Contribution ID: **469** Type: **Poster Presentation**

Montecarlo simulations of gas transportation in multifractal shale reservoirs

Wednesday, 1 June 2022 14:50 (1h 10m)

The oil or gas producing shales are ultra-tight source rock predominantly containing organic rich consolidated formation of clay-sized particles. The clay content severely limits the fluid flow within the shale matrix. It is, therefore, necessary to understand the organic content, level of thermal maturity, mineral composition, natural fractures, shale porosity, pore structure and permeability, adsorption characteristics to determine production potential potentiality of undiscovered shale resources. Shale reservoirs are multiscale pore structures because of which exactly predict of the fluid flow mechanisms through the medium, the governing factor to exploit the resource become highly challenging. In this work, we have made an attempt to study the shale fractals, which describe the pore distribution and implemented the Monte Carlo technique to predict the rarefied fluid flow through the shale formation. A probabilistic model is developed by analysing various parameters which intervene in the fluid flow during dynamic conditions. Each parameter's respective impact of risk and uncertainty in prediction and forecasting models are thoroughly evaluated. In addition, fluid flow at insitu conditions is characterised by solving partial order differential equations viz., unsteady-state flow equation for slightly compressible fluids. By examining the sensitivity analyses for the influential parameters, the model is more optimised to obtain more certainty in evaluating the shale reservoirs.
Evaluating and predicting the accurate fluid flow heuristics for various shale samples at laboratory scale becomes increasingly exorbitant due to long lab hours and experimental errors. Computational approach finds its advantages if it captures the variability and complexity of the flow controlling constraints in shale porous media. Though researchers have worked in illustrating the flow mechanisms adopting effective medium theory, stochastic approach, however it is still persisting to be the arduous task to characterise the surface irrugalarities and microstructure heterogeneties in the shales. Hybrid of fractal analyses and montecarlo simulation considering microstructure scaling lacunarity provides an effective way to characterize the complex pore structures in shale and can bridge microscale structures and macroscale transport properties. The developed probabilistic model analyses various parameters which intervene in the fluid flow during dynamic conditions. Each parameter's respective impact of risk and uncertainty in prediction and forecasting models are thoroughly evaluated. In addition, fluid flow at insitu conditions is characterised by solving partial order differential equations viz., unsteady-state flow equation for slightly compressible fluids. By examining the sensitivity analyses for the influential parameters, the model is more optimised to obtain more certainty in evaluating the shale reservoirs.

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Participation

In person

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Session Classification: Poster

Track Classification: (MS03) Flow, transport and mechanics in fractured porous media