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MODELING OF OIL DISPLACEMENT BY THE INJECTION OF HOT WATER THROUGH HIGH PERMEABLE WELL RADIAL CHANNELS

1. INTRODUCTION

Republic of Kazakhstan is one of the largest gas and oil producing countries in the World with considerable hydrocarbon reserves. 2.9 billion tons of oil and gas condensate reserves, 1.8 trillion cubic meters of gas (excluding sea minefields) are explorated on the Kazakhstan's territory. Predicted resources of oil and condensate on the land and shelf of Kazakhstan are estimated in 12–12 billion tons.

Oil reserves in the majority of West Kazakhstan's oil fields (Uzen, Zhetybai, Karazhanbas) are hard to recover ones. Hard to recover reserves are mostly ones with heavy and high-viscosity oil. Exploitation of such oil fields at the traditional methods of oil extraction provides extracting only 5–9% of geological reserves with low technical and economic indicators, that's why only the largest and most productive fields which have favorable geological and physical characteristics are involved into exploitation. Therefore, involving hard recovering reserves of West Kazakhstan into exploitation is actual problem for oil producing companies and institutes dealing with problems of theoretical exploitation.

Nowadays, there is tendency to increasing number of hard to recover reserves due to intensive exploitation of reserves with low-viscosity oil. For instance, number of hard to recover reserves in Russia is up to 55% of whole oil reserves. In Tatarstan, part of heavy oil exceeds 35%, in Perm region – 58%, in Udmurtia – 83% of local oil reserves.

Thermal methods of impact on stratums which contain high-viscosity oil are widely applying for increasing oil's fluidity and effectiveness of oil fields exploitation [1–3].

Effectiveness of thermal method grows as fast as speed of interaction of hot water with high-viscosity oil in the stratum. Highly permeable radial channel, created by jetting method of drilling [4], allows increasing intensity of interaction of thermophore with high-viscosity oil.

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In this paper we investigate the efficiency of pumping hot water into the reservoir with high permeability channels using the radial hole through computational experiments a mathematical model of two-phase filtration.

2. CALCULATION RESULTS

Numerical calculations carried out under the following physical-geological conditions:

- bottom hole pressure in injective and producing wells: 12.0 MPa and 8 MPa respectively;
- length and width of investigated block: $L_x = 100$ m, $L_y = 100$ m;
- stratum's permeability – 302 mD;
- porosity – 0.22;
- length of radial channel varies from 25 m to 75 m;
- permeability of radial channels – 30 D.

Calculation results of thermal method of radial water-oil displacement are presented below on the figure 1–3.

Dynamic of water cut by time with and without radial channels presented on the figure 1.

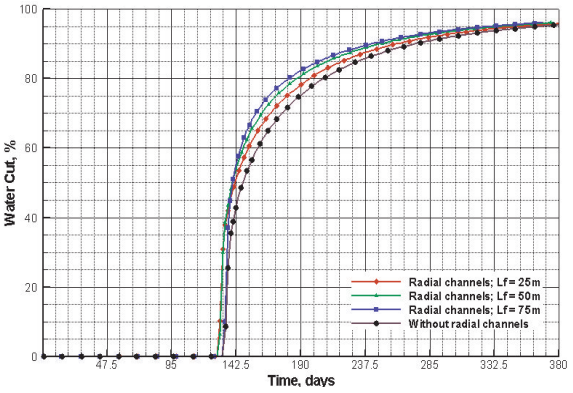

Fig. 1. Water cut in the cases with and without radial channels

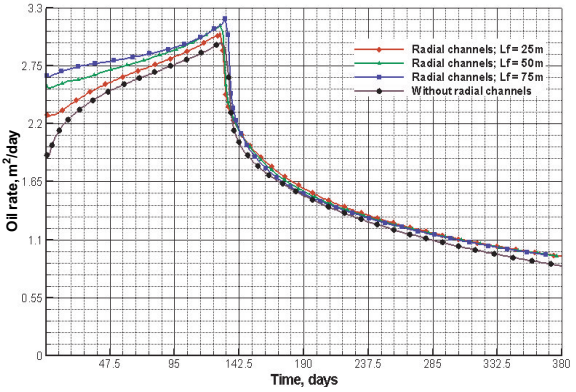

Fig. 2. Oil rate in the cases with and without radial channels

Figure 1 shows that water breaks through to the productive well earlier in the case of water-oil displacement with radial channels than in the case without them, because length of the radial channel is much larger than width and permeability is much higher than stratum's permeability and water fills stratum along the channel.

Sharp declines in oil rate graphs can be explained by water breakthrough to the productive well (Fig. 2). Graphs on the figure 2 show that initial rate in the case with radial channels are much larger than rate without channels. Water breakthrough occurs at time moment t = 140 days.

