Computational Method for Fluid Flow Process in Porous Media with Heterogeneity of Permeability

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ABSTRACT

The effective oil and gas field development is a complicated problem, especially in conditions of low oil price and depleted reservoirs. Currently more often we need to produce hard-to-extract oil, which requires application of complicated enhance oil recovery methods and modern geophysical researches. Therefore, for engineers, there is an acute problem of fast evaluation and selection of a suitable production system and a well completion.

One of the most effective enhance oil recovery techniques is hydraulic fracturing (HF) [1]. More than a half of oil reserves are hard to extract or tight reserves, which can be produced only with hydraulic fracturing. The development of tight oil formations is becoming more important today. Many scientists are involved into the modeling of fluid flow to the well with hydraulic fracturing [2]. But generally the highly permeable fracture is considered to cross the well symmetrically. For the selection of the optimal well placement, it is especially important to solve the complex problem, which includes choice of the best production system, well distance and the most suitable completion. The proper way must be based on the economical effectiveness and productivity. Intelligent use of HF allows optimizing the waterflooding especially on the first stage of field development. As modern level of geophysics and technology can study the exact orientation of fractures, we can more accurately predict flow parameters.

Mostly the numerical simulation is used for solutions of complex problems, but commonly these methods are time consuming. The main part of published papers about the waterflooding well placement is dedicated to a one special case. So we need to develop a new more fast and exact semi-analytical technique to estimate the productivity of a well and even the most suitable well pattern, taking into account fractures.

In this paper the flow process in the production wells system with massive hydraulic fracturing will be studied. The steady-state flow process of incompressible fluid to the number of production wells with HF in a reservoir of constant height and permeability is considered. The task is solved by the representation of flow potential by singular Cauchy type deferential equations. The unknown part in is solved analytically and numerically. The pressure distribution, field performance parameters, streamlines and characteristics of waterflooding process are studied for various permeability values and different placement of hydraulically fractured production and injection wells. The water breakthrough time and breakthrough sweep efficiency is analyzed for different parameters of well spacing. The sensitivity analysis was introduced depending on the length of fracture and distance between wells in various types of well pattern. In this article, it is shown how to take into account the size and direction of fractures during waterflooding design with massive application of hydraulic fracturing.

REFERENCES

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