IOSR Journal of Engineering (IOSRJEN) **www.iosrjen.org**
ISSN (e): 2250-3021, ISSN (p): 2278-8719
Vol. 05, Issue 08 (August. 2015), ||V2|| PP 05-14

Analysis about well pattern adaptability to reservoir in Bozhong 25-1 South oil field in lower member of Minghuazhen

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Abstract: - Bozhong 25-1 South oil field is a complex fluvial facies conventiona heavy oil field discovered in Bohai bay, after putting into operation since 2004,thy have achieved remarkable development effect. To keep stable or more efficient in the next development, we must relalise the reservoir adaptation present of well pattern. This article from the sand body width and layer well spacing, degree of control of sand well spacing to each sand body, degree of control of development well spacing to each sand body, these three main aspects to analysis the reservoir adaptation of well pattern, then fold together all the small layers in the same oil group vertically, gather parts into a whole,to analysis sand body of the whole oil group influenced by the degree of well pattern control. The final conclusion, the control of reservoir in Bozhong 25-1 south oilfield is low degree, the development potential is very great.

Keywords: *- layer well spacing, sand well spacing, development well spacing, degree of control*

I. INTRODUCTION

After more than 40 years of exploration and development, Bohai oilfield has obtained abundant oil reserves in the Minghuazhen group and the Guantao group of the neogene system. It has already accounted for 56.3% of the total proven oil reserves in Bohai oilfield (Bohai oil field reserves statistics in 2012), to achieve the efficient development of such reservoirs is of great significance for the increase production and stable production of Bohai oil field[6].

According to the present research of sedimentary characteristics and development situation of Bozhong 25-1S oil field, clear the subsurface sand body exploitation degree, namely situation of sand body by well control, can be a basic understanding of the potential of development, that has advantage for the next step development strategy deployment [1] .

II. OVERVIEW OF RESEARCH AREA

Bozhong 25-1S oil field located in Bonan uplift west plunging end in regional structure, near the Bonan sag in eastern, next to Bozhong depressions in northern, which is a large neogene conventional heavy oil field founded in Bohai Sea[2-3]. The main purpose layers are in the lower Minghuazhen group, is an important part of oil-bearing formation in Bozhong sag. After a period of research, Bozhong 25-1 south in purpose layers of study area is divided into 6 oil group (I to VI oil group) in vertical, a total of 68 sedimentary units. Main ecological reservoir located in the IV, V, VI oil group, that is subdivided into 13, 8, 6 depositional time unit, each unit has channel development, there are 129 channels developed in these three oil groups.

III. RESEARCH PURPOSES

Althoughg we have achieved significant development effect in Bozhong 25-1S oilfield at present, the area still faces has great developing potential or not, and production rate decline,and how to deploy mining scheme next step to achieve sustainable high yield. To solve these problems, the most important thing is to define the degree of reservoir development. The concrete content of the research is the division of the layer and the adaptability of the well pattern to the reservoir. In short, it is to analyze whether the current well pattern density suits to the sand body in the study area. After study, channels in IV, V, VI oil group in Bozhong 25-1 oilfield is small scale, small well spacing density, large well spacing. Whether so large well spacing can control the narrow channel sand body, can control to what extent, are the problems need to carefully study. In particular, is to determine whether wells in the small layer can drill sand bodies in this layer, as well as in the direction along the river sand body can control the entire river.

IV. PRELIMINARY STUDY PREPARATION

4.1、Define there well-spacing

In order to make the analysis more concise and clear, we must first clarify the concept of the three well distance before beginning the research.

4.1.1、Layer well spacing:

In the region of the determined boundaries, dividing the well pattern in whole region for the closest development zone, relatively dense development area, the normal density and thin development area according to the well point density. The different well spacing density boundary in 1/2 of well spacing, then statistics of all kinds of well spacing density parameters; to develop the region well spacing density standard; statistics different well spacing density well distance of the 27 layers, that is the layer well spacing(table 4.1-1，Fig.4.1-1).

