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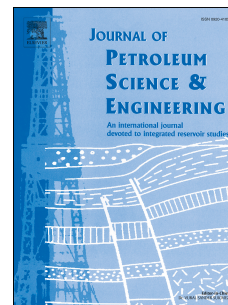
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Analysis of Pre-Darcy flow for different liquids and gases

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Abstract

Fluid flow in porous media is extensively associated with Darcy's law. Deviations from Darcy's law and its limitations result in modifications known as non-Darcy flow at high velocity and Pre-Darcy flow at low velocity. In this paper, experiments were conducted to explore significance of departure from linearity at low fluid velocity (Pre-Darcy flow) in porous media. Effect of different liquid and gas types on the onset of Pre-Darcy flow were studied for water, condensate, n-hexane and n-heptane as liquid phase and CH₄, CO₂ and N₂ as gas phase. Superficial velocity versus pressure gradient was measured and different onset values were reported. The minimum observed Darcy velocity was 0.189×10^{-05} m/s, below which Pre-Darcy flow prevails. Analysis was performed in terms of friction factor and Reynolds number for different particle size of 0.15, 0.25 and 0.3 mm. Pre-Darcy, Darcy and Non-Darcy flow regimes were observed and characterized in terms of $Re_{\sqrt{k}}$, Re_d and Re_p . The range of Reynolds number were reported for different flow regimes, different particle sizes and different types of liquids. For the case of condensate in 0.15 mm sand pack, Pre-Darcy flow was observed in the range of $Re_{\sqrt{k}} < 2.81 \times 10^{-06}$, $Re_d < 0.0014$ and $Re_p < 0.0005$. In addition to new liquids and gases that are investigated in this study, one of the differences between this study and previous ones, is investigation the relevance of Pre-Darcy flow to fluid properties in addition to rock properties for wide ranges of liquids and gases. The existence of Pre-Darcy flow means that, there is unknown opportunities for improved oil recovery in petroleum reservoirs. Also, accurate emission velocity is effective for reduction of soil pollution by hydrocarbon leakage. This velocity can be corrected by considering Pre-Darcy flow.

Keywords: Pre-Darcy flow, hydrocarbon, superficial velocity, Reynolds number, friction factor

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