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# The comprehensive evaluation of classified reservoir of Ⅳ oil group of He San period of Wang 9 wellblock

Li Jiaona[1],Li Meng[1],Wang Shuang[2],Zhang Shoulun[3],Ma Zhipeng[4]
*1.Northeast Petroleum University, Daqing, Heilongjiang, China, 163318*
*2.Eighth Oil Production Plant, Daqing, Heilongjiang, China,163514*
*3.Fourth Oil Production Plant, Daqing, Heilongjiang, China,163511*
*4.Logging&Testing Services Company, Daqing, Heilongjiang, China,163853*

**Abstract:** The reservoir of Wang 9 wellblock of WangJi oil field mainly contains conglomeratic sandstone,fine sandstone and siltstone.It develops sedimentary microfacies,which mainly contains underwater distributary channel sands,underwater shore sands,front sheet sands and turbidite sands.The reservoir physical property is better,and the reservoir belongs to medium porosity and medium permeability reservoir and medium porosity and high permeability reservoir.This study is on the basis of comprehensively analyzing the geological data of Wang 9 wellblock, appropriately seeking the sandstone thickness, effective thickness, porosity, permeability and sedimentary microfacies as main parameters and establishing the reservoir comprehensive classification evaluation standard.The reservoir of the study area which from good to bad is evaluated for A, B, C, D four types.The evaluation result indicates: In the each small layer of Ⅳ oil group of He San period of Wang 9 wellblock,widely distributes type B and type C reservoir,type A reservoir appear less in this area,type D reservoir widely distributes in some individual small layers.

***Key words:*** *Wang 9 wellblock; comprehensive evaluation of classified reservoir; sedimentary microfacies; reservoir physical property*

## I. INTRODUCTION

WangJi oil field is located in the easternmost part of the north slope zone of BiYang sag of Nanxiang basin[1-2],which between TangHe county and BiYang county,and the exploration area is almost 100 $km^2$,it has the characteristics of multiple source,multiple sedimentary system development and fault development[3-4].Wang 9 wellblock is located in the west wing of WangJi rolling nose-like structure,its structure is relatively simple,the stratum raises from southwest to northeast as a whole,leaning to southwest,and the stratum dip angle is 4°～17°.It mainly develops two north east east strike f3 and f4-2 faults,and one north east strike f4 fault,the three faults and sandbody control the Wang 9 wellblock's oil-gas accumulation.The reserves of Wang 9 fault is $220\times10^4$t,the main oil-producing layer is Ⅳ oil group and Ⅴ oil group of He San period.

Reservoir evaluation is an important technical means of predicting and evaluating oil-gas favorable zones,and it is comprehensive understanding and judgment of reservoir study.Reservoir classified evaluation is an important part of studying oil field development geology and reservoir engineering,doing a good job in this work will have a importantly realistic significance in improving the exploitation effect and exploitation level and realizing scientifically manage oilfield. Reservoir evaluation is mainly from the view of sedimentary facies,petrology,lithology and so on,synthesizing diadenesis,the temperature and pressure of reservoir , reservoir physical property,oil-gas possibility,conducting the reservoir comprehensive evaluation.This study combines Wang 9 wellblock's geologic feature, appropriately seeking the sandstone thickness, effective thickness, porosity, permeability and sedimentary microfacies as main parameters,conducting a comprehensive evaluation of the reservoir of the study area.

## II. SEDIMENTARY MICROFACIES DISTRIBUTION CHARACTERISTICS

As to sedimentary facies, the Ⅳ oil group of He San period of Wang 9 wellblock is located in delta front,prodelta and deep lake-half deep lake subfacies,which mainly develops underwater distributary channel sands,front sheet sands, underwater shore sands and turbidite sands.

The study area of WangJi oil field Wang 9 wellblock is smaller,the main interest intervals of Ⅳ oil group of He San period are totally influenced and controlled by the northwest (north) WangJi delta front,and the southeast HouZhang delta has less influence on it.Its sedimentary face and sand body development are not that complex.

