The effects of the parameters involved in shale gas reservoir simulation are investigated using an improved transport equation for description of gas flow in nano-Darcy permeability media. This approach takes into account the effects of molecular collisions at the pore wall and is valid in all flow regimes: Darcy, slip, transition, and free-molecular flow. The study generalizes a transport equation valid for all flow regimes for an ideal gas in a capillary tube and extends the formulation to quantify the effect of a distribution of pore sizes for different flow regimes. We first describe the adopted methodology to model ideal gas transport and then account for real gas behavior by modifying the conventional definition of the mean freepath.

The relationship of this approach to the Klinkenberg correction for slip flow and other published formulations that are described as the sum of a Darcy term plus a diffusive transport term are examined. An application of the present approach and its implications are demonstrated by means of a numerical example involving a hydraulically-fractured shale gas reservoir producing at a constant rate. The bottomhole pressure predictions from the non-Darcy formulation indicate a substantial deviation from the bottomhole pressure predicted by assuming Darcy flow and consequently, can be expected to have serious implications for production forecasting and planning for well abandonment. In particular, for infinite acting flow regimes that are commonly observed for shale gas wells, our calculations indicate that flowing bottomhole pressures tend to be higher than those calculated using a transport formulation governed by Darcy’s law, thereby describing the potential for significantly enhanced productive well life.