

# Adaptability Analysis of Three or Four Strips with Small Well Spacing in Zone A Transitional Zone

Xiaojuan Liu

Geological Research Institute of Daqing Oilfield Third Oil Production Plant, Daqing, China

**Abstract:** Small well spacing tests were carried out in three and four zones of the transitional zone to solve the problems of poor effect of water flooding and low reserves utilization. In order to improve the effect of water drive development in the transitional zone of Area A, the two test zones in area a have been reopened and utilized, well pattern is changed from anti-nine-point method to five-point method. Through strengthening the tracking adjustment of oil and water wells, the variation law of production and water cut in the test well area with small well spacing in the development process is understood, and the adaptability of different well patterns and well spacing in three or four zones is verified, it provides a technical reference for the adaptability of water injection in three or four zones of the transition zone.

**Key words:** Transition zone, small well spacing injection production system adjustment adaptability.

## 1. General situation of three or four zones in Area A

In Area A, the main depositional type of the transitional zone is the delta inner front, and the large and medium channel sands are less developed, the drilling bed number ratio is 23.0% , the ratio of drilled layers is 77.0% , which is distributed as narrow strip, lump and thick lump. The development of oil reservoir is gradually worse from one belt to four belts. The average single well sandstone and effective thickness of three or four belts are obviously lower than one or two belts. 1.2 Physical Property Characteristics of Crude Oil in Three or Four Zones

## 2. Analysis of well network adaptability

Since entering the later stage of high water cut development, the adaptability of the injection production system in the three or four zones has gradually deteriorated, mainly manifested in the following aspects:

### 2.1 large injection-production well spacing, low number of injection-production wells, and low control of well pattern on sand body

Three zones of transition zone in area a adopt 350m well spacing four-point method area water injection well pattern, four zones adopt 250m well spacing inclined linear water injection well pattern. The channel sand bodies in transition zone of Area A are small-scale, discontinuous, narrow-strip and sporadic, and the channel sand is mainly controlled by single well. Under the current well pattern, the proportion of imperfect sand body below

4 well points is high, and the control of water flooding in channel sand is low. In Area A, the density of well pattern is small, the distance between injection and production wells is 250-350m, the rate of injection and production is low, the ratio of effective thickness is high in one-way and two-way communication, but the ratio of effective thickness is low in three-way communication, far below one or two bands. At present, it is difficult to control narrow and small sand bodies with small development area by well spacing and well pattern density.

### 2.2 The injection pressure is high, the injection condition is bad, the water injection adjustment is difficult

The injection condition of the three or four zones in area A is obviously worse than that of the one or two zones due to the development of oil layers and the characteristics of well patterns. The average injection pressure of single well in three or four zones is higher than that of the whole zone. The average intensity of single injection and actual injection was lower than that of the whole region. The completion rate of three or four strip injection is obviously lower than that of the whole region. The average water injection interval of single well is lower than that of the whole area, and the water injection adjustment is difficult.

### **2.3 Large proportion of low production and low efficiency wells, low recovery rate**

From the perspective of single well fluid and oil production intensity, the three or four zones are far lower than the level of the entire region. From the daily oil production classification table of different zones in Zone A, it can be seen that the proportion of low production and low efficiency wells in the three to four zones is relatively large, with the proportion of low production wells with oil production less than 1.0t being 31.03% and 49.18%, respectively, which are significantly higher than those in the first and second zones. In terms of extraction degree, the extraction degree of the three and four belts is lower than that of the first and two belts. The extraction degree of the three belts is 33.46%, while the extraction degree of the four belts is only 16.36%.

### **2.4 Scattered distribution of remaining oil, making it difficult to tap potential**

Based on the results of fine geological research, the paper systematically analyzes the remaining oil wells in three or four zones of the transitional zone in SA a area, and determines several kinds of remaining oil: (1) the well spacing is large, the controlling area of sand body is small, and the controlling degree of water flooding is low; Formed the remaining oil between wells. The remaining oil is scattered, mainly distributed in the front facies of the thin difference layer and the surface of the outer layer, the sand body distribution area is large, the oil layer is thin, poor physical properties, this type of remaining oil is more than 50% . (2) the remaining oil is distributed in the imperfect injection-production zone and some sand bodies in the stagnant zone have not been injected, resulting in imperfect injection-production systems such as injection-production without injection, production without injection or production without injection, in some wells, the remaining oil is formed because the water injection has not been driven to or bypassed. (3) there is some residual oil on the edge and top of the river course, because water passes through the center of the river course, the water can not drive it, or the oil layer becomes worse or even shrinks out at the edge of the river course, or the oil layer has not perforated to form the pressure relief point, the remaining oil is formed because of the poor water flooding effect and the serious heterogeneity in the thick oil layer, but the top is not flooded or the degree of flooding is low. In the late stage of high water cut production, although there is still a certain amount of remaining oil, the well pattern has a small control area on sand body.

## **3. Application of small well spacing test area**

In response to the problems of poor development of oil layers and low well density in Zone A, such as difficulty in injection and production, poor reservoir utilization, low recovery rate, and poor development effect, combined with the distribution characteristics of remaining oil, a method of appropriately reducing the injection production well spacing was adopted for the three and four

transitional zones in Zone A. The two experimental zones were reopened and utilized. After a series of adjustments to the injection production system such as sealing, hole filling, and injection conversion, the experimental zone achieved good development results.