Dynamic of cumulative oil production showed on the figure 3. Oil producing in the case with radial channels greater on 8.5% than without channels. However, when we use radial channels, water producing grows with growing of oil producing (cumulative water production, Fig. 4). At the figure 4 showed that water accumulates approximately on 35% in the case of using channels greater than without them.

Water saturation distribution for the thermal flooding case showed on the figure 5.

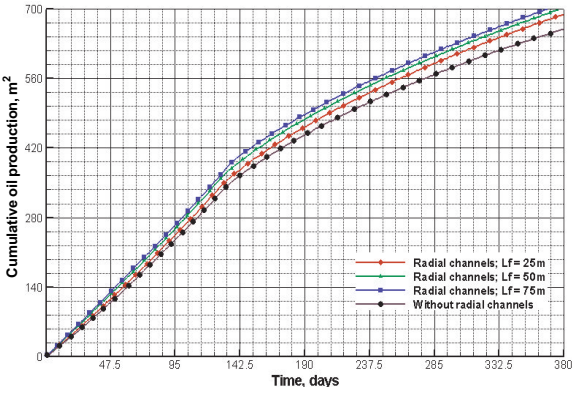

Fig. 3. Cumulative oil production in the cases with and without radial channels

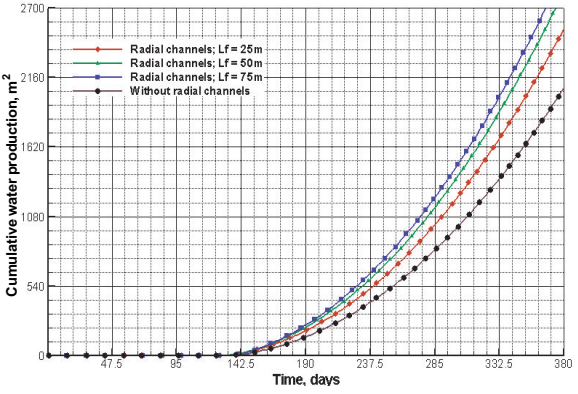

Fig. 4. Cumulative water production in the cases with and without radial channels

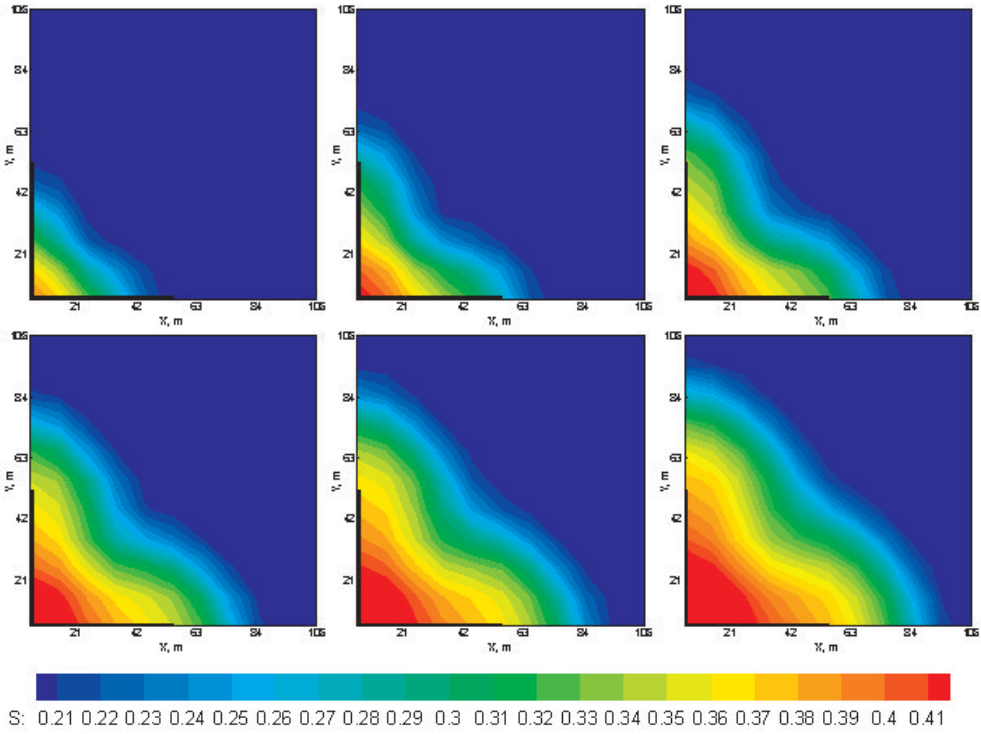

Fig. 5. Distribution of water saturation field at different points in time with the radial channel of length 50 m located in the injection well

3. CONCLUSIONS

The efficiency of radial channels in the wells of low-permeability reservoirs was shown. It was established that the application of hydro-monitored drilling the oil production flow rates increase by 40%, whereas the oil recovery increases by 7–8.5%.

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