## III. SAND BODY THICKNESS AND EFFECTIVE THICKNESS DISTRIBUTION CHARACTERISTICS

### 3.1 Sand body thickness distribution characteristics

Sandstone thickness can reflect a certain layer,namely in a period of sedimentation the source supply quantity and the source property. The sand body distribution of Ⅳ oil group of He San period of Wang 9 wellblock is mainly influenced by the northwest (north) WangJi source,but each small layer has different source supply and sedimentary characteristics in its puberty,which leads to the distribution regular of each small layer exists obvious difference. The sand body intensively develops in $H3Ⅳ5^1$, $H3Ⅳ5^2$, $H3Ⅳ5^4$, $H3Ⅳ5^5$, $H3Ⅳ6^4$, $H3Ⅳ7^1$ and $H3Ⅳ7^2$ small layers, the sand body distribution is relatively continuous,but internal sand body appears the characteristics of thick and thin alternative distribution.As a whole the thick sand body distribution is strip-shaped, and its extension direction is basically from northwest to southeast.The sand body distribution scale in other layers is smaller,especially in $H3Ⅳ5^3$,$H3Ⅳ6^2$ and $H3Ⅳ6^3$ small layers,the sand body don't develop,and it mainly contains lacustrine facies mudstone or thin layer sandstone.

### 3.2 Effective thickness distribution characteristics

The difference of effective thickness development of each small layer of Wang 9 wellblock is larger,and H3Ⅳoil group is the main oiliness layers, $H3Ⅳ6^4$,$H3Ⅳ7^1$ and $H3Ⅳ7^2$ most develop,respectively the single layer average effective thickness is 3.5 m,2.25m and 2.22 m; the second is $H3Ⅳ5^1$ and $H3Ⅳ5^4$, respectively the single layer average effective thickness is 1.77 m and 1.83 m.Among them, $H3Ⅳ5^2$ small layer's effective thickness is 0.6 m to 1.5 m,the average is 0.97 m,its effective thickness distribution is basically strip-shaped; $H3Ⅳ6^4$ small layer's oiliness sand body thickness is large,its effective thickness is 1.0 m to 6.2 m,the average is 3.5 m,and the effective sand body mainly develops in the north of the Wang 9 wellblock; $H3Ⅳ7^2$ small layer's effective sand body mainly distributes in the north-central of the study area,and its effective thickness is 0.6 m to 4.6 m,the average is 2.22 m.

## IV. RESERVOIR PHYSICAL PROPERTY DISTRIBUTION CHARACTERISTICS

### 4.1 Porosity distribution characteristics

Based on the core and electric logging interpretation, the porosity of the purpose layers of Ⅳ oil group of He San period of Wang 9 wellblock is between 10.03% and 36.02%,the average is over 18.16%[5].The difference of the porosity value of every small layer of Ⅳ oil group is larger,the porosity value of the small layers in which channel sands relatively develops is large,the drilled well points is much,distributes widely,such as $H3Ⅳ5^4$,$H3Ⅳ6^4$ and $H3Ⅳ7^1$.But in the top and bottom of the large-scale channel,the porosity value is little low because of the shaliness, such as $H3Ⅳ5^5$,$H3Ⅳ6^4$ and $H3Ⅳ7^2$.The porosity value of the middle is the highest,which indicates there is some certain correlation between sedimentary microfacies and reservoir porosity.

**4.2 Permeability distribution characteristics**

The average permeability of every small layer of Ⅳ oil group distributes differently on the longitudinal,as a whole the permeability is lower,the average permeability is between $124\times10^{-3}\mu m^2$ and $559\times10^{-3}\mu m^2$,but the relatively high permeability section has some regularity,which keeps a line with the cyclicity of the thick channel sand body.The permeability of the purpose layers of this area mainly belongs to medium permeability,and the minority is high permeability.

In conclusion,to the physical property of the main sand layers of this part,the porosity gives priority to the medium-high value ,and the permeability mainly belongs to medium value,a few belongs to high value.Combining with the analysis of the logging interpretation of the permeability characteristics, the main sand layers basically belong to the types of medium porosity and medium permeability and high porosity and medium permeability reservoir.

## V. RESERVOIR PHYSICAL PROPERTY AND SEDIMENTARY MICROFACIES

Reservoir physical property is controlled by the types and distribution of the sedimentary microfacies,by the statistical analysis of the reservoir physical property and sedimentary microfacies of every small layer sand body,the average porosity of underwater distributary channel sand body is 20.62%,the average permeability is $293\times10^{-3}\mu m^2$,so the underwater distributary channel sand body has the characteristics of medium to high porosity and medium to high permeability;The average porosity of underwater shore sands is 19.77%, the average permeability is $169\times10^{-3}\mu m^2$,the underwater shore sands is sedimentation which the underwater distributary channel's edge becomes thin,and its physical property relatively getting worse,so the underwater shore sands mainly has the characteristics of medium porosity and medium permeability; The average porosity of front sheet sands is 19.12%, the average permeability is $189\times10^{-3}\mu m^2$,it is transformed veneer of the front end of the underwater distributary channel,and has the characteristics of medium to high porosity and medium permeability; The average porosity of turbidite sands is 18.47%， the average permeability is $139\times10^{-3}\mu m^2$,and it has the characteristics of medium porosity and medium permeability.The interest interval reservoir of this research is mainly consist of underwater distributary channel sands and front sheet sands,so the reservoir physical property gives priority of medium to high porosity and medium to high permeability,and some has the characteristics of medium porosity and medium permeability.

Underwater distributary channel sands(figure 1):porosity distributes between 10.8% and 36.02%,porosity distributes in unimodal type.Among them,medium porosity reservoir takes up 77.15%,high porosity reservoir takes up 15.03%;Permeability distributes between $7\times10^{-3}\mu m^2$ and $2670\times10^{-3}\mu m^2$,medium permeability reservoir takes up 71.94%,high permeability reservoir takes up 13.03%.So the underwater distributary channel sands gives priority to medium porosity and medium permeability reservoir,and a few belongs to medium to high porosity and high permeability reservoir.

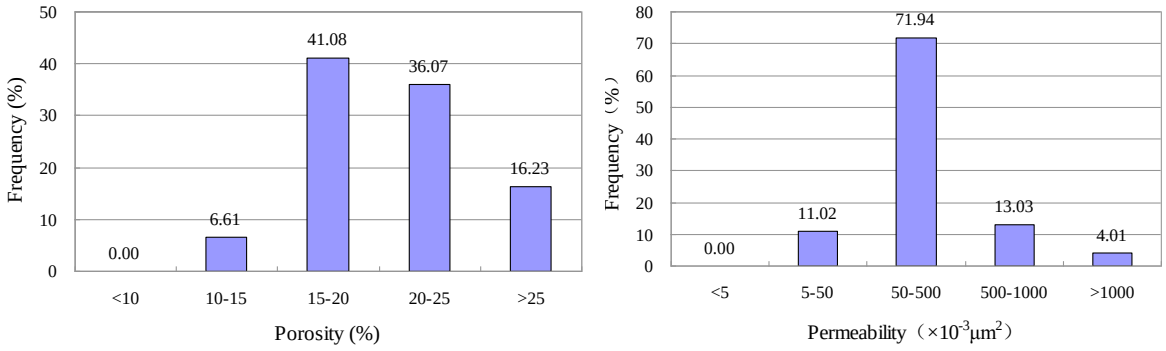


Fig.1 physical property distribution of underwater distributary channel sands

Underwater shore sands: porosity distributes between 16.02% and 24.34%,which belongs to medium porosity reservoir.Porosity distributes in unimodal type,but it has certain difference with the underwater distributary channel sands; Permeability distributes between $33\times10^{-3}\mu m^2$ and $420\times10^{-3}\mu m^2$,among them,medium permeability reservoir takes up 94.44%,low permeability reservoir takes up 5.56%, so the underwater shore sands gives priority to medium porosity and medium permeability reservoir, and a few belongs to medium porosity and low permeability reservoir.

Front sheet sands(figure 2): porosity distributes between 10.03% and 27.61%, and porosity distributes also in unimodal type.Among them,medium porosity reservoir takes up 79.19%,low porosity reservoir takes up 13.71%;Permeability distributes between $6\times10^{-3}\mu m^2$ and $1252\times10^{-3}\mu m^2$, medium permeability reservoir takes up 69.54%, low permeability reservoir takes up 25.38%,so the front sheet sands gives priority to medium porosity and medium permeability reservoir, and a few belongs to medium porosity and low permeability reservoir.The distribution of the permeability offsets to the low value obviously,but a few high permeability reservoir also exists.

