Exploration on the Governance of Wells with Deficient Liquid Supply in B Block

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Abstract. By directing at wells with deficient liquid supply in B Block of A development area, this paper made a comprehensive analysis on the causes for wells with deficient liquid supply by utilizing static, dynamic and fine geological research achievements from the aspects of engineering and geology. It summarized two categories and 8 subclasses of factors resulting in deficient liquid supply of mechanical oil production wells, and proposed corresponding governance countermeasures. Comprehensive governance was conducted for 42 wells with deficient liquid supply, which can provide references for the governance of other wells.

1. Introduction
With the development of Block B, some oil wells suffer from a shortage of liquid supply. In this paper, the causes of underfed wells are systematically studied, and the treatments and effect are compared. Aiming at the underfed wells in fault area, high efficiency area, casing damage area and other areas of Block B, this paper carefully analyses the relationship between injection and mining of underfed wells and the regularities of distribution of residual oil under the guidance of the study of earthquake in wells, the multidisciplinary study of oil deposit and the refined description of reservoirs on the basis of deep analysis of the causes. This paper also conducts a comprehensive treatment of underfed wells by means i.e. the transferred injection and infill drilling of new wells, one-layer and cross-layer reperforating and other adjustment and overhaul of the net of layered well, optimization of oil wells, adjustment of manufacturing parameters and transferred bailing to improve the time rate of well opening and ensure the regular production of underfed wells, so as to control the decrease in production and the rising speed of watercut and improve the development of blocks. This paper is expected to provide an important reference for the future development and adjustment of oil field.

2. Exploitation status
At present, there are 400 producing wells in A area, including 51 intermittent pumping wells and wells with deficient liquid supply, which occupy 12.75% of all producing wells. They are mainly distributed in the fault zone. Among them, 22 wells have been shut in, and their proportion in all producing wells is 5.50%. Before they were shut in, the daily fluid output was 831 t/d, the daily oil output was 91.0 t/d, the comprehensive water content was 89.04%, the flowing pressure was 3.02 MPa, the liquid level was 631 m, and the submergence depth was 233 m. There are 29 intermittent pumping wells, taking up 7.25% of all producing wells. The excessively low submergence depth leads to the expansion of pressure drawdown distribution, and the crude oil is degassed in stratum. As a result, wax precipitation happens to the output liquid in the pump and shaft, and eccentric wear of rods and tubing is caused. If the oil well operates under low liquid level for a long time, deep-well pump depletion and pump
leakage might be caused. Hence, the liquid production capacity of the producing well will be reduced. Therefore, the causes for wells with deficient liquid supply should be analysed, so as to guide the governance for deficient liquid supply of producing wells and to fully increase the capacity of oil wells.

3. Causes for wells with deficient liquid supply
Wells with deficient liquid supply are classified into wells with deficient liquid supply caused by engineering constraints and wells with deficient liquid supply caused by geological constraints. There are two categories and 8 subclasses. There are 39 wells with deficient liquid supply formed under strata conditions and well pattern conditions, occupying 76.0% of all wells with deficient liquid supply. Thirteen wells of them are located in the fault zone. In the following, we will analyse the causes for deficient liquid supply of producing wells from these two aspects.

3.1. Engineering factors
There are 5 wells of this type, and deficient liquid supply of such wells is caused by unreasonable pump parameters, mainly covering the following factors:

3.1.1. Phenomenon that the big horse pulls a small carriage. There is one well of such type. CYJ10-4.2-53HB pumping unit is applied to C1 well; the stroke is 3.0 m and the jig frequency is 2.5 n/min. Though the operating parameters were adjusted to the minimum during production, the liquid production capacity decreased rapidly and the pump efficiency was only 18.2%, for the submergence depth was comparatively low (67 m).

3.1.2. Unreasonable parameters of stroke, jig frequency and pump diameter. There are 4 wells of such type. By taking C2 well as an example, its production parameters are as follows: the stroke is 2.2 m and the jig frequency is 6 n/min; the submergence depth is only 13.43 m. The swabbing parameter is too big, which leads to unreasonable lifting height. The greater the stroke and jig frequency are, the lower the fullness coefficient of the pump and submergence depth will be.

3.2. Geological factors

3.2.1. Imperfect injection production in fault zone. All of the 7 wells with deficient liquid supply in the southwest of B Block are in the fault intensive area. Owing to the complex regional structure, sheltering of fault and water injection risks at the edge of fault, there are few water injection wells in the region, the inflow direction is single, and the injection-production relationship is imperfect. Moreover, under the influence of fault development, sand body development between injection and production wells is poor, the connectivity is low, and water injection can hardly be effective. By taking the encrypted producing well C3 well as an example, this well went into operation in Apr. 1981: exploitation of Pu II and high oil layer. The perforated sandstone thickness is 16.7 m, the effective thickness is 7.1 m, and the formation capacity is 0.412 μm²·m. It underwent intermittent pumping due to deficient liquid supply on 8 Dec. 2016. During production, the daily fluid output was 7.5 t, the daily oil output was 0.6 t, and the water content was 92.0%. There was only one well (C4) for water injection. The general scheme was formulated in Nov. 2017. Layer section 2 PI18-9-PII10 of C4 well lifted 10m³ of water, and Layer section 4 GI10 - GI13 lifted 10m³ of water. At present, water injection is conducted through breaking of bursting pressure, but the liquid supply requirements cannot be satisfied yet. According to analysis on the production situations of producing wells in the same well array, C5 well and C6 well were shut up on 14 Feb. 2015 and 9 Jan. 2015 respectively due to the failure of wave measurement. When the general schemes C7, C8 and C9 were adopted for these two wells in 2016, no obvious effect was shown. All of the three producing wells are between 77# and 78# faults. According to analysis on the sand body connectivity, the producing well and water injection well belong to connection of Class 2. Besides, the thickness of connected sand bodies is small. The
dynamic response proves that the connectivity between wells is poor and the driving energy is insufficient, which can hardly meet the need of exploitation.

