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Contribution ID: **624** Type: **Poster (+) Presentation**

Analytical Modeling of Mass Transfer Integrating Diffusion and Dispersion in Solvent Injection Based Heavy Oil Recovery Methods

Monday, 31 May 2021 19:35 (1 hour)

An innovative analytical 2D model for solvent injection-based heavy oil recovery was generated with respect to complicated mass transfer mechanisms integrating diffusion and dispersion, dynamic viscosity reduction, and fluids mixture expansion. The high nonlinear process caused by coupled diffusion and fluids movement, viscosity reduction, and mixture volume expansion were analytically captured and analyzed in this model and applied in variable well configurations including single vertical wells and fractured wells.

This proposed analytical methodology is developed by use of the pseudo-pressure and pseudo-time based diffusivity equation linearization, and integral image method (IIM) for whole reservoir scale modeling. The pseudo-time can be converted to the real-time domain by evaluating reservoir average pressure in the region of investigation using IIM. Dynamic mixture volume expansion using linear expansion model was analytically treated as a kind of variable-rate additional source/sink integral within each discretized reservoir domain. Dynamic mass transfer domain and fluids flow pressure domain was coupled analytically in this work and the systematically iterative method was used to make calculation in these two domains as a closed-loop in Laplace domain. Dimensionless terms were used for providing universal solutions. Normalized transient pressure behaviors were calculated and discussed their features in log-log plots.

This method was validated against finely gridded commercial numerical simulation models under limiting cases. The results were well matched and clearly showed fluids mixture expansion acting as an additional source to increase the pressure in porous media compared with the conventional dispersion process. Accordingly, dimensionless pressure and pressure derivative type curves were developed to match flow behaviors, such as radial flow, linear flow, and boundary dominate flow. By comparing with the standard type curve, the mechanism of viscosity reduction and mixture expansion can be quantifiably captured to analyze the expansion features of the solvent and heavy oil mixture, which will become useful tools for accurately evaluating the solvent functional ability in heavy oil recovery methods. A typical cold-oil-production-with-sand (CHOPS) well the configuration of a single fracture structure had been modeled using solvent injection process. Transient pressure behavior with respect to different time domains had been plotted and discussed based on its physical meaning.

This work proposed a new analytical methodology of modeling mass transfer integrating diffusion and dispersion in solvent injection-based heavy oil recovery methods. Solvent diffusion and dispersion, dynamic mixture viscosity reduction, and mixture volume expansion were analytically captured and integrated into reservoir scale modeling using an additional source/sink integral method. This study will also help improve the Post-CHOPS characteristics, and will directly provide operating companies the technique to analyze and have a better understanding of the transient pressure data of solvent injection process in heavy oil recovery methods.

Time Block Preference

Time Block C (18:00-21:00 CET)

References

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Student Poster Award

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Session Classification: Poster +

Track Classification: (MS8) Mixing, dispersion and reaction processes across scales in heterogeneous and fractured media