Well pattern density standard	Measure /km^2	Number	Average well density,well/ km^2	Average well spacing/m	Proportion%	Measure sproportion%
The whole area	65	175	3	610	100	100.0
The most dense-	5	27	6	420	15.4	7
More dense-	22	82	4	520	46.9	35
Normal dense-	19	52	3	610	29.7	29
More dilute-	19	14	1	1170	8	29

Table 4.1-1: Statistics of well spacing density

4.1.2、Sand well spacing:

Within each layer, connecting the two adjacent wells direction among wells drilling inside channel sand bodies, and connecting all wells in the river into a line, the total length of the line is equal to accumulated well spacing along channel, so the average well spacing between two adjacent wells is sand well spacing (sand well distance = accumulation spacing along channel / well spacing section number)(Fig.4.1-2).

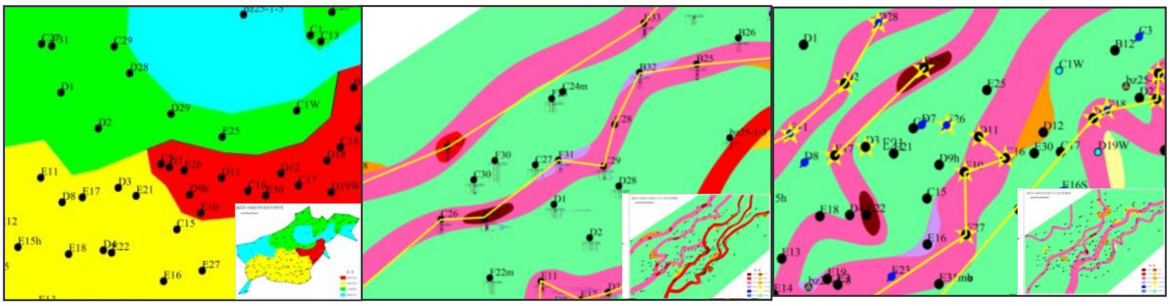

Fig.4.1-1: Measurement of layer spacing Fig.3.1-2: Measurement of sand well spacing Fig.3.1-3: Measurement of development well spacing

4.1.3、Development well spacing:

Within each layer, developed wells drilling the layer inside channel sand bodies(stars in figure), connecting the two adjacent wells along the channel direction, connecting all development wells in river into a line, the length of the line is development cumulated well spacing along the channel, so that average length between two adjacent wells is development well spacing. (development well spacing = cumulative development well spacing along the channel/development well spacing section number)(Fig.4.1-3).

4.2、Channel sand body classification

In order to facilitate the formulation and adjustment of the development plan, the channel sand body is divided into different classes of each river, which can clear the main development sand body. In the process of studing well pattern adaptability, we need to specific analyse according to channel classes, not all sand lump together. The process of dividing the river course is as follows:

4.2.1、Selecting parameters related to river types and the formulating standards

Parameter one:Channel width

The width of the channel is closely related to the size of the sand body and the development of the channel. Therefore, according to the distribution of the width of the channel, the channel type is established(Table 4.2-1(a))；

Parameter two: Channel sand body thickness

The thickness of channel sand body is closely related to the size of reserves, so the standard of river type is formulated according to the thickness of the river channel sand body(Table 4.2-1(b)；

Parameter three: Micro facies type and proportion

Micro facies types are determined by the single well curve, the thickness of sandstone and the interpretation of logging, which can explain the characteristics of the micro facies sand body, reservoir capacity, and so on. Therefore, determine the channel type according to the micro facies type of channel sand body and the proportion(Table 4.2-1(c).

