Study on determining the dominant flow path of oil reservoir by static data

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Abstract-Block A is a 2016-2017 production block. After infilling, block 1, 2 and 3 are divided into three segments, block 4 is divided into two segments, block 4 is divided into two segments, and block 4 is not divided into segments, that is, Gaotaizi first segment. With the increase of well pattern density and the increase of vertical upper strata, the whole injection-production relationship becomes more complex and the dynamic adjustment is more difficult. By integrating the static data, we can determine the dominant wells and the dominant zones among the well groups, and find out the dominant channel of each zone by comparing the seepage capacity in each direction of the water coming from the sub-zone. To further subdivide the connecting types, and finally determine the dominant channel of each sedimentary unit by combining the reservoir thickness, well spacing and source direction. For the case of multiple well patterns interacting with each other, aiming at the sections of the dominant wells and formations which are in the front of the sequence and are easy to be overinjected. For the interval in the middle of the sequence of dominant wells and formations, the water injection volume fluctuates frequently and needs to be checked and matched. For the interval in which the sequence of dominant wells and formations is backward, the measures of increasing injection are adopted. It has important guiding significance for efficient development of Gaotaizi reservoir in the later stage of ultra-high water cut.

1. Basic facts
The five-point method of 212m is used to connect 4 wells, the average sandstone thickness of the connected wells is 42.4 m, the average effective thickness of the connected wells is 19.9 m, the total injection quantity of the well group is 627M3, and the injection-production ratio of the well group is 1.10, sedimentary features: mainly in the Delta Front and the Outer Front, located in the Delta plain outside the direction of the lake, below the lake level, for the river and Lake Water intersection zone, active sedimentation, it is the sedimentary area of Underwater Distributary Channel Sand Body, sheet sand body and mouth bar sand body.

2. Existing problems and countermeasures
A. After the new well is put into production, the water saturation of the main well a perforated layer is the statistical interval. Compared with the water saturation of each reservoir group, it is found that the water saturation of the new well 2 # Oil layer is lower than that of the 1 # oil layer and the 3 # oil layer, the water cut of well a decreased from 96.14% to 94.35% before Arai put into production, and decreased by 1.62 percentage points.
B. During the course of forming the new balance of injection and production, due to the interference of three sets of well patterns, the pass rate of formation section decreases and the production situation becomes worse, from October 2016 to January 2018, in order to coordinate the balance of injection and production, a total of 15 wells were tested and adjusted, with an average of 2.5 wells being tested and adjusted per well, once every month and once every two months. A is a production well with 1 # oil layer, 2 # oil layer and 3 # oil layer. There are three sets of well patterns in the same area, which are the old well pattern for 2 # oil layer and the new well pattern for 2 # oil layer. Plane Contradiction: Well Pattern is more complex, there are more water direction, well gap is big. Interlayer contradiction: The main well has a long mining interval and a great difference in permeability. So, through the experience of dynamic analysis, we can integrate these static data, simplify them, and through the "one side" and "three degrees" of static data, that is: subdivide the type of communication (plane), well spacing (length), reservoir thickness (thickness), Source Direction (angle), determine the dominant well, interval interval interval.

1). Classification of sand bodies according to their development and connectivity.

| Item | One kind connected | Three kinds connected |
|------|--------------------|-----------------------|
|      | Channel Sand | In Table | Out table | Channel Sand | In table | Out table | Relation between main well and connected well |
|      |                      |                      |           |                      |                      |                                      |
| Code | 11 | 12 | 13 | 31 | 32 | 33 | 34 | 35 |
| Sort | 1  | 2  | 4  | 3  | 5  | 6  | 7  | 8  |

2). Under the same sand body type of reservoir thickness, the dominant channel is determined by comparing different sandstone and effective thickness.

3) source direction Source direction north to south.

Figure 4 lithofacies profile of SAPU high oil layer in Daqing Field
4), well spacing, main well spacing and connected well spacing are 58m, 191m, 248m, 293m, 330m and 341m respectively. The source direction (angle) is determined by subdividing the connection type (plane), the well spacing (length) and the thickness (thickness) of the reservoir.

Table 2 sequence table of dominant channels in interwell group

| Key Target | Sequence | Direction | Dominant Well | Spacing | Thickness |
|------------|----------|-----------|---------------|---------|-----------|
| 1          | 1        | 1         | 58            | 191     | 248       |
| 2          | 2        | 2         | 293           | 330     | 341       |

At the same time, combined with the remaining oil map, in view of the remaining oil reserves more than 50 T of small reservoirs to increase the tapping potential, high water cut later in order to exploit the remaining oil reserves in higher reservoirs, taking into account the ease of plane, inter-layer contradictions. The higher the sequence is, the greater the influence on the well group is, and the higher the sequence is, the easier the overinjection is.

