Contribution ID: **459** Type: **Oral 20 Minutes**

Upscaling Anomalous Gas Behavior in Nanopores in a Multiporosity Shale Gas: Impact on Macroscopic Mass Transfer and Shape Factors

Wednesday, 16 May 2018 14:55 (15 minutes)

We consider a shale gas reservoir with multimodal distribution composed of networks of natural and hydraulic fractures along with nano and micropores dispersed within the organic and inorganic matters.

Under the long term pseudo-steady state regime, characterized by the absence of pressure variability in the matrix, mass transfer between matrix and fractures can be approximated by the classical resistance law, which requires the precise evaluation of the shape factor.

Such a framework is well established for bulk fluids in a matrix composed of a single solid phase but still not well understood for highly reactive systems such as shale, characterized by the presence of both organic and inorganic matters.

By proceeding within the framework of formal homogenization, we analyse precisely the influence of gas adsorption in the organic matter and Knudsen effects on the validity of the pseudo-steady regime and the magnitude of the shape factor. By discretizing the coupled non-linear diffusion equations by the Finite Element Method, numerical experiments illustrate the influence of gas adsorption and organic matter upon the accuracy of the pseudo-steady regime for several arrangements of fracture networks.

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Session Classification: Parallel 8-F

Track Classification: MS 1.25: Upscaling Porous Materials with Strong Solid-Fluid Interactions