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An improved formation heating model for steam injection with horizontal well in thin reservoirs

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The accurate determination of formation heating area is the basis for productivity evaluation and dynamic prediction of cyclic steam stimulation in heavy oil reservoirs. In early research, formation heating area is considered to be an isothermal region and its temperature has the value of injected steam temperature. In fact, as to our knowledge, the temperature of heating area gradually decreases from the steam temperature till the original formation temperature. In this paper, we firstly established governing equations to predict thermophysical properties of injected steam (i.e. steam quality, temperature, pressure and mass flow rate) in the horizontal wellbore. Then, the heating process of steam injection with horizontal well in thin reservoirs is separated into three stages by defining the first and the second critical time. On this basis, the equations for radius of hot fluid zone and steam zone at different stages were derived respectively according to a more realistic temperature distribution of formation. Next, comparisons have been made between the new model results and STARS results to verify the accuracy of the new model. Finally, after the new proposed model is validated, the effects of some factors (i.e. steam quality, temperature and injection rate) on heating area are analyzed in detail. The results indicate that the new model is in better agreement with the STARS results than the classical model. In addition, the new proposed model can be solved directly rather than with the trial method like classical model does for the reason that it supposes heat transfers linearly in the formation after the frontier of heating area arrives at the boundary. Moreover, it is found that high steam quality and injection rate can improve heating area, but the steam temperature has little impact on the heating area.

References

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