Elrod –Adams free boundary model : A Tentative of physical justification

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The cavitation phenomenon is widely accepted as being a critical aspect in the description and the simulation of lubricated devices. Three models are commonly used to cope with this free boundary problem: Gumbel (Half Sommerfed), Reynolds and Elrod Adams models.
For most of the usual devices, the differences between the results of computations issue from these three models in terms of load are not very different. However, difference occur by considering output and input flow values that can vary by more than twice time between these models.

One of the interesting properties of the Elrod Adams model being a mass flow conservation relation which does not explicitly exists in the two other models. Moreover, these various models can be also discussed from the boundary conditions involved.
More recently, it has been observed that the study of the influence of possible slip condition at the fluid-solid interface or of laser texturing roughness leads to very different conclusions whether one or other of these boundary conditions is considered.

None of these 3 free boundary models have been rigorously introduced: They are always obtained by slight modifications of the well known Reynolds equation, even if the resulting equations have very different mathematical features.

The goal of this paper is to try to obtain a more rigorous justification of the Elrod-Adams model by way of an asymptotic approach from a biphasic free boundary 3-D Stokes model. It will be seen that the results are not completely satisfactory in term of pressure. However it has been possible in terms of free boundary location and saturation functions to gain solutions very closed to the Elrod Adams one.