Johnson, R. E.

Power-law creep of a material being compressed between parallel plates: A singular perturbation problem. (English) Zbl 0571.76032

J. Eng. Math. 18, 105-117 (1984).

The compression of a viscous or creeping material in a narrow gap h between parallel plates of length L is studied as a twodimensional problem. The effective viscosity is assumed to be proportional to the inverse of an n th power of the second stress invariant. For small h/L ratio, a regular perturbation solution is constructed and leads to the classical lubrication theory. The solution is not uniformly valid near the planes of symmetry, i.e. the mid-plane between the two plates and that normal to the plates. In these planes of symmetry, the solution predicts infinite longitudinal stresses. This singularity is removed by the addition of two inner solutions. For the inner solution near the mid plane parallel to the plates, the normal distance is rescaled by $h(h/L)^{1/n}$. For the inner solution near the mid-plane normal to the plates, the normal distance is rescaled by h. The inner solutions are necessary in order to obtain a uniformly valid stress field but they do not significantly affect the velocity field given by the outer or lubrication theory solution.

Reviewer: L.Ting

MSC:

76M45 Asymptotic methods, singular perturbations applied to problems in fluid mechanics

76D10 Boundary-layer theory, separation and reattachment, higher-order effects

76A05 Non-Newtonian fluids

Cited in **1** Document

Keywords:

power law creeping flow; narrow gap; parallel plates; twodimensional problem; effective viscosity; n th; second stress invariant; regular perturbation solution; lubrication

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