Multiphysics Modeling of Spring-Supported Thrust Bearings for Hydropower Applications

F. Xavier Borràs[1], Jan Ukonsaari[2] and Andreas Almqvist[1]
1. Luleå University of Technology, Division of Machine Elements, Luleå, Sweden;
2. Vattenfall, Vattenfall Research and Development AB, Luleå, Sweden.

It is never easy to support 500 tones rotating load over a lubricant film thinner than a paper. This is the goal of the thrust bearings for hydropower applications. A thrust bearing predictive model has been developed in order to facilitate the designing task of these huge power generating machines.

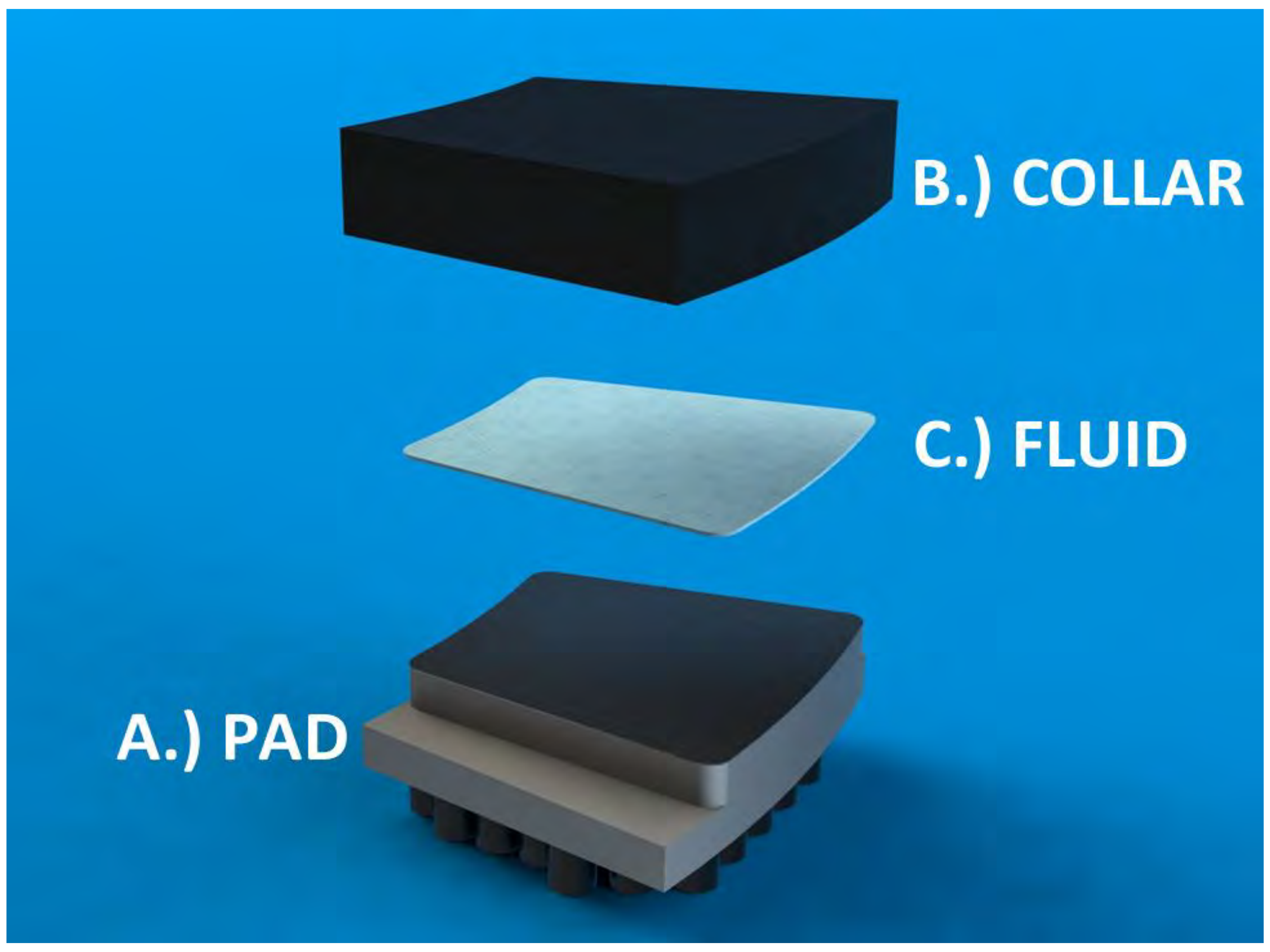

Figure 1. Schematics of the 3 domains (pad, collar, fluid).

