COMPARISON OF A VISCOELASTIC AND A COUPLE STRESS MODEL IN A SIMPLE SLIDER BEARING WITH A POROUS SURFACE

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ABSTRACT

The tribology literature over many years abounds with articles concerning the effects of various non-Newtonian lubricant models on bearing properties. There is a virtually infinity of combinations of different models, bearing types, film rupture conditions and effects considered (e.g., temperature rise). It is difficult to make meaningful comparisons of one result to another. Different categorizations are possible, but we look at: a time dependent or viscoelastic model [1], and a multi polar model (in which the fluid possesses an inherent microstructure) [2].

The geometry is that of a steady 1D plane inclined slider with a porous layer attached to the sliding surface. The porous layer flow properties are described by the Darcy model.

The two continuum models (the upper convected Maxwell model UCM and Stokes couple stress CS model) are based on entirely different underlying physical assumptions. In the UCM model, the fluid is characterized by a time scale. In the CS model, the fluid element surface can support a couple stress (N-m/m^2), which is characterized by a length scale loosely representing a size of particles within the fluid.

However, when the thin film assumptions are applied the governing equations of the two approaches look surprisingly similar. Likewise, the computed results are similar, see Figs. 1 and 2. The abbreviation N represents the Newtonian case, or the case when the fluid time scale and length scale are

In both cases the non-Newtonian effect tends to increase the pressure, in the absence of a porous layer. The effect of the porous layer in the Newtonian case is to decrease pressure due to the porous layer providing an escape route for the confined fluid. The combined effects of the porous layer and non-Newtonian flow are also shown.

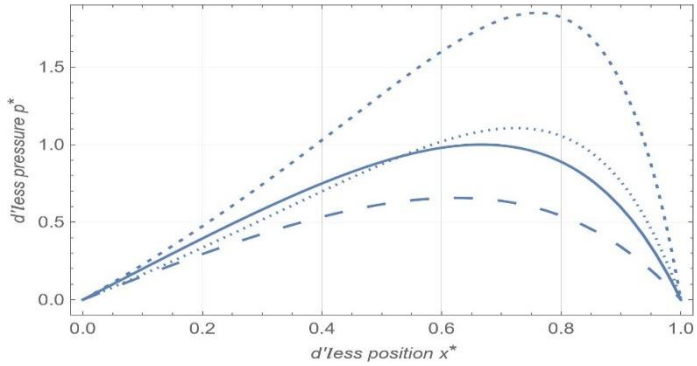

Fig 1 Pressure profiles, UCM case. Solid line (N, no porous layer), long dashed line (N with layer), small dashed line (UCM, no layer), tiny dashed line (UCM with layer)

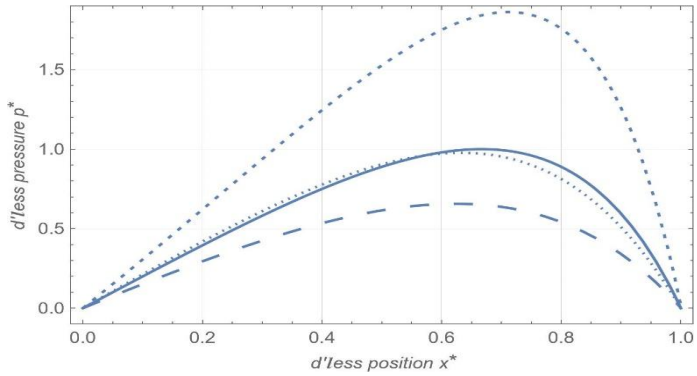

Fig 2 Pressure profiles, CS case. Solid line (N no porous layer), long dashed line (N with layer), small dashed line (UCM, no layer), tiny dashed line (UCM with layer)

REFERENCES

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