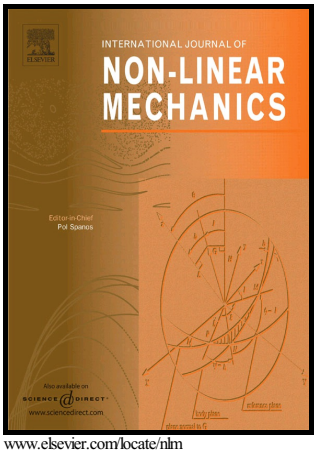

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On the lubrication approximation for a class of viscoelastic fluids

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Abstract

We present a rigorous derivation of a dimensionally reduced Reynolds type equation for thin film flow lubrication of a class of viscoelastic fluids by employing a perturbation analysis on the upper-convected Maxwell model in natural orthogonal coordinates. This approximation accounts for the viscoelastic and curvature corrections to the classical Reynolds lubrication approximation. Comparison of our approximation with the classical Reynolds approximation suggests that viscoelasticity can have a significant influence on the lubrication characteristics, at least for certain values of the film thickness and of the eccentricity ratios of the journal bearing.

Keywords: viscoelastic fluid, hydrodynamic lubrication, Reynolds equation

1. Introduction

It is well known that the lubrication characteristics of, say motor oils, can be changed by adding polymers to the lubricants. These changes have been well studied and documented since the appearance of multigrade oils, see, *e.g.*, [7, 25, 6, 30]. The addition of polymers brings about a characteristic relaxation time and thus makes the lubricant fluids non-Newtonian and viscoelastic, cf. [7].

One of the simplest, and thus most often used, models to study the effect of viscoelasticity on flows which have relevance in lubrication is the Upper Convected Maxwell (UCM) model, cf. [23, 25, 29, 31, 17]. In [29, 31, 17], a perturbation method was applied to the UCM model to examine a thin flow between two-dimensional surfaces. Based on an order

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