

were,

$$\bar{p}_t = \frac{p_t}{p_s} \quad (3.16)$$

The basic aspect of the problem lies now in quantifying the coefficient of discharge C_d . Waumans [40] showed that C_d is a unique function of:

$$C_d = f(\Lambda_e, \bar{p}_t, geo) \quad (3.17)$$

in which *geo* stands for the entrance gap geometrical properties. The entrance number Λ_e depends on the supply pressure, geometry of the bearing problem and its fluid properties:

$$\Lambda_e = \frac{\mu r_f}{p_s h^2} \sqrt{\frac{\Re T s}{\kappa}} \quad (3.18)$$

As a result, the original entrance flow problem is now reduced to a practical lumped parameter model which relies on an underlying physical model instead of only experimental data. It takes both the Reynolds number and Mach number at entrance into account and is therefore an accurate and efficient method. Moreover, tabulation of the coefficient of discharge C_d into a lookup table will reduce the computing time significantly.

3.3.4 Film flow: the Reynolds equation

Assuming a fully viscous fluid flow over the entire bearing area, the flow between the bearing surfaces can be described by the well-known Reynolds equation, which is derived from the viscous flow and continuity equations [12, 19]. For a two dimensional Cartesian coordinate system, assuming a constant pressure across the fluid film, the time-dependent Reynolds equation can be expressed as:

$$\nabla \cdot \left[\underbrace{\frac{\rho h^3}{12\mu} \nabla p}_{\text{Poiseuille}} - \underbrace{\frac{1}{2} \rho h \mathbf{V}_t}_{\text{Couette}} \right] = \underbrace{\frac{\partial}{\partial t}(\rho h)}_{\text{squeeze}} \quad (3.19)$$

which is composed of the pressure induced Poiseuille term and the Couette or shear flow term on the left-hand side, and the time dependent squeeze term on the right-hand side. The two unknowns in this equation, i.e. the pressure p and the density ρ , can be found by solving the simplified energy equation and the equation of state simultaneously over the entire bearing gap. These three equations contains three unknowns: p , ρ and the film temperature T . However, by assuming an isothermal behaviour the energy equation and the equation of state can be dropped from the analysis in favour of a much simpler approach