Investigation on effectiveness of analytical models to describe steam chamber growth during steam-assisted gravity drainage

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Abstract

The analysis of analytical approaches to steam chamber growth during crude oil recovery by steam assisted gravity drainage method has been represented. The numerical model which takes into account most of the assumptions applied to analytical approaches has been developed and used for the effectiveness assessment. The model includes the mass balance equations for water, steam and oil saturations, the energy conservation law with latent heat of vaporization/condensation of water as well as Darcy’s law of filtration. Computer implementation of the model is based on numerical solution to the developed system of equations by finite-element method with respect to the saturation and pressure variables. The results of numerical simulation have shown a quasi-stationary regime of the steam chamber growth in horizontal and vertical directions caused by convective flux of cold water to the interface. However, the considered analytical solutions predict a linear (or close to it) rise of the steam chamber during the whole process of heating. This can lead to the incorrect values of oil production rates on the initial stage of recovery. At the stage of vertical growth a formula which takes into account non-stationary heat flux through the steam chamber boundary gives the best qualitative agreement with numerical solution. Meanwhile a qualitative and quantitative agreement between the most considered models and numerical results has been observed when the steam chamber approached to the top of oil horizon. The analytical evaluations of its width after reaching the top have a qualitative disagreement with the results of the proposed model which predicts substantially non-linearity of the steam chamber evolution.

Keywords

- crude oil
- steam-assisted gravity drainage
- multiphase flow
- multiphysics modelling
- analytical models


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