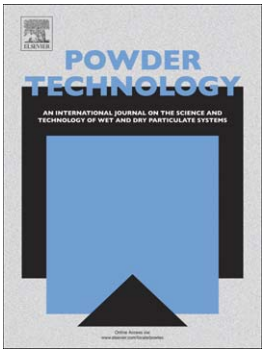

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Permeability Calculations in Unconsolidated Homogeneous Sands

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Summary

Permeability, *k*, is a property of a porous medium that measures the capacity and ability of the medium to transmit fluids. The permeability of a porous medium (porous rock, soil, packing) can be predicted using empirical relationships, capillary models, statistical models, and hydraulic radius theories. It generally has been recognized that grain size is the fundamental independent variable that controls permeability in unconsolidated sediments[Shepherd, R. G. 1989].

Sub-pore scale modeling is used in this study to evaluate the relation between grain size distribution and permeability of the porous media. In this method the governing equations are applied directly on the porous medium images. The meshing algorithm is applied directly on the pore and grain sections of the images, and the studied mechanism is simulated at the level of pores and grains. Virtual porous media are generated using regular packings of uniforms spheres. The permeability of each packing is calculated computationally and then compared to the predictions of the Kozeny-Carman equation. An in-house developed pattern generator is used to generate spherical grains packing with pre-specified particle size distributions. A sub-pore scale modeling approach is used to calculate permeabilities of generated virtual porous media. The equivalent diameters that provide match from the Kozeny-Carman equation are then predicted.

Introduction

Permeability, as a representation of the ability of a formation to transmit fluids, is a fundamental rock property that controls the directional movement and the flow rate of the reservoir fluids in the formation. Permeability estimation is essential for description of different physical processes such as secondary and tertiary recovery. Due to the complicated geometry of the void space it has been very difficult to develop theoretical models for permeability. Conventional experimental permeability measurements are designed for consolidated porous media such as carbonates and consolidated sandstones. Oil sands, as the third-largest proven crude oil reserve in the world, are defined as either loose sands or partially consolidated sandstones. There are several methods for permeability estimation. Three major methods are very broadly used:

1. Conventional well testing or field pumping or injection testing that gives a reliable estimation of the field permeability. It is considered an expensive and time consuming method (Shepherd, R. G. (1989)). This method on oil sand reservoirs with extra high viscosity bitumen content is not applicable. Modified methods such as thermal well testing was introduced for heavy oil reservoir with some limitations (Ghahfarokhi, A. J. (2015)).
2. Measurement of pressure drop and gas or liquid flow through samples in laboratory experiments. Experimental methods are designed for consolidated media. There are some