### **3.1 Reuse of experimental area and increase in well network density**

After the trial area is put into operation, it is equivalent to a one-time encryption of the original well network. Compared with the old well network, the well spacing is reduced by twice and the well network density is increased. The density of the 125m well spacing well network in the central experimental area has increased from 17.4 to 65.8 wells/km<sup>2</sup>, while the density of the 175m well spacing well network in the eastern experimental area has increased from 6.8 to 30.6 wells/km<sup>2</sup>.

### **3.2 injection production adjustment, oil and water well drilling, and tapping remaining oil potential**

After the trial area was put into production, the original well network was adjusted in the injection production system, from the original inverse nine point method to the five point area well network. In response to the single mining layer, oil and water wells were drilled to effectively excavate remaining oil. A total of 727 small layers were added to the oil and water wells in the two experimental areas, with a sandstone thickness of 913.1m and an effective thickness of 530.7m.

## **4. Effect analysis of small well spacing test area**

### **4.1 Increasing the proportion of multi-directional connectivity and improving the degree of water drive control**

After infilling the well network, adjusting injection and production, and supplementing oil and water wells, the multi-directional connectivity ratio of the 125m and 175m well spacing sets of five point method area well network has reached over 45%, and the degree of water drive control has both reached over 90%.

### **4.2 Injection pressure decreases and injection conditions significantly improve**

After the trial area was put into production, the start-up pressure decreased and the injection pressure decreased, with an average single well injection pressure of 12.22 MPa, a decrease of 1.16 MPa compared to the original well network. Apparent water injectivity index and injection completion rate increased, and the injection completion rate reached 92.1%, which is 20.4% higher than the original well network, indicating a significant improvement in injection conditions.

### 4.3 The proportion of low production and low efficiency wells has decreased, and the recovery situation has improved

From the production end, the average single well fluid production intensity and oil production intensity increase 0.34 t/D respectively. M and 0.06 t/d. M, the ratio of low production and low efficiency wells is 26.19% less than the original well pattern, and the recovery condition is better than the original well pattern. After well pattern infilling, the problem of "Difficult injection and difficult production" caused by three or four well pattern with small density and small sand body is improved.

### 4.4 Oil reservoir utilization is better than the original well network

From the water injection profile of the water injection well, the effective thickness utilization ratio of the two experimental areas increased by 18.51% and 23.73% compared to the original well network. From the production profile of the oil well, the effective dynamic thickness ratio of the two experimental areas increased by 4.97% and 14.16% compared to the original well network. The profiles of oil and water wells are better than the original well network. From the perspective of the oil layer group, both experimental areas show the highest proportion of S2 utilization, with significant improvement in the S2 and S3 groups, with a well spacing of 175 meters being better than 125 meters in utilization.

Table 1 Comparison of water absorption status between the experimental area and the original well network

Oil reservoir group	Original well network (%)			125meter (%)			175meter (%)		
	Number of layers	sandstone thickness	effective thickness	Number of layers	sandstone thickness	effective thickness	Number of layers	sandstone thickness	effective thickness
S1	41.7	33.6	37.2	23.5	31.4	22.6	30.8	33.3	38.8
S2	50	62.5	62.3	61.3	72.2	78.3	73.3	81.1	86.3
S3	0.0	0.0	0.0	12.5	17.6	19.1	38.5	22.4	24.2
subtotal	43.3	50.9	50.6	54.6	68.1	69.2	33.1	69.7	74.3

### 4.5 Significant increase in oil recovery rate

After the trial area was put into production, the oil recovery rate significantly increased, with the two sets of oil recovery rates increasing by 0.23% and 0.17% for the 125m and 175m well spacing, respectively. Through the analysis of development index prediction curves, the 125m and 175m well networks are expected to increase oil recovery by 1.62 and 2.80 percentage points.

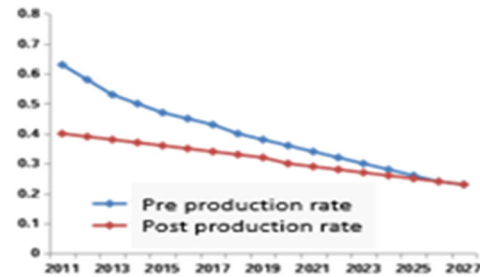


Figure 1 -Production rate curve before and after infill of 175m well network

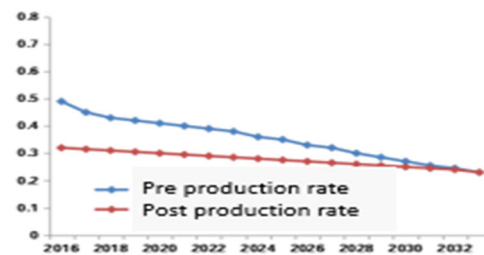


Figure 2 -Production rate curve before and after infill of 125m well network

## 5. Conclusion

1. The three or four zones are affected by the development of oil reservoirs and the characteristics of well networks, resulting in low water drive control, poor reservoir utilization, and low recovery. Entering the later stage of high water cut production, although there is still a certain amount of remaining oil, the control area of the well network on the sand body is small, and the difficulty of tapping potential under the current well network conditions is increasing.
2. Combining the distribution characteristics of remaining oil in three or four zones, it is feasible to adopt the method of appropriately reducing the injection production well spacing to improve the development effect. After the trial area was put into operation, it was equivalent to a one-time densification of three or four belt wells, increasing the density of the well network and improving the degree of control. The trial area verified the feasibility of the small well spacing five point method area well network in the three or four belt wells.
3. After the trial area was put into production, the injection and production conditions were improved, the oil recovery rate was significantly increased, and the oil reservoir utilization was better than the original well network, indicating that small well spacing is beneficial for improving the development effect of three or four zones.

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