The Reynolds Equation, viz.

$$\nabla\left(\frac{\rho\cdot h^3}{12\cdot\eta}\cdot\nabla p\right)=\nabla\begin{pmatrix}U_x\\U_y\end{pmatrix}\cdot\rho\cdot h$$

governs the fluid flow and is used to predict pressure distribution and velocity field.

The equation is specified in the Lubricant Shell physics which is defined on the pad surface. The geometry of the gap between the pad and the collar h is dependent on the elastic and thermal deformation of both pad and collar surfaces.

The temperature distribution is obtained solving the Energy Equation in the fluid model,

$$\rho\cdot C_p\cdot\left(u_f\cdot\frac{\partial T}{\partial x}+v_f\cdot\frac{\partial T}{\partial y}\right)-k\cdot\frac{\partial^2 T}{\partial z^2}=\eta\cdot\left[\left(\frac{\partial u_f}{\partial z}\right)^2+\left(\frac{\partial v_f}{\partial z}\right)^2\right]-\frac{T}{\rho}\cdot\frac{\partial\rho}{\partial T}\cdot\left(u_f\cdot\frac{\partial p}{\partial x}+v_f\cdot\frac{\partial p}{\partial y}\right)$$

The temperature distribution is used as boundary conditions on the pad and collar domains.

The fluid film thickness, the pressure profile and the temperature distribution play an important role. Typical results are depicted in Fig. 2.

