6th European Conference on Computational Mechanics (ECCM 6)
7th European Conference on Computational Fluid Dynamics (ECFD 7)
11-15 June 2018, Glasgow, UK

Influence of the viscoelasticity on cavitation in bearings

Sultan Sinem Eren[1], Daniele Dini[2] and Luca Biancofiore[1]

[1] Dept. of Mechanical Engineering, Bilkent University, 06800, Ankara, Turkey.
[2] Dept. of Mechanical Engineering, Imperial College London, London SW7 2AZ, UK.

Keywords: *Cavitation, Viscoelasticity, Reynolds equation, Bearings*

The addition of polymers in lubricant mineral oils is common practice. The lubricants become then viscoelastic due to these additives [1] and their load capacity increases. Furthermore friction and wear can be reduced by using polymeric lubricants. Polymer additives have a relaxation time λ, which varies between $10^{-4} - 10^{-6}$ s. If the lubrication process and the polymers relaxation time scales are commensurable, a strong time dependent effect is expected [2]. Deborah number, defined as $De = \frac{\lambda U}{L}$, where L is the bearing length and U is the sliding speed, is used to evaluate this time dependence. Another important phenomenon occurring in bearings is cavitation, which can strongly influence the load capacity and have disruptive effect on the bearing. For this reason, accurate predictions of the cavitation appearance are fundamental. In this work we examine the effect of the viscoelastic behaviour on cavitation. We solve then the Reynolds equations modified by the Elrod algorithm [3] to model cavitation and the upper convected Maxwell model to study viscoelasticity. We have analysed several bearing geometries, such as a parabolic slider, a pocket and a ridge. Viscoelasticity has a beneficial effect by reducing the cavitated region in the lubricant film, as shown in fig. 1 where the pressure distribution is shown for two different minimum film thicknesses h_{min}.

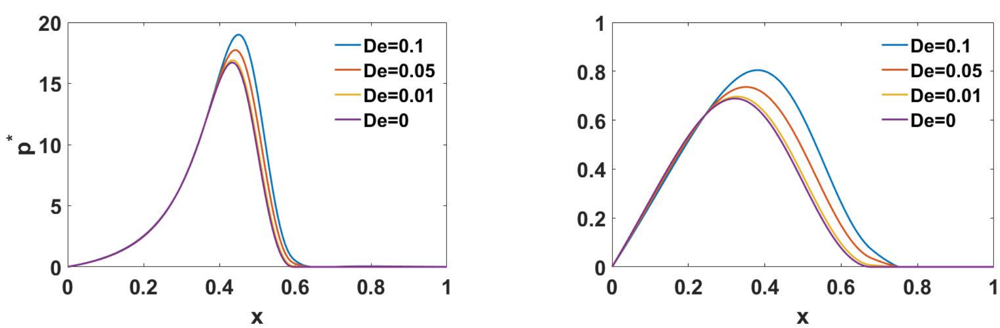

Figure 1: Non-dimensional pressure $p^* = \frac{p}{\mu U L / h_{max}}$ (where h_{max} is the maximum of the film thickness), for a parabolic slider with minimum film thickness (left) h_{min}=0.1 and (right) h_{min}=0.5. The lubricant cavitates where $p^* = 0$.

REFERENCES

[1] Li, X. K., et al., Applied Mathematical Modelling, **35**, 5, 2011, 23092323.

[2] Tichy, J. A., Journal of Tribology, **118**, no. 2, 1996, p. 344.

[3] Elrod, H. G., Journal of Lubrication Technology, **103**, no. 3, 1981, p. 350.