Type	Width	Scale
Ia	700≤W<800	Large a
Ib	600≤W<700	Large b
Ic	500≤W<600	Large c
IIa	400≤W<500	Middle a
IIb	300≤W<400	Middle b
IIIa	250≤W<300	Small a
IIIb	200≤W<250	Small b
IVa	100≤W<200	Smaller a
IVb	W<100	Smaller b

Type	Thickness	Scale
Ia	10≤H<12	Thickest
Ib	8≤H<10	Thick a
IIa	6≤H<8	Thick b
IIb	4≤H<6	Mid thick
III	2≤H<4	Thin
IV	H<2	Thinest

Type	Facies and proportion	
Class I	Main and class I>70%	
Class II	----	50%-70%
Class III	----	30%-50%
Class IV	----	<20%

Table 4.2-1(a): According to width Table 3.2-1(b): According to thickness of sandTable 3.2-1(c): According to types of micro facies

In addition, the permeability and porosity of the river are the reference standard, and when the channel sand body width and thickness is medium, the proportion of the micro facies is moderate, if the permeability and porosity is high, the river can be judged as a good type of river.

4.2.2、Application of established standards to determine the type of river

According to the above standard, the 129 rivers in 27 layerse are divided into four categories:I,II,III,IV. In the process of judging, when we meet individual sand bodies are wide and the physical parameters is not high or the sand body is narrow and the physical parameters is high, according to the concrete analysis, the main channel classification standard is of size of the sand body.

Analyse the results of the classification of the channel, among 129 rivers in 27 small layers, the class II and class III channel are majority, class I channel and class IV channel is less development.

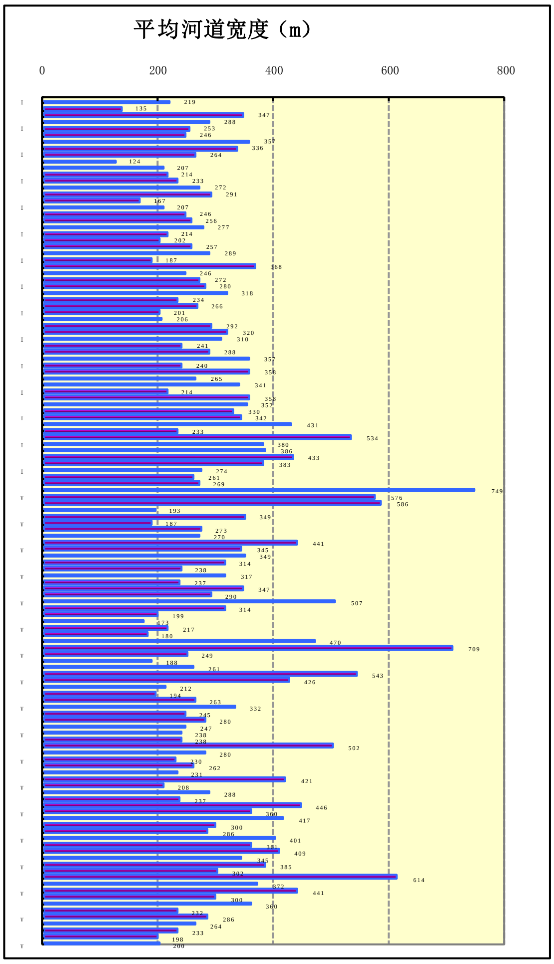

Fig. 4.1-1: Stick plot of Channel width control sand body

V. CONTROL LEVEL OF RESERVOIR BY WELL PATTERN

The adaptability of the well pattern to the reservoir is the key concern of the development. Whether current well pattern can control the sand body in the layer, directly determine the effect of the exploitation, and the deployment of the next development plan. Therefore, it is critical to accurately possess the control of current sand body[5]. The relationship between the width of the channel sand body in vertical direction and the distance between layers determines the sand body control level. If the width of sand body is larger than that of well distance, the sand body can be drilled in the vertical direction for at least one well, sand body is wider, more wells drilled; Conversely, the width of the sand body is less than the well distance, sand body can't or at least drilled by one well[7]. For selection of layer well spacing, the calculated distance above are 420m, 520, 610m, 1170m,that is not convenient to apply, so we choose rounding numerical 400m, 500m, 600m, 1000m,then the analysis below uses integer values.