3.2.2. Imperfect injection production caused by casing damage. The casing damage zone of Group 14 of B Block has an area of 0.67 km², and waterflooding, Class 1 and Class 2 reservoirs coexist. There are 97 oil-water wells, including 41 water wells and 56 oil wells. The well spacing density is 145 sets/km², and casing damage of the N2 bottom layer was discovered in Jun. 2015. We found 18 casing damage wells and 27 dead wells. At the water flooding reservoir, we found 2 casing damage wells and 9 dead wells. The first round of stability evaluation was conducted in Apr. 2016, and the average minimum drift diameter was 105 mm, decreasing by 6 mm when compared with the average minimum drift diameter at the discovery time (111 mm). The stratum was still unstable and repair could not be implemented. The second round of stability evaluation was conducted in Mar. 2017, and the average minimum drift diameter was 108.5 mm, increasing by 3.5 mm when compared with that of the first round. The stratum was still unstable and repair could not be implemented. The third round of stability evaluation was conducted in Oct. 2017, and the average minimum drift diameter of a single well was 108.2 mm, decreasing by 0.3 mm when compared with that of the second round. The stratum was almost stable, and repair could be implemented.

As for the major problems and causes for the casing damage zone, the wells in the casing damage zone of Group 14 are dead, and wells in other places are to be updated after scrapping. As a result, injection production of local well areas is imperfect and the factor of oil well casing damage appears. Hence, oil wells have no energy supply, leading to 11 intermittent pumping wells and wells with deficient liquid supply.

3.2.3. Wells with deficient liquid supply in other well areas. The causes for 28 intermittent pumping wells and wells with deficient liquid supply in other well areas cover six aspects. Nine of them are formed due to the fact that reservoir development is poor; 7 wells are formed due to the fact that Class 2 reservoir is blocked and Sa 1 group controls the water injection intensity; 1 well is formed due to the fact that Class 2 reservoir of the oil well is blocked; 6 wells are formed due to the fact that the injection-production relationship is imperfect; 2 wells are formed due to the fact that the connection between oil-water wells is poor; deficient liquid supply has existed in 3 wells since they went into operation.

4. Paths to improve the development effect of wells with deficient liquid supply
According to the analysis results about wells with deficient liquid supply, corresponding governance countermeasures have been proposed for different types of wells with deficient liquid supply via the method of classified governance.

4.1. Parameter optimization for wells with unreasonable parameters
Parameter optimization was conducted for rod pumped wells according to the principles of long stroke, low jig frequency, parameter adjustment first and pump replacement second. The parameters of oil wells with relatively high stroke and jig frequency as well as large glib were reduced. Pump detection was conducted for wells with a comparatively large pump diameter, and a small pump was used to make the rod pumped well conduct production under a relatively reasonable submergence depth.

4.2. Improvement for the injection-production relationship of oil-water wells
For well areas with imperfect well patterns, injection production in fault zone, and injection production caused by casing damage, injection-production system adjustment was conducted, including injection transfer and reperforating. The percolation conditions were changed through crushing and reperforating. The injection-production system was improved through overhaul, updating, side-tracking and replenishing of water wells.
4.3. Comprehensive governance measures like water injection program adjustment and production and injection increase for oil-water wells

In well areas with poor reservoir connectivity and low waterflooding control degree, measures like injection-production system adjustment, crushing and reperforating were taken to change percolation conditions. The water wells were replenished and injection-production system perfected. The water injection program was adjusted, the absorption situation changed, and the interlayer and plane conflicts reduced.

5. Effect of comprehensive governance

5.1. Adjustment of production system and increase of oil well production capacity

The parameters of 7 rod pumped wells were reduced. After implementation, the average stroke was 2.3 m, and the average jig frequency was 4.2 n/min. The outputs before and after the adjustment did not show a great difference. The daily fluid output decreased from 89.5 t before the adjustment to 75.2 t; the daily oil output decreased from 3 t to 2.7 t. The comprehensive water content decreased from 96.6% to 96.4%, and the liquid level increased from 804.83 m to 369.57 m. During pump inspection for oil wells, two of them were replaced with small pumps. After pump inspection, the daily fluid output was 82 t, and the daily oil output was 8 t. It recovered to the normal production level before the overhaul. The flowing pressure rose from 3.24 MPa to 4.27 MPa, increasing by 1.04 MPa. The working fluid level increased from 767 m to 549 m.

5.2. Effect of comprehensive governance measures for oil-water wells

For wells with deficient liquid supply caused by geological factors, comprehensive governance was conducted for 35 wells according to the above measures. After the governance, the daily fluid output was 1656 t, the daily oil output was 142 t, the comprehensive water content was 91.4%, the flowing pressure was 3.19 MPa, and the submergence depth was 394.14 m. Compared with the situation before the governance, the daily fluid output increased by 167 t, the daily oil output increased by 38 t, the water content decreased by 1.59 percent points, the flowing pressure increased by 1.43 MPa, and the submergence depth increased by 321.29 m.

6. Conclusions

(1) There are many reasons that can result in deficient liquid supply of oil wells. Therefore, a deep analysis should be made on the causes for deficient liquid supply, so as to determine the factors and propose corresponding governance countermeasures.

(2) As for wells with deficient liquid supply caused by geological factors, comprehensive governance should be conducted from the injection end and production end, in order to gain a relatively good effect.

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