A non-Linear transport model for determining shale rock characteristics

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Unconventional hydrocarbon reservoirs consist of tight porous rocks which are characterised by nano-scale size porous networks with ultra-low permeability [1,2]. Transport of gas through them is not well understood at the present time, and realistic transport models are needed in order to determine rock properties and for estimating future gas pressure distribution in the reservoirs. Here, we consider a recently developed non-linear gas transport equation [3],

$$\frac{\partial p}{\partial t} + U\frac{\partial p}{\partial x} \;\; = \;\; D\frac{\partial^2 p}{\partial x^2}, \qquad t > 0, \tag{1}$$

complimented with suitable initial and boundary conditions, in order to determine shale rock properties such as the permeability K, the porosity ϕ and the tortuosity, τ. In our new model, the apparent convection velocity, $U = U(p, p_x)$, and the apparent diffusivity $D = D(p)$, are both highly non-linear functions of the pressure. The model incorporate various flow regimes (slip, surface diffusion, transition, continuum) based upon the Knudsen number Kn, and also includes Forchchiemers turbulence correction terms. In application, the model parameters and associated compressibility factors are fully pressure dependent, giving the model more realism than previous models. See [4].

Rock properties are determined by solving an inverse problem, with model parameters adjustment to minimise the error between the model simulation and available data. It is has been found that the proposed model performs better than previous models. Results and details of the model will be presented at the conference.

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