5.1、Relationship between width of channel sand body and layer well spacing

5.1.1、Control of width of the channel by layer well spacing

The width of the 129 channels is made into rods, each of which represents a channel, and the length of the rod represents the width of the channel. In the 400m, 500m, 600m width position,using vertical lines to mark them, beyond tag line in right represents the channel controlled by the 400m, 500m, 600m layer well spacing. Then statistic the number and proportion of channel controlled by 400m, 500m, 600m layer well spacing, including number and proportion of all types of channel.

As can be seen from the diagram, only a small part of of the rods beyond the 400m scale. This indicates that the current density of well pattern can control a total of 20 rivers, only 15.5% of the total number of rivers, among them there are 9 Class I channels, 75% of the total number of Class I channels, 11 Class II channels, 14.47% of the total number of Class II channels.

There are 109 channels uncontrollable, there are 3 class I channels and most of the Class II channels, all of the Class III and Class IV channels. Among uncontrolled channels ,about 13% of the channel width is nearly 400m, almost all of which is a Class I and Class II channels, and this part of the river also have possibility of drilling by wells under the condition of 400m layer well spacing.

From the width of the river, the well spacing is so large that the current well pattern can not control most of the channel sand bodies. We can reasonably infer that the the sand bodies beyond control of the well pattern also have a lot of potential and can be the focus of the next step(table 5.1-1).

Layer well spacing（m）	Number	Proportion	Class I channel	Class I proportion	Class II channel	Class II proportion
＜400	109	84.5%	3	25%	65	85.53%
400	11	8.53%	3	25%	8	10.52%
500	6	4.65%	3	25%	3	3.95%
600	3	2.33%	3	25%	0	0%
1000	0	0%	0	0%	0	0%

Table 5.1-1: Statistical table about channel controlled by well pattern

In order to clear the degree of difference of oil group controlled by the current well pattern, find out critical developing object in three oil groups. Then statistics degree of channel width in IV, V, VI oil group controlled by well pattern respectively.(Fig. 5.1-2).

There are 3 channels in IV oil group under the control of current layer, all of them are class II channel; There are 11 channels in V oil group under the control of current layer, 6 Class I channels, 5 Class II channels; There are 6 channels in VI oil group under the control of current layer, 3 Class I channels, 3 Class II channels

