Dynamic Analysis of the Long Plain Journal Bearing in the Nanotechnology Environment

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ABSTRACT

Stability analysis is performed for the long plain journal bearing using a **Simplified Flux Law of a Rarefied Gas Film** (**SFLR**) that is deduced from the essential rarefaction-compressibility interaction according to the results of the companion paