# PREDICTION OF OIL SAND PERMEABILITY

*Saeed Taheri*
*University of Calgary*

*Shahin Ghomeshi*
*University of Calgary*

*Evgeny Skripkin*
*University of Calgary*

*Jonathan Bryan*
*University of Calgary; PERM Inc*

*Hossein Hejazi*
*University of Calgary*

*Apostolos Kantzas*
*University of Calgary; PERM Inc*

## Introduction

Canada has some of the largest oil reserves in the world and most of these reserves are in the oil sands. Oil sand recovery process design relies heavily on the accurate prediction of reservoir transport properties that affect the mass and thermal flow and distribution of reservoir fluids, such as porosity, permeability, thermal conductivity, capillary pressure and relative permeability curves. Accurate prediction of recovery performance is possible only if reservoir transport properties are measured with reasonable accuracy. Accurate estimation of these properties happens through incorporating core analysis. The challenge is that the inherent complexity of oil sands as unconsolidated reservoirs complicates experimental measurement of the properties. Therefore, while these are important properties to know, they are often not measured to the accuracy level required to properly characterize the reservoir.

## Theory and/or Method

Most core analysis experiments and their corresponding procedures are designed for consolidated rock samples. While core analysis of unconsolidated material is also common in Oil Sands producers, these tests are always run on disturbed samples, i.e. samples where the original pore size distributions and even fluid locations may have been disturbed from their original state due to the coring process. This paper demonstrates a digital core analysis approach for the prediction of different unconsolidated rock properties in a reasonable time frame and with considerable accuracy. The method is based on conducting computations of transport phenomena at a sub-pore scale.

Geological reconstruction of porous media has been made possible using a 3D virtual porous medium generator. A 3D virtual pattern that represents the pore structure and connectivity is generated. Porosity match is used as a primary decision point parameter prior to further computations. Subsequent transport phenomena computations at the sub-pore scale provide accurate calculations of permeability, formation factor, thermal conductivity and mass transfer. The input for the virtual porous medium is either particle size distribution data that comes from real experimental oil sands or mathematical particle size distribution functions.

In this study, tests are run based on measured particle size distribution data for a set of oil sand samples. Particle-size distribution (PSD) is a list of values that shows the relative amount of grains with different sizes present in a specific volume of the sample. There is a strong relationship between different rock transport properties and particle/grain size distribution data. Based on the measured PSD, a numerical porous medium is generated and the permeability is predicted and compared to corresponding plug permeability measurements that were made on sister core samples.

## Conclusions

A virtual 3D medium as a representative of the real sample is generated. Porosity as well as pore-body and pore-throat size distributions are calculated directly after generation of the virtual medium. Single phase flow properties are computed directly on the generated medium to extract the permeability of the sample.

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