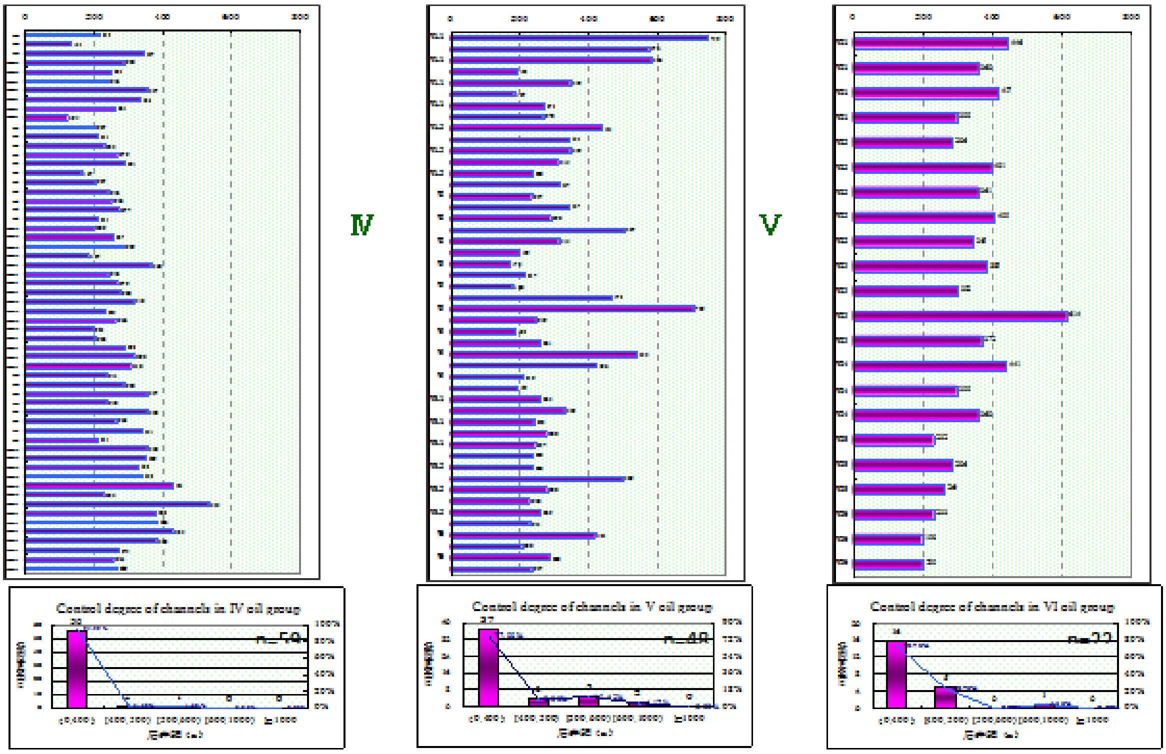

Fig. 5.1-2: River width controlled by the current well pattern in each oil group

On the whole, of the three oil group, channes in VI oil group has highest controllable degree,among four types of channels Class I and Class II channel has highest controllable degree. For the number of controllable channels, all the three oil groups need to be further developed, the remaining oil potential is great.

5.1.2、The control rate of width of all kinds of channels by the layer well spacing

In order to reflect the extent of the width of the channel controlled by the layer well spacing exactly, express the ability of each channel controlled by the layer well spacing quantitatively, a new concept called ” control rate” is introduced . Channel width / layer well spacing is the value of control rate, which means in the case of the current layer well spacing, the river in the vertical direction of source can at least drilled by how many wells. If the control rate was 1, that means well spacing is equal to river width, at least one wells can be drill in the river,and the river is controllable; Conversely, control rate was less than 1, well spacing is bigger than the width of the river, channel sand body is difficult to be drilled by wells; so the of the river that has control rate more than or equal to 1 can be controlled[4].

Under the control of 500m layer spacing, the control rate of each channel is as follows (Figure 4.1-3).

In Class I river, the proportion of control rate is more than or equal to 1 is 75%, and no river has control rate less than 0.5; proportion of Class II channel that has control rate more than or equal to 1 is 14.47%; is less than 1. Therefore, under the condition of 500m layer well distance, the control level of the Class I channel is the highest, which is much higher than that of the Class II and Class III channels,the Class IV channels are all uncontriollable.

