Agenda & Introductory Remarks

Erdal Ozkan, Colorado School of Mines

Agenda – May 1, 2015

08:30 am – 09:00 am Continental Breakfast

09:00 am – 09:15 am Opening Remarks

- 09:00 am – 09:15 am Agenda and Introductory Remarks – *E. Ozkan*

09:15 am – 12:10 Presentations

- 09:15 am – 09:45 am Experimental Study of Phase Behavior in Nanopores – *E. Parsa*
- 09:45 am – 10:10 am DSMC vs. LBM Slip Model - *X. Yin*
- 10:10 am – 10:30 am Modeling of Pressure Depletion with Membrane Filtration – *Z. Zhu*

10:30 am – 10:50 am Coffee Break

- 10:50 am – 11:10 am Bubble-Point Suppression Correlation - *T. Calisgan*
- 11:10 am – 11:40 pm Thermodynamic Modeling of Phase Behavior in Confinement – *H. Sarak*
- 11:40 am – 12:10 am Horizontal-Well Interference in the Existence of Fractures – *A. Gaol*

12:15 pm – 01:30 pm Lunch Break *(Marquez Hall Atrium)*

01:30 pm – 02:50 pm Presentations

- 01:30 am – 01:50 am Transient Drainage Volume of Fractured Horizontal Wells – *C. Yesiltepe*
- 01:50 pm – 02:20 pm Numerical Modeling of 1D Anomalous Diffusion – *R. Holy*
- 02:20 pm – 02:50 pm Anomalous Diffusion Models for Unconventional Reservoirs – *A. Albinali*

02:50 pm – 03:05 pm Coffee Break

03:05 pm – 03:30 pm Discussions

03:30 pm Adjourn

Introduction

- Phase 2 of UREP started on Nov. 1, 2014, which coincided with the downturn of the oil price.
- We lost 6 members but signed up 2 new members
- Down from 12 members in Phase 1, we currently have 8 members

PHASE 2 MEMBERS

- Apache
- BHP Billiton
- EOG Resources
- Hess Corporation
- Kappa Engineering
- Petrobras
- Saudi Aramco
- SM Energy

Introduction

Despite the negative effect of low oil prices, we have secured sufficient budget to continue our research program.

Phase 2 support :	$370,000/year
Carry over from Phase 1:	$60,000
Funding as of May 1, 2015:	$240,000

We have reallocated our budget items and re-prioritized our research agenda

Our priority is to ensure uninterrupted support of the students and researchers

When the oil price improves we will be more proactive to recruit new consortium members.

Executive Summary

1. PVT Behavior in Nanoporous Media

One postdoc, one PhD student, and one MS student

Experimental Work :

- Improved experimental setup, enhanced protocols and precision
- Manufactured new nano-chips
- Focused on propane phase behavior experiments
- Run more experiments
- Compared Kelvin equation with observed phase behaviors
- Results indicate that adding the effect of capillary forces by using Kelvin equation is not sufficient
- We will continue working on the modification of Kelvin equation to more accurately predict the phase behavior in confinement

Executive Summary

1. PVT Behavior in Nanoporous Media (Cont.):

Theoretical Work:

- Improved the robustness of our algorithms and computational codes
- Worked with Kappa Engineering to compare our phase behavior results.
- Will extend the correlations to a larger set of data.
- Extended our procedures and computational codes to estimate the condensation point in nano-pore confinement.
- Obtained some preliminary condensation point enhancement results
- Will work on developing practical correlations

Executive Summary

2. Anomalous Diffusion in Nanoporous, Fractured Porous Media:

Two PhD students

Analytical Work:

- Modeling flow in naturally fractured reservoirs by anomalous diffusion.
- Different combinations of anomalous diffusion and normal diffusion in matrix and fracture media
- Effects of sub-diffusion, super-diffusion, and both sub- and super-diffusion.
- Physical interpretation of the flux coefficient and its relation to measurable physical qualities of the porous medium.

Executive Summary

2. Anomalous Diffusion in Nanoporous, Fractured Porous Media (Cont.):

Numerical Work:

- 1D numerical modeling of anomalous diffusion in tight, fractured, unconventional reservoirs.
- Mathematical representation of a physical no-flow boundary under anomalous diffusion formulation.
- Next phase of this research will consider extending anomalous diffusion to multi-phase flow conditions.

Executive Summary

3. Modeling of Pressure Depletion with Membrane Filtration:

One MS student

In Phase 1:

- Investigated membrane behavior of nano-porous media due to steric hindrance of long-chain hydrocarbons.
- Developed a procedure to determine filtration efficiency of a medium
- Defined fluxes of the hindered and unhindered components

In Phase 2:

- Combine the filtration efficiency of the nano-porous medium with the phase behavior in pore confinement
- Develop a physically comprehensive model for flow and pressure depletion in unconventional reservoirs.

Executive Summary

4. LBM and DSMC Slip Models:

Collaboration with CRAFT Tech on DSMC modeling of slip flow and comparison of the results with our in-house LBM model.

CRAFT Tech provided the results of their DSMC model for the rarefied flow of N2 through a 2D channel.

Five Knudsen numbers: Kn = 0.0064, 0.0399, 0.0845, 0.120, 0.171.

Comparison of the DSMC and LB + Maxwell slip flow models:

Kn = 0.0064 to 0.120: DSMC profiles are very close to parabolic (no-slip flow model with a slip boundary is a good approximation)

From Kn = 0.0064 to 0.120: LB + Maxwell slip model is in very good agreement with DSMC.

We will verify LB + Maxwell model in a periodic array for low Kn flows

We will conduct DSMC for high Kn flows and run gas / liquid flow experiments

Executive Summary

5. Transient Drainage Area and Well Interference:

Two MS student

Drainage Area & Well Spacing:

- Developed a simple approach to determine the “contacted reservoir volume” (CRV) at a given cut-off rate
- An alternative to conventional drainage area concept
- Also provides a recovery factor estimation based on the CRV.

Executive Summary

5. Transient Drainage Area and Well Interference (Cont.):

Well Interference:

Developed an analytical model to study interference between two fractured horizontal wells in the presence of natural fractures.

The model is capable of considering fractures cross-cutting both horizontal wells.

Preliminary Results:

A single, cross-cutting fracture does not distort the production characteristics of the wells

However, a single, cross-cutting fracture is sufficient to significantly affect the pressure buildup and injection characteristics.

Executive Summary

6. COZSim-UREP Simulator:

Due to restricted funding, only some bug-fixing and code improvement work has been done

Work on incorporating heterogeneous pore-size distribution will resume

Condensation point correlation and filtration efficiency results will also be included in the simulator.