D Formation Analysis and next step Adjustment Direction:

Table 3 statistical table of well inspection and allocation data

| Dominant well sequence test interval | Date of fitting | Well head pressure | Flowing degree | Different completing allocation | Level completions | Dynamic data | Static data | Next move |
|-------------------------------------|-----------------|-------------------|---------------|--------------------------------|------------------|--------------|-------------|-----------|
| 2016-12-01 | 2016-11-11     | 2.5               | 16             | 11                | 1.00             | Stabilizes   | 2           | 1         | 25.90     | 29.02     | 1 Encrypting matching |
| 2016-12-05 | 2016-09-15     | 5.3               | 20             | 20                | 0                |              | 1           | 1         | 36.63     | 30.03     | 1 Plugging to increase the pressure of the whole well |
| 2016-06-10 | 2016-05-10     | 7.4               | 16             | 15                | 1.00             |              | 1           | 1         | 58.98     | 36.31     | 1 Stabilizes |


It is found that the results of dynamic data are consistent with those of static data, and the adjustment principles are as follows: The injection is blocked or adjusted downward for the interval in which the dominant wells and formations are arranged ahead of each other and are easy to be overinjected; It is necessary to carry out infilling, infilling, infilling, infilling and infilling for the interval with the advantage well and the interval with the later sequence, and infilling for the interval with more remaining oil.

Table 4  statistical table of downhole step adjustment direction of water injection wells

| Projects | B                  | D                  | E                  |
|----------|--------------------|--------------------|--------------------|
| 1        | Plugging 2# 10-10M | Increase the water  | 1# stimulation     |
|          | 2# 10-10M          | volume of 3# and 5# | matching            |
|          |                    | in three zones to  |                   |
|          |                    | tap the remaining   |                   |
|          |                    | oil                 |                   |
| 2        | Encrypted          | Encrypted          | Stabilizes         |
|          | matching           | matching            |                   |
|          |                    |                   |                   |

3. Conclusion
1. It is possible to analyze the remaining oil and water saturation of the adjacent wells in this direction with the fine and small layer data of the new well.
2. In view of the more connected wells, the seepage capacity of each direction of the water coming from the small layer is compared, find the dominant channels in the sublayers. Further subdividing the connecting types, and combining the reservoir thickness, well spacing and source direction to determine the dominant channel of each sedimentary unit.
3. For the interval in the middle interval of the sequence of the dominant well or formation, the water injection volume fluctuates frequently and needs to be checked and matched, the measure of increasing injection is carried out, and the injection is carried out in the section with more remaining oil.

References
[1] Britt L K.Optimization Oil well fracture of moderate permeability reservio[C].SPE 14371,1985
[2] Huang Yanzhang, percolation mechanism of low permeability oilfield [M], Beijing: Petroleum Industry Press, 1998
[3] Li Daopin, development of low permeability Sandstone Oilfield [m], Beijing: Petroleum Industry Press, 1997
[4] Hao Fei, Cheng Linsong, Li Chunlan, etc., [J], Journal of Southwest Petroleum Institute, 2006,28(6) ; 29-32
[5] Wang Yupu, Ji Bingyu, Guo Wankui, et Al., development technology of ultra-low permeability and ultra-low abundance reservoirs outside Daqing, [j], Journal of Southwest Petroleum Institute, 2006, (06) ; 70-74
[6] Liu Ziliang, Wei Zhaosheng, Chen Wenlong, et Al. . Reasonable injection-production pattern in fractured low permeability sandstone oilfield [J], oil exploration and development, 2003, (04) ; 85-89
[7] Sun ye-kuang, Shi fu-geng, Wang cheng-feng-long, et al. , [J] , Petroleum Exploration and development, 2004, (04) ; 79-82
[8] Qu Xuefeng, Sun Wei, Wei Hongmei, et Al. . Geological characteristics and development countermeasures of Chang 8 reservoir in Baima area, Xifeng District Oilfield [j], Journal of Northwest University, 2006,36(2); 301-305
[9] Zhong Dekang, Li Bohu. Oil Exploration and development, 1998,25(5); 53-59
[10] Xue Yunfei, Chan Yung, Liu Bingkang, et al. . Well pattern adaptability of Longhupao low permeability oilfield [J], petroleum geology and development of Daqing, 2004,23(6); 301-305