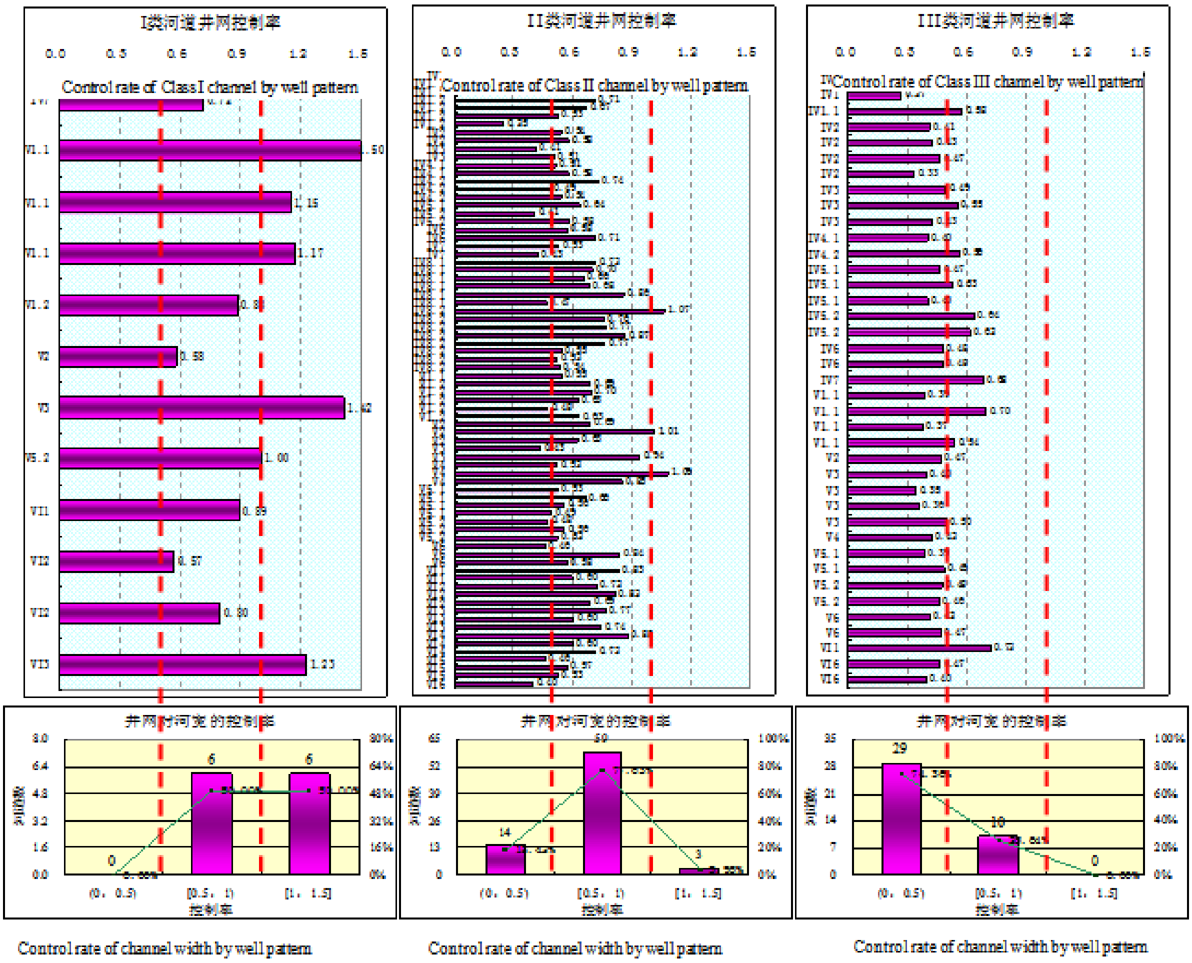

Fig.5.1-2: Control rate of each type of channel in 500m layer well spacing

Under the control of 500m layer well spacing,studing the control rate of each type and each river:in Class I channel, control rate of 50% channels is greater or equal to1, no channel has control rate < 0.5; control rate of 3.95% Class II channels is more than or equal to. Therefore, under the condition of 500m layer well spacing, the control level of Class I channel is the highest, which is much higher than that of the Class II channels, all of the Class III and Class IV channels are all uncontriollable.

Under the condition of 600m layer well spacing , the channel can be controlled is very few, less than 5%, and under the condition of 1000m layer well spacing ,all the channels are not controllable, therefore, we don't go on a thorough study. In addition, the regional distribution of 500m layer well spacing is the widest and most representative, so the research on the control rate under the condition of 500m layer well spacing is the most significant, and the conclusion of the control rate of 500m layer is the focus of the development strategy research.

5.2、Analysis of the degree of sand body controlled by sand well spacing

Different from the control of channels by layer well spacing, sand well spacing is well spacing along the direction of the channel. Since each channel has been drilled along the direction of the source, so the control of sand well spacing is reflected in the size of the sand body and the number of the drilled wells. The average sand well spacing of all the channels is 770m; the average sand well spacing of Class I channel is 770m; the average sand well spacing of Class II channel is 760m; the average sand well spacing of Class III channel is about 790m, and the average sand well spacing of Class IV channel is about 950m.

The sand well spacing of Class I and Class II channels is always range from 400-750m, the well spacing is relatively small in all the channels, which is more favorable to production. Therefore, the controllable degree of Class I and Class II is relatively high from the point of the sand well spacing.

5.3、Analysis of the degree of sand body controlled by development well spacing

The analysis method of development well spacing is similar to that of sand well spacing, and the distance between the development well is greater than and sand well spacing. By the statistic of the well and the river, the average development well spacing of the all channels is 830m. The average development well spacing of Class I channel is 850m; the average development well spacing of Class II is 850m; the average development well spacing of Class III channel is 710m.

