas condensate reservoir types

The condensate gas reservoir in the south two stage of the Hu and lake sag is buried deep in 1825 ~ 2639m, and the methane content of the gas is from 82.004% to 65.088%; The content of ethane and above hydrocarbons was from 15.65% to 30.68%; Nitrogen content of 0.992% ~ 1.8%; Carbon dioxide content of 0.54% ~ 5.991%; The relative density of natural gas is from 0.7018 to 0.8997 (Table 1)..

Fluid under ground is single gas phase, C₁+N₂ is 66.08% to 83.8%, C₂-C₆+CO₂ is 15.96% ~ 32.97% and

C₇+ is 0.228% ~ 0.931%. In the fluid reservoir fluid type triangular diagram, in condensate gas pool. Ground condensate oil color was light yellow transparent, the oil group composition dominated by saturated hydrocarbons, saturated hydrocarbon was 70.83% ~ 74.21%, with an average of 72.52%; The average of aromatic hydrocarbon is 14.876%, the average is 2.16%, the average is 10.915%, the density is 0.7047 ~ 0.8177g/cm³ (20), the average is 0.7612 g/cm³; The average viscosity of crude oil was 0.42 mPa.S ~ 2 mPa.S (20), the average was 1.21 mPa.S, the freezing point was 25°C~21°C, the content of sulfur was 0.067%, and the wax content was 9.8%. The change range of gas oil ratio of condensate gas reservoir is generally distributed between 10389m³/m³ ~ 25000m³/m³, and the gas oil ratio between Huhehu depression is between 1450 ~ 1000m³/m³. According to the output of the gas oil ratio of condensate gas pools are classified as low content of gas condensate, condensate oil, high gas condensate oil and high gas condensate oil and condensate gas reservoirs^[7]. Huhehu sag is a medium - high gas condensate gas reservoir.

1.2 Origin and source of gas condensate reservoir

The carbon isotopic composition of natural gas is the main geochemical parameter for studying its genesis and maturity.. The carbon isotopic compositions of methane in natural gas are mainly controlled by maturity.. And C₂+ depends mainly on the organic matter types of gas source rocks.. The analysis results show that the emphasis on natural gas carbon isotope of Huhehu sag, methane carbon isotope distribution in the -39.081 per thousand to -39.695 per thousand, c₂₋₅ heavy hydrocarbon gas carbon isotopic values were greater than 28 per thousand, alkane carbon isotope values may be affected by the mixing of coal type gas and oil type gas resulted in partial reversal. Through the geochemical characteristics and genesis of gas in well He10, natural gas is a gas mixture of condensate and coal gas mixture, and mainly from coal source rocks of second section of Nantun formation^[8].

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Table1 natural gas components in second segment of Nantun formation

井号	井深/m	CH ₄ /%	C ₂ H ₆ /%	C ₃ H ₈ /%	C ₄ H ₁₀ /%	C ₅ H ₁₂ /%	C ₆ H ₁₄ /%	C ₇ H ₁₆ /%	N ₂ /%	CO ₂ /%	ρ 相对
He10	1825-1831	82.004	7.644	5.272	1.15	1.087	0.276	0.167	1.8	0.54	0.7018
Hex1	2286.2-2449	65.088	10.525	11.291	3.197	3.616	1.121	0.638	0.992	3.221	0.8997
He18	2634-2639.6	79.064	9.526	4.563	1.013	1.331	0.479	0.369	1.564	1.864	0.7261
He18	2536-2639.6	72.984	10.192	5.676	1.105	1.533	0.482	0.391	1.441	5.991	0.7865

From the point of view of saturated hydrocarbon chromatography parameters, various sets of hydrocarbon source rock of coal measures of Pr / ph (basking Jiao alkane / phytane) were higher, suggesting it was derived in typical lacustrine facies sedimentary environment. The average Pr/Ph of crude oil is 4.28, and the Pr/Ph of second section of Nantun formation is higher, the average is 4.52, and the Pr/Ph of the coal series is 2.62, and the Pr/Ph of the coal series is lower, and the average is less than 2..

2 reservoir forming characteristics

2.1 high abundance and widely distributed mature coal source rocks are the intrinsic factors of the formation of gas accumulation formation.

The essential condition for the formation of condensate gas reservoir is that the gas content in hydrocarbon is far more than that of liquid, and the creation condition of the liquid in the gas phase [9]. From the generation and evolution mechanism of oil gas, the thermal evolution of organic matter is the important intrinsic geological element for controlling gas condensate reservoir..

During the deposition of the second section of Nantun formation, Huhehu depression is shallow marsh lake, lithology is mainly sand, coal and mud interbed. mudstone TOC of second section of Nantun distributed between 0.45% ~ 6.95%, S1 + S2 distributed between 0.09 mg / g to 22.74mg/g that of chloroform bitumen "a" distributed between the 0.0089% 1.0659%, mudstone organic matter abundance reached medium to good hydrocarbon source rock standard. Southern section of the coal and rock S1 + S2 distributed between the 26.72mg/g 324.37mg/g HI distributed between 54.1mg/g ~ 470.89mg/g, H/C distributed between 0.73 ~ 1.12, coal organic matter abundance reached medium to good hydrocarbon source rock standard [10]. The main source rocks of second section of Nantun are humic type, and the microscopic components of the coal source rocks are the main types of the microscopic components of the coal source rocks, and belong to the type II ~ III. The Ro distribution of source rocks is between two 0.5~ 1.67%, and is in the mature stage, and the main gas and the certain amount of

condensate are generated.. The thickness of the mudstone in single well is between 28.2m ~ 499.5m, the average thickness is 249.2m. The average thickness of the coal seam is between 12.6 m ~ 116.4m, the average is 72m. in the south of the area ,The area of Ro 0.5% reached 449km2 and the area of Ro more than 1% reached 82km2 . In summary, the high abundance of the south two stage, the widely distributed mature coal source rocks is the inherent factor of the formation of gas condensate reservoir.

