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Case Histories of Production Technologies in Separate Zone Water Flooding in Daqing Oilfield

Yang Ye, SPE, Zhang Shujin, SPE, Liu Chongshu, Ma Qiang, Ban Li, SPE, Zhang Chuanxu, SPE and Yuan Wei, Daqing Oilfield Company Limited, PetroChina

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Abstract

Daqing oil field is a giant, heterogeneous, multilayer sandstone oil field with 80-120 small layers, interlayer permeability difference of over 60 times. It has performed a miracle of keeping year of stable production of 357 million bbl for 27 years during its 49 years of development. Till the end of 2007, recovery factor had exceeded 50%. The developed oil production technologies have played important roles in keeping high and long-term stable production.

However, water cut becomes extremely high (91 % on average) as a result. Technologies originally developed in low and medium water cut period may not suitable for extra-high water cut development period. There are contradictions between newly developed technology and traditional old technologies.

This paper reviews production technologies development history of Daqing oilfield, such as separate layer water injection, separate layer allocation, water shutoff, profile chemical control, and separate layer frac technologies. The paper also discusses issues in the extra-high water cut period development.

1. Introduction

Daqing Oilfield is the sediment of a river and its delta in the middle of Cretaceous period, which belongs to heterogeneous multi-layer sandstone reservoirs. The permeability of reservoirs is from 30 to 1200 milliDarcy, and the thickness of reservoirs is from 0.2 to 20-odd meters. The exploitation strategy is to inject water to keep the reservoirs' pressure. The major oil reservoirs' physical properties are quite different from the secondary ones. During the water injection process, the water & oil distribution and the rule of their motion are extremely complex, commingled production method could lead the injected water underground easily to be finger advanced. Therefore separate layer oil production technologies that are suitable to Daqing Oilfield's real situation were developed in order to reduce these differences among layers, control rising water-cut, fully exploit each single oil layer, and provide vital technical support for high-efficiency oilfield development.

2. Separate Layer Water Injection Technologies

Separate layer water injection technologies in Daqing Oilfield were developed and improved continually with the course of the oilfield development, which have experienced four stages: concentric water injection; eccentric water injection; integrated concentric water injection and bridge eccentric water injection.

Daqing Oilfield was in the state of the low water-cut flowing period in the 1960s. Concentric injecting regulator was developed to balance the production among layers. Each interval's injection can be adjusted through changing the size of nozzles in the concentric regulator from downhole. However, separate layer testing data can not be achieved.

The medium water-cut period began from the beginning of the 1970s to the end of the 1980s. With the increasing scale of oilfield development and the number of the injection wells, it is impossible for the concentric water injection to fulfill such lots works. Meanwhile, in order to simplify the water injection techniques and to improve the injection quality, the Model 665 eccentric regulator and its matching injection technology were researched. Due to the blanking plugs setting in the eccentric holes of the regulators, the fishing tools can be run through the main passage of the string to catch several blanking plugs in single trip. It can not only control the injection efficiently, but also solve the problems of testing the packers' sealing performance, pressure and liquid flow rates, which can not be done with the concentric injection technology. The eccentric regulators have been used in the oilfield for quite a long time and good effect was seen on site.