Water Resources Research 2011 vol.47 N11

How much floating light nonaqueous phase liquid can a phreatic surface sustain? Riesenkampf's scheme revisited

Kacimov A., Obnosov Y., Al-Maktoumi A., Al-Balushi M.
Kazan Federal University, 420008, Kremlevskaya 18, Kazan, Russia

Abstract

Steady, Darcian, one-phase, phreatic surface flow of groundwater into a horizontal well with a pancake lens of light nonaqueous phase liquid (LNAPL) accumulated in the water table trough is studied by the method of complex analysis. A sharp interface model assumes groundwater capped by two isobaric limbs (groundwater-vadose zone interfaces) of a free surface with an in-between cambered segment of an immiscible LNAPL-water interface, along which pressure is hydrostatically increasing with the depth of the LNAPL "channel." The complex potential polygon is mapped onto an auxiliary half plane where the complex physical coordinate of the flow domain is represented in terms of singular integrals as a solution of the Keldysh-Sedov problem. The shapes of semi-infinite "wings" of the water table contacting the vadose zone gas and of a finite length LNAPL-groundwater interface are found from parametric equations that involve the sink strength and location with respect to the pancake surface, the ordinate of the lowest trough point, and the volume of LNAPL accreted in the lens. Critical conditions, corresponding to the lens contour cusping toward the sink, are found. The Riesenkampf solution contains a free parameter, which is fixed by specifying either a point on the free surface or the volume of the trough-intercepted LNAPL. Copyright 2011 by the American Geophysical Union.

http://dx.doi.org/10.1029/2010WR010369