In Class I and Class II channels, the development well spacing is relatively small of the 0-800m for 16.67% and 25%, and the degree of control is generally. The effective development well spacing of Class III channels are very few, the development well spacing of 0-800m accounts just for 15%, the controllable degree is relatively low, the Class IV channels are all uncontrollable. Therefore, from the point of the development, the purpose sand body has the greater developing potential, the current development wells can not satisfied the needs of the sand body.

VI. LAMINATED SAND BODIES IN EACH LAYER AND THE OVERALL DISTRIBUTION OF SAND BODOES IN EACH OIL GROUP

Through the above research, the reservoir in Bozhong 25-1 oilfield is controlled by low level, poor use of channel sand body. However, this is not in the actual situation of the oil field exploitation, how to explain the contradiction becomes very important, so we superimpose the small layers in different oil groups of the riverd together, make oil group as the unit of analysis, which is also consistent with the current development accuracy.

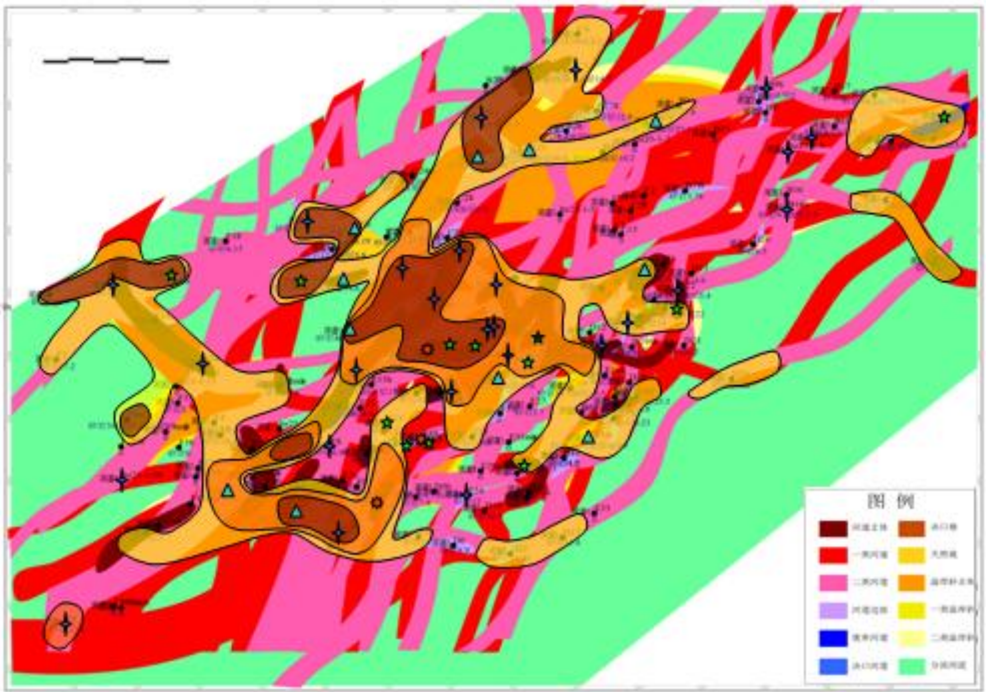

Fig.6-1: Sand body of each layer polymerization in Ⅴ oil group

For V oil group as an example, the sand body of eight small layers in V oil group is stacked together, then analyze sand body distribution of all the oil groups. From the point of plane, the sand body distribution area of all the oil groups are very extensive, rivers multiply in superposition (Fig. 6-1). According to the development form and source of the river, the sand body is connected with the thick area, in addition, there are many multiplied times (usually more than 4) and the development of sandstone is also included in the region of the sandstone. Can be seen, the sandstone in V oil group is thick and has good continuity, a lot of wells drilled good reservoir. In the oil group, it can be found that the size of sand body is large, and the control of well pattern is relatively high, which is the reason for the good production of oil field developed in preliminary stage. Nowadays, the sand body reserves gradually reduced, oil field gradually into the fine development stage,then inject stratified use the small layer as the unit, inject centralized in residual oil advantage gathered area becomes more efficient development plan. This requires the above research: detailed master the sand body developing in each layer, do the digging, studing from an oil group to each sand body in detail.

