Integrated Optimization of Thermal Processes In Heavy Oil Recovery - VISTA-biannual-report-2011.doc

by Mohammad Ghasemi — last modified 2011-07-26 09:31
History

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Approve Report	Trine Gerlyng	2011-07-26 09:31	No comments.
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Biannual report VISTA 2011

Project title

Project director: Whitson, Curtis H., NTNU-IPT

Post-doc/ scholar: Ghasemi, Mohammad

Project duration: May 1, 2009 - May 1, 2012

Technical contact person in Statoil: Høier, Lars

Division head: Høier, Lars

Project number: 6346

Object

The main objective of the project can be divided in two parts: (1) modeling the thermodynamic behavior of solvent with heavy oils; and (2) optimization of thermal methods in heavy oil recovery. Modeling of phase behavior of thermal process in heavy oil requires detailed information of heavy-end fractions. However, significant amount of heavy oil cannot be distilled and remains as an undistillable solid. Characterization of heavy oil with its SARS fractions has been done. Recently new method has been developed to enhance fulfilled optimization of a thermal process (e.g. optimization of real SAGD process). Following items will be studied for the last part of the project:

1. Modeling solubility, density and viscosity of different solvents (N2, CO, CO2, C1, C2 and C3) with Athabasca bitumen using recent published data (we are currently doing this part).

2. Develop a black-oil approximation model (similar to recent developed method) for co-injected solvent with steam or /steam alternative solvent in SAGD using tuned model in *step 1*.

3. Comparison of black-oil proxy vs. thermal model in full filed optimization.

4. Writing up and finalizing.

Status:

Upon careful analysis of the SAGD process, one finds that *oil flows only along a narrow zone along the outer edge of the steam chamber* - "edge oil-flow zone". The temperature gradient within this narrow zone is perpendicular to the oil flow direction and is practically impossible to model with any precision because of the large temperature variation and dynamic steam chamber shape over time. The black-oil model solubility gradient also varies, analogous to temperature in a thermal model, from zero to fully-saturated (Rs*) with an associated drop in oil viscosity from μoi to μo*.

Recently, we developed a new approach to model steam-assisted gravity drainage (SAGD) using an isothermal black-oil (BO) reservoir simulator. The oil viscosity reduction caused by heating in the actual SAGD process is emulated by a *tuned* saturated pseudo-oil viscosity relation where solution gas-oil ratio (Rs) is used as an "equivalent temperature variable". The proxy model saturated pseudo-oil viscosity μo(p) relation used is found by history matching a full-physics thermal model performance prediction of oil rate, BHFP, and cumulative oil for a 2D homogeneous model

We also see the potential of using the black-oil proxy model for solvent-based SAGD (future plan), with the pseudo-oil viscosity model depending on both T* and solvent; thermal compositional modeling is yet-even slower and less suitable for optimization.

Our recent work shows that developed black-oil proxy in modeling SAGD is applicable for a wide range of reservoir heterogeneity, injection and production rates, and well placement.

Courses: 4 PhD courses (corresponding to 30 credits) have been completed.

Publications:

Ghasemi, M., Whitson, CH. 2011. Modeling SAGD with a Black-Oil Proxy. Paper SPE 147072 submitted to present at the 2011 SPE Annual Technical Conference and Exhibition. Denver, Colorado, USA 30 Oct-2 Nov.