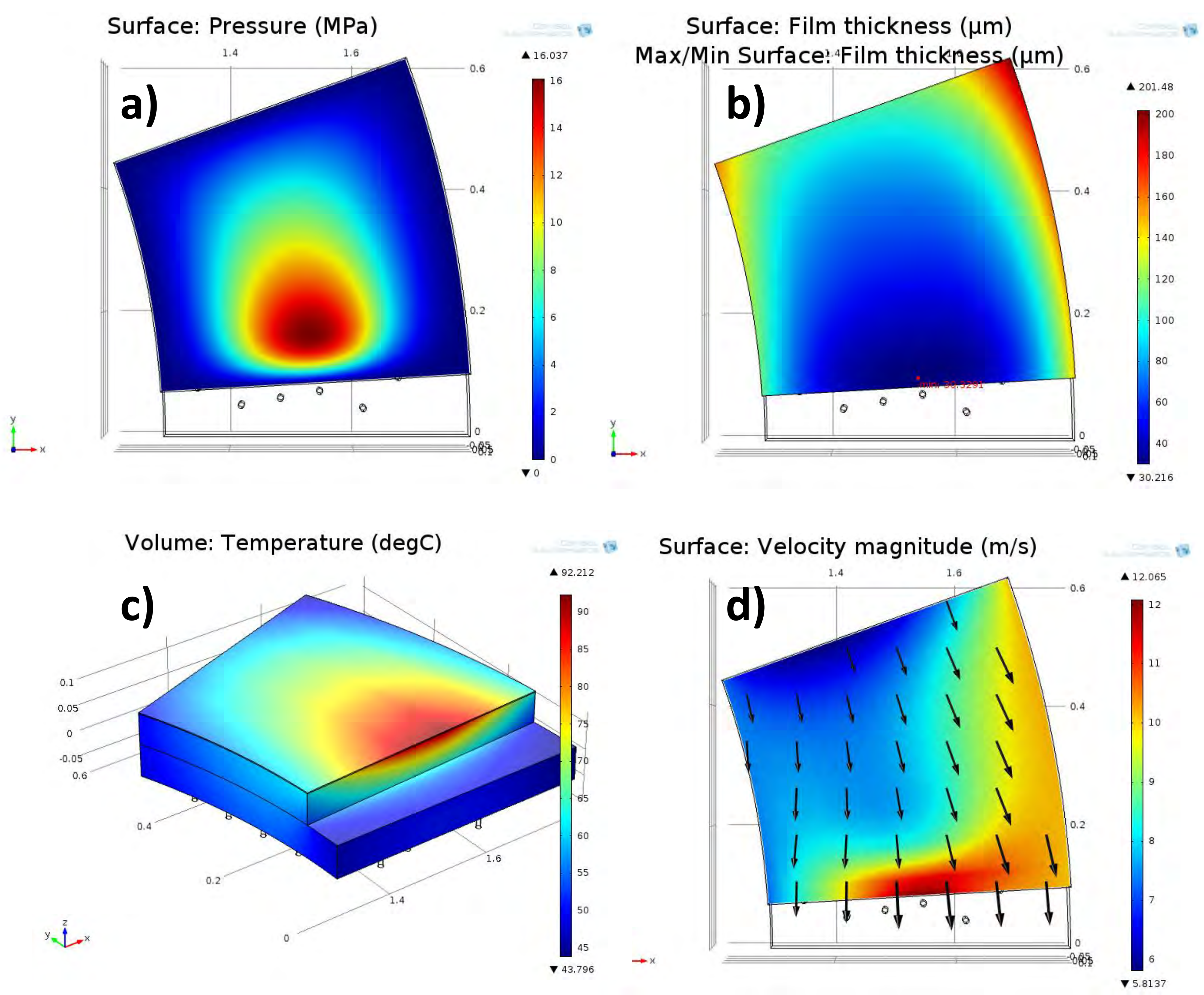

Figure 2. a) Pressure, b) Film thickness, c) Temperature on the pad, d) Fluid velocity field at $z=h/2$.

The present model is suitable for simulating most types of spring-supported thrust bearings. Some para-meters require fitting against exp-eriments. The model developed allows to predict e.g. overload situations, test different kinds of lubricants, or test different springs distribution. The model developed could be a useful tool when designing or modifying thrust bearings.

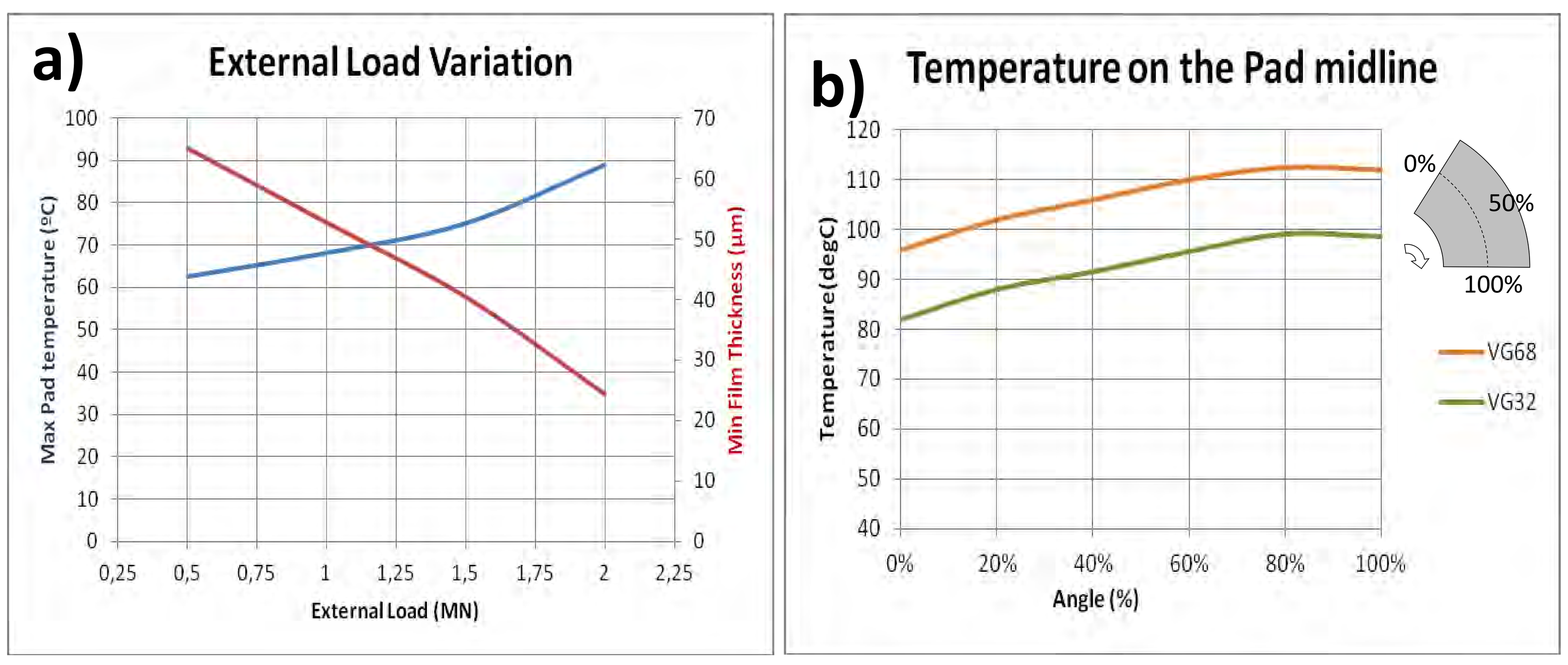

Figure 3. a)Variation of film thickness and pad temperature with the external load. b) Film thickness on the pad midline using two different lubricants.

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