VII. CONCLUSION

Through the above research, the control level of the resevior by well pattern in vertical direction of channel is width of 84.5 channel sand bodies is less than 400m, which is the average level of the sand well pattern in the most dense development area, the well pattern can control the channel sand body at present. The control rate is 0.5-1, and the development area of the normal well spacing is more difficult to control.

Due to the high degree of difficulty in the offshore oil field exploitation and the current injection production relationship, the current well pattern is not easy to adjust a lot. In order to realize the development of the main layer of the river, use rolling adjustment. Therefore, according to the reservoir characteristics of the narrow river, it is recommended to use irregular well pattern, small well spacing along the direction perpendicular to the river, big well spacing along the river direction. Focus on improving density of development well spacing in the direction vertical to channel and the direction along the river[8-10]. The most effective solution is to arrange the row spacing of the parallel channels, and the arrangement of the production and injection wells[11].

REFERENCE

[1] Deng Yunhua,Li Jianping.Breakthroughs of geological concepts in exploration and evaluation of BZ25-1 field[J]. Petroleum Exploration and Development,2007,06:646-652.

[2] Hu Yong,Xu Pin,Yang Qinghong,Hou Dongmei,Wang Lirong.Study on the macroscopic heterogeneity of the reservoir in Bozhong 25-1S Oilfield[J]. OFFSHORE OIL, 2010,03:26-30.

[3] Dong Yanlei， Zhu Xiaomin, Li Dejiang,Bian Shutao,Yang Junsheng,Zhu Shifa,Zhang Yuyin. Depositional characteristics of highstand delta of Dong'er sequence, Liaodong Bay , Bohai Basin. PGRE,2008,15(2); 56-60+115.

[4] Sun Hefeng,Zhou Xinhuai,Peng Wenxu,et al.Late-stage hydrocarbon accumulation and enrichment in the Huanghekou Sag,southern Bohai Sea[J].Petroleum Exploration and Development, 2011, 38(3): 307-313.

[5] Yang Wenjuan,Wu Guanrong,Wang Donghui,Yi Xiaoyan,Chen Kui.Evaluation of well pattern adaptability for wellblock DK13 of Daniudi has field[J],Petroleum Geology and Engineering, 2013,06:81-84+151.

[6] Guo Taixian, Yang Qinghong, Huang Kai, Zhang Jianmin. Techniques for high-efficient development of offshore fluvial oilfields[J]. Petroleum Exploration and Development，2013,06:708-714.

[7] Zhang Wu Ding Xiaojun. Well pattern compatibility appraisal by applying geology statistical method[J], XinJiang Oi1& Gas, 2009,02:53-55+114-115.

[8] Mei Rong，Gao Chun-ning，Lei Qi-hong，Liu Li-li，Wang Gang.Adaptability Research of Well Pattern in Low Permeability Chang 6 Reservoir in Block Bai 153 of Hua-qing Oilfield[J]. Journal of Oil and Gas Technology,2013,02:131-135+1.
[9] Xia Tongxing, Ming Jun. Application of fine reservoir description technology in the construction of Bohai A oilfield[J]. Natural Gas Industry, 2007, 27(Supp. A): 384-386.
[10] Yu Lan.Study on the Secondary Development of Well Pattern Reconfiguration in Middle West of Sa-thong Development Area[D]. China University of Geosciences (Beijing),2000.
[11] Liu Yujuan,Xie Congjiao,Ouyang Minghua. Adaptability Research of Well Pattern of Ⅷand Ⅸ Oi1 Sets in Shuanghe Oilfield[J].Fault-Block Oil＆Gas Field, 2005,03:44-46+91-92.