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Boundary Layer Thickness in Dual Potential Fluid Flow through Porous Medium B. MARKICEVIC, Kettering University, A. NALA, D. HEIDER, S.G. ADVANI, University of Delaware — A transient, two-dimensional fluid flow through porous medium in a dual potential field has been studied analytically and experimentally. The field in a rectangular domain is created by placing two inlets: manifold along one of the edges at potential φ_1, and the other inlet is a channel placed in the center of the domain perpendicular to the first inlet on the top surface at potential $\varphi_2(x)$. For any location in the domain with potential $\varphi(\mathbf{x}), \mathbf{x} = (x, y)$, we define two potential differences $\Delta\varphi_1 = \varphi(\mathbf{x}) - \varphi_1$ and $\Delta\varphi_2 = \varphi(\mathbf{x}) - \varphi_2(x)$ with respect to the two inlets. Therefore, two distinct sub-regions of the porous medium exist, where $\Delta\varphi_1 < \Delta\varphi_2$ and $\Delta\varphi_1 > \Delta\varphi_2$. The interface between the regions satisfies $\Delta\varphi_1 = \Delta\varphi_2$ which we define as a boundary layer of thickness $\delta(x)$. In the experiments, we varied: the channel cross-sectional area, medium width, and thickness. The same fluid of very high viscosity (to reduce mixing) was used at both inlets with one stream dyed; thus, visualizing the flow and the two distinct sub-regions. We have also developed an analytical model to predict the boundary layer thickness, $\delta(x)$. Both, implicit and explicit solutions are found, where the explicit solution is given in the form of the inverse Lambert function. The solution has only one physical constant which is a function of the pressure gradient and the directional permeabilities of the porous medium. A comparison between experimental and analytical results reveals an excellent agreement.

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