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On the modelling of Joule-Thomson Effects: Analytical and Numerical Formulations

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Expansion and compression of fluids by injection or production in the reservoir leads to cooling or heating effects due Joule-Thomson and adiabatic processes. This effect on the near-wellbore temperature becomes significant in some applications such as carbon dioxide storage in a depleted gas reservoir. Commercial reservoir simulators using a compositional approach can model these effects. However, setting up and running compositional simulations can be very cumbersome and computationally costly, making it difficult to incorporate these simulations in workflows for uncertainty quantification, history matching and optimization. In order to allow incorporation of carbon dioxide injection modelling in workflows and networks, while keeping the relevant physics, we have derived two simplified models that account for Joule Thomson effects. The first is an analytical model based on solving for temperature and pressure equations with variable rate assuming a cylindrically shaped homogenous reservoir. In this case temperature and pressure are decoupled. This model calculates first the temperature profile based on the energy balance, and then computes the bottom hole pressure by integrating the pressure gradient given by Darcy's law for the different viscosity regions in the reservoir. We found an excellent match of this analytical model with a commercial reservoir simulator. The second model, a numerical model, allows for more complex geological features and fluid properties modelling. We have extended an open-source fully implicit black-oil thermal reservoir simulator to account for Joule-Thomson effects. We have compared the two-models against an industry-standard compositional simulation.

Participation

In-Person

References

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