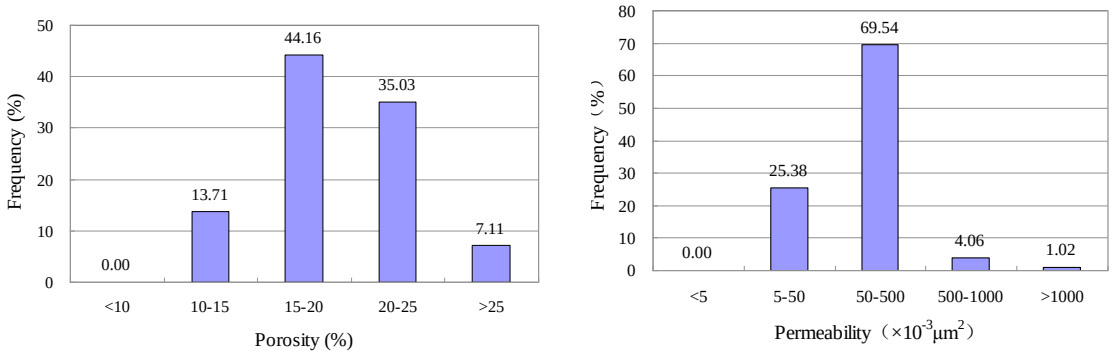


Fig.2 physical property distribution of front sheet sands

Turbidite sands: porosity distributes between 11.88% and 27.30%, and porosity distributes in unimodal type.Among them, medium porosity reservoir takes up 66.67%, low porosity reservoir takes up 25.93%; Permeability distributes between $7\times10^{-3}\mu m^2$ and $710\times10^{-3}\mu m^2$,which gives priority to medium and low permeability,medium permeability reservoir takes up 66.67%,low permeability reservoir takes up 29.63%,so the turbidite sands gives priority to medium porosity and medium to low permeability reservoir.

## VI. THE COMPREHENSIVE EVALUATION OF CLASSIFIED RESERVOIR

The relationship between the porosity and permeability of the sandstone reservoir of WangJi oilfield is complex,and the anisotropy mainly belongs to medium to relatively strong,so the reservoir comprehensive evaluation is difficult[6-8].This research is based on the study of the sandstone thickness, effective thickness, porosity, permeability and sedimentary microfacies,combining the reservoir physical property classification standard of the oil and gas industry,so the reservoir comprehensive classified evaluation standard has been established(table 1).

Tab.1 reservoir evaluation standard of H3Ⅳ oil group of Wang 9 wellblock

| | Type A | Type B | Type C | Type D |
|---|---|---|---|---|
| Sandstone thickness h（m） | h≥5 | 3≤h＜5 | 1≤h＜3 | h＜1 |
| Effective thickness $h_e$（m） | $h_e$≥3 | 2≤$h_e$＜3 | 1≤$h_e$＜2 | $h_e$＜1 |
| Porosity Φ（%） | Φ≥25 | 20≤Φ＜25 | 15≤Φ＜20 | Φ＜15 |

| Permeability K（$\times10^{-3}\mu m^2$） | K≥1000 | 500≤K＜1000 | 50≤K＜500 | K＜50 |
|---|---|---|---|---|
| Types of sedimentary microfacies | 1 | 2 | 4 | 3 |

Based on the established evaluation standard,the reservoir of this study area which from good to bad is evaluated for A, B, C, D four types.Among them,for the type A reservoir,its sand body thickness is more than 5m, it belongs to the high porosity and extra-high permeability reservoir of the underwater distributary channel; For the type B reservoir, its sand body thickness is between 5m and 3m, it mainly belongs to the medium porosity and high permeability reservoir of the underwater distributary channel; For the type C reservoir, its sand body thickness is between 3m and 1m,it belongs to the medium porosity and medium permeability reservoir of a few underwater distributary channel sands, underwater shore sands, front sheet sands and turbidite sands; For the type D reservoir, its sand body thickness is less than 1m, it belongs to the low porosity and low permeability reservoir of the underwater shore sands, front sheet sands and turbidite sands.

Synthesising the evaluation result of each layer of the Ⅳ oil group of He San period of Wang 9 wellblock,we can get the conclusion that type A reservoir appears less in this area,it just distributes in the very few wells in $H3Ⅳ5^4$,$H3Ⅳ5^5$,$H3Ⅳ6^4$ and $H3Ⅳ7^1$;Type B reservoir distributes widely,and its distribution scale includes most of the underwater distributary channel sands and a few turbidite sands; Type C reservoir distributes widely in the most layers of this area, and its distribution scale includes a few underwater distributary channel sands, underwater shore sands, front sheet sands and turbidite sands; Type D reservoir widely distributes in the $H3Ⅳ5^1$ and $H3Ⅳ5^2$ where the underwater distributary channel doesn't develop,and it just distributes in the individual wellblock of other small layers.

## VII. CONCLUSION

(1) The objective interval reservoir of this research is mainly consisted of underwater distributary channel sands and front sheet sands,and the reservoir physical property gives priority to medium to high porosity and medium to high permeability,and some has the characteristics of medium porosity and medium permeability.

(2) Combining the parameters such as sandstone thickness, effective thickness, porosity, permeability and sedimentary microfacies,the reservoir comprehensive classified evaluation standard has been established, and the reservoir of this study area which from good to bad is evaluated for A, B, C, D four types. In the each small layer of Ⅳ oil group of He San period of Wang 9 wellblock,widely distributes type B and type C reservoir,type A reservoir appear less in this area,type D reservoir widely distributes in some individual small layers.

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