



Steady Flow from an Array of Subsurface Emitters: Kornev's Irrigation Technology and Kidder's Free Boundary Problems Revisited

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Abstract Kornev's (Subsurface irrigation, Selhozgiz, Moscow-Leningrad, 1935) subsurface irrigation with a periodic array of emitting porous pipes is analytically modeled as a steady potential Darcian flow from a line source generating a phreatic surface. The hodograph method is used. The complex potential strip is mapped onto the triangle of the inverted hodograph. An analogy with the Deemter (Theoretische en numerieke behandeling van ontwaterings-en infiltratie stromings problemen (in Dutch). Theoretical and numerical treatment of flow problems connected to drainage and irrigation. Ph.D. dissertation, Delft University of Technology, 1950) drainage problem and Kidder (J Appl Phys 27(8):867–869, 1956) free-surface flow toward an array of oil wells underlain by a “wavy” oil–water interface is drawn. For a half-period of Kornev's flow, the “wavy” phreatic surface has an inflection point. The “waviness” of the phreatic surface is controlled by the spacing between emitters, the strength of line sources, and the pipe pressure and radius. Numerical modeling with HYDRUS involved two factors which constrained the saturated–unsaturated flow: the positive pressure head at the outlet of the modeled domain and lateral no-flow boundaries, with a qualitative corroboration of analytical solutions for potential (fully saturated) and purely unsaturated flows. HYDRUS is also applied to a generalized Philip's regime of an unsaturated flow past a subterranean hole, which is impermeable at its top and leaks at the bottom.

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