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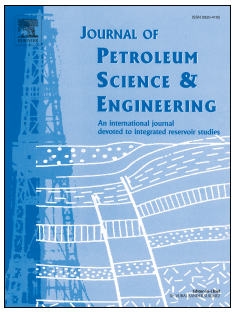

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An Improved Two-phase Model for Saturated Steam Flow in Multi-point Injection Horizontal Wells under Steady-state Injection Conditions

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Abstract

Previous models neglected the effect of frictional heating on steam quality and enthalpy in wellbores when saturated steam is injected into multi-point injection horizontal wellbores.

In this paper, new energy conservation equations were developed for increasing the calculation accuracy of steam quality in inner tubing (IT) and annuli. Then, coupled with the momentum balance equations, the distributions of steam quality and pressure along the IT and annuli were obtained by using the straight forward numerical method. The predicted results from the new model were compared against field data and previous models. It is found that: (a). The effect of heat loss to surrounding formation on the temperature profiles is weak. However, the heat loss has a significant influence on the profile of steam quality in wellbores. (b) When removing the item of frictional work from the energy balance equations, the predicted values of steam quality and enthalpy are lower than actual data. This error in energy conservation equation may be hidden when the predicted temperatures showed good agreement with field data. (c) With the help of multi-point injection technique, formation heating effect at both heel-point and toe-point can be improved.

Keywords

Heavy oil; multi-point injection; horizontal well; two-phase steam flow; steam quality; friction work

1. Introduction

Thermal technique has been widely adopted in many aspects of engineering, and the mathematical modeling methods are widely used in describing and estimating the performance of fluid