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3rd World Congress on

Petroleum Engineering and Natural Gas Recovery

July 20-21, 2018   Sydney, Australia

Experimental investigation of non-linear flows in artificial multi-scale frac-vuggy media

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The size of the fractures and vugs ranges from micron scale to centimeter scale in frac-vuggy reservoir and there is almost no flow in the rock matrix. Due to the multi-scale of media, inertial coefficient is a key parameter to predict the correct production performances and behaviour of frac-vuggy reservoirs. This paper introduced the process of making multi-scale frac-vuggy media and will study the inertial coefficient of Forchheimer equation and its effect on oil-water two-phase flow in the media. The experimental results of flow law showed that if flow rate is constant, the existence of non-linear flows for single water phase is determined by the fracture width and filling degree and the effect of the vug can be ignored. However, for oil-water two-phase flows, the fracture and vug both play an important role. Meanwhile, based on rescaled range analysis (R/S), a mathematical model of judging non-linear flow is proposed. The receiver operating characteristic (ROC) curve showed that it can accurately determine the flow law for oil-water two-phase flow. Through the analysis of the experimental data of non-linear flow, this paper proposed a modified Geertsma's empirical expression of inertial coefficient which is a function of wetting phase saturation, fracture width, vug diameter, fracture porosity, vug porosity and total permeability. It is more suitable for multi-scale frac-vuggy media than previous literatures reports. This study showed the no linear flows and oil-water relative flow capacity in unconsolidated frac-vuggy media. They are both important in frac-vuggy reservoir numerical simulation.
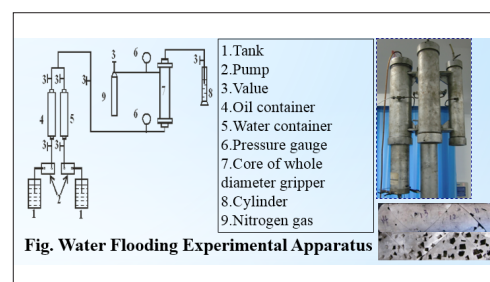

1.Tank
2.Pump
3.Value
4.Oil container
5.Water container
6.Pressure gauge
7.Core of whole diameter gripper
8.Cylinder
9.Nitrogen gas

Fig. Water Flooding Experimental Apparatus

Recent Publications

- Chukwudozie C P, Tyagi M, Sears S O, et al. (2012) Prediction of non-Darcy coefficients for inertial flows through the castle gate sandstone using image-based modeling. Transport in Porous Media; 95: 563-580.
- Salahi M B, Sedghi Asl M, Parvizi M (2015) Nonlinear flow through a packed column experiment.   Journal Hydrologic Engineering; 20(9): 04015003.

Biography

Yang Yang is a Reservoir Engineer and has studied reservoir engineering and reservoir numerical simulation.

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