9th International Workshop
Characterization of Porous Materials:
From Ångströms to Millimeters
May 19 - 22, 2024 | Delray Beach, FL-USA

Contribution ID: **118** Contribution code: **Board 14** Type: **Poster Presentation**

Estimation of porous media transport properties solely based on mercury intrusion porosimetry

Monday, May 20, 2024 7:10 PM (20 minutes)

The relationship between the microstructure of porous media and their permeation properties is a problem that has been addressed in many instances. Experimental measurement of intrinsic permeability remains a challenge, especially for tight materials, and several approaches have been proposed in the literature to directly compute the transport property of a porous medium (e.g. network models or continuous-based upscaling). If these techniques can now be very powerful, they remain quite computationally demanding. Other approaches, used widely in engineering applications, rely on analytical formulas in which the input is the characterization of the pore size distribution (PSD) of the material. Pioneering works by Kozeny (1927) have been followed by various approaches where the PSD is first simplified, averaged or idealized to estimate the transport properties. However, these simplifications can lead to important error in the final transport property estimation, especially for tight material.
This contribution presents a model capable of providing estimates of the transport properties directly from the pore-size distribution without any idealization. The model is based on a hierarchical assembly of capillaries with decreasing diameter, generated randomly. The technique yields a porous network, which mimics the pore space measured experimentally by mercury intrusion. The intrinsic permeability and the evolution of the apparent permeability with mean pressure are provided by equating Darcy's law and a combination of Poiseuille's and Knudsen's laws [1]. Gas and liquid relative permeabilities can be also derived [2]. The technique has the advantage of remaining simple and engineering-oriented while allowing accurate estimation over several orders of magnitude of permeabilities (from 10-19 to 10-12) for very different kind of porous materials (see Figure 1). During the conference, new measurements will be presented and discussed on various synthetic and natural materials.

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Session Classification: Poster Session

Track Classification: Poster Presentations