2.2 the high temperature pressure is the external factor of the formation of the condensate gas reservoir

A necessary condition for the formation of condensate gas reservoir is the original formation pressure is higher than the dew point pressure, formation temperature is between the critical temperature and critical coagulation analysis between temperature and dew point pressure and critical temperature is mainly affected by under the conditions of formation of gas oil ratio and hydrocarbon mixtures of original composition factors influence, gas oil ratio and light hydrocarbon content is high, heavy hydrocarbon content is low, the higher the critical pressure of oil and gas reservoir system, the critical temperature is lower. gas condensate reservoir PVT phase behavior experiment analysis in Well He10 showed that between condensate gas reservoir formation temperature (68.75 DEG C) between the critical temperature (63.28 DEG C) and critical condensate condensate temperature (12.41 DEG C), the condensate gas reservoir pressure 17.1MPa is higher than the dew point pressure (11.58 MPa).The source rocks in second section of Nantun formation are deeply buried, the reservoir temperature is high, and hydrocarbon of hydrocarbon is higher, which is favorable for forming gas condensate reservoir..

2.3 the high quality reservoir is the main controlling factor for the enrichment and the high yield of gas condensate reservoir

In the second section of Nantun formation, the main source system of the short axis is the main source system, the fan delta and braided river delta are deposited.. The

reservoir physical property is controlled by the phase belt and diagenesis.. Shore shallow lake sand body porosity distribution in 1.6% to 11.3%, generally less than 10%, the reservoir is poor; braided river delta plain and fan delta plain sand body porosity distribution in 1.1% ~ 40%, generally less than 10%, local distribution of high quality reservoir; braided river delta front sand body porosity distribution in 1.3% to 23%, generally greater than 10%, confirmed that the frontal sand body reservoir of high quality reservoir. The relationship between the gas bearing zone and the sandstone in the sandstone relationship shows that the gas bearing zone is mainly distributed in the reservoir of plain and front and the porosity is greater than 10%..

Longitudinal development of multiple secondary porosity development zones. Secondary porosity is mainly intergranular dissolution pore and intragranular dissolution pore, dissolution pores is mainly feldspar, debris and carbonate interstitial material acid labile group is generated after the dissolution, south of sand, mud and coal seam coexistence provided for the formation of secondary pores and acidic medium.

2.4 a thick mudstone cover is the important guarantee for gas condensate reservoir formation.

Good cap rocks are essential for the reservoir forming of condensate gas reservoir.. Quality of cap rocks can effectively prevent condensate gas of vertical oven, maintain the proportion of oil and gas and stable critical temperature pressure system. Damoguahe group which covering Nantun formation develops deep lake facies dark mudstone the ration of mudstone is 71.15%~97.24%, the average value is 85.98%. Thickness distribution between with~930m, average for 577m. The early fracture system of the end of the formation of the Yimin formation is rarely cut through the large part of the mudstone, and therefore, the large mudstone is the direct cover of condensate gas reservoir in second segment of Nantun formation

3 Favorable exploration direction

The reservoiring characteristics in southern Huhehu depression is source- reservoir together , mature source rocks in second segment of Nantun formation which are high abundance in organic, widely distributed , coal measuring provide rich materials for the formation of condensate gas reservoir. braided river delta and fan delta from the short axis develpe good reservoir and directly contact with sources rocks, it is favorable for gas accumulation. Series of fault nose and fault block structure in gentle slope transition zone provides a good place for

the enrichment of oil and gas accumulation. Overlying Dayi section developed thick mudstone, privid cap rocks. second segment of Nantun formation in gentle slope and steep slope zone near the trough area are deeply buried, with high temperature and pressure. Above all, lower part of the gentle slope and conversion tectonic in subsag which easy to form the self generation and self storage type gas condensate reservoirs, are the favorable exploration areas .

4 conclusions

(1) In Huhehu sag, condensate gas reservoirs mainly belong to medium - high gas condensate gas reservoir, natural gas condensate associated and coal type gas mixture, mainly from the coal measure source rocks in Nantun formation .

(2) Second section of Nantun formation has condensate gas reservoir forming conditions, high abundance, widely distributed, coal measuring, mature source rocks provide rich material base, braided river delta front sandbody provides good reservoir conditions , high temperature and high pressure making the light oil dissolved in gas condensate reservoirs, thick mudstone in K_{1d1} prevent condensate gas dissipation reservoir, maintain condensate gas reservoir to the dynamic equilibrium state.

(3) Lower fault order and conversion tectonic belt on the southern gentle slope have good source reservoir cap combination, easy to form the self generation and self storage type gas condensate reservoirs, are condensate gas reservoir favorable exploration zones.

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