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Integrated Technologies of Testing and Controlling for High Efficiency Separate Layer Water Injection

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Abstract

We introduce an integrated technology for testing and controlling of high efficiency sub-divided zonal water injection in Daqing oilfield. The Oilfield is a heterogeneous multi-layer giant continental sandstone oilfield. After long-terms of water flooding, 95% of main pay zones have been in production and water cut has exceeded 91%. The development of the oilfield has also aimed at relatively thinner and less permeable layers to maintain stable production.

Separate layer water injection in these thin and less permeable layers is more challenging than the thicker ones. Traditional testing and controlling techniques used for thick layers may not fully suitable for the thinner layers. In recent years, innovations on separate layer water injection were integrated and a technology of testing and controlling for high efficiency sub-divided zonal water injection was developed to fulfill the requirements of efficiency, precision, prompt, and economics. The technique has the following features: target layers can be smaller than 1 meter, the average number of subdivided sections increased up to 6, barrier thickness required decreased from 8 meters to 1.5 meters, average seal ratio increased from 85% to 95%, minimum zonal injection can be as low as 20m³ or even less.

This paper introduces the technique and presents application results in Daqing oilfield.

1. Introduction

For Daqing Oilfield is a water-flooding oilfield, preferred reservoir target layers have changed from thick, high water-cut layers to low permeable laminated layers after the Daqing oilfield has gone into high water-cut period. Separate layer water injection is still basic means to control the rising water cut. With the increasing number of the injection wells and the further subdivided intervals, testing and controlling of separate layer water injection will have more and more work to do.

Traditional testing and controlling techniques used for thick layers may not fully suitable for the thinner layers. On the one hand, the fixed water nozzles and their carriers— blanking plugs need to be fished several times to find the appropriate sizes of nozzles controlling the water injection into the reservoirs. The operation not only wastes time but also labors, for the average testing and controlling period is 4-5 days. On the other hand, the traditional testing accurate ratio is only 64.0% four months later the initial testing through tracking the change of water injection in different well patterns. The original six-month testing cycle has to be shortened to improve the injection quality and precision.

Therefore, innovations on separate layer water injection were integrated and a technology of testing and controlling for high efficiency sub-divided zonal water injection was developed to fulfill the requirements of efficiency, precision, prompt, and economics.

2. Integrated technology of testing and controlling for high efficiency separate layer water injection

Water injection controlling equipment consists of surface facilities (namely the normal cable truck) and downhole controlling systems which include centralizer, testing & controlling processor, fishing controller (comprising sealed transmission mechanism, universal shaft and oriental guiding mechanism), as well as adjustable blanking plug (see figure 1).

Principle

The adjustable blanking plug is put in the eccentric hole of the water regulator in the well for long terms. The sealed transmission mechanism of the fishing controller is an electrical motor controlled device that exports rotating torques. After the testing & controlling processor logging the actual water injection and comparing with the predetermined data, valve's