

Proceedings of the Royal Society A: Mathematical, Physical and Engineering Sciences 2014
vol.470 N2168

Meniscus on a shaped fibre: Singularities and hodograph formulation

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Abstract

Using the method of matched asymptotic expansions, the problem of the capillary rise of a meniscus on the complex-shaped fibres was reduced to a nonlinear problem of determination of a minimal surface. This surface has to satisfy a special boundary condition at infinity. The proposed formulation allows one to interpret the meniscus problem as a problem of flow of a fictitious non-Newtonian fluid through a porous medium. As an example, the shape of a meniscus on a fibre of an oval cross section was analysed employing Chaplygin's hodograph transformation. It was discovered that the contact line may form singularities even if the fibre has a smooth profile: this statement was illustrated with an oval fibre profile having infinite curvature at two endpoints. © 2014 The Author(s) Published by the Royal Society. All rights reserved.

<http://dx.doi.org/10.1098/rspa.2014.0113>

Keywords

Capillary rise, Complex variables, Hodograph transformation, Matched asymptotics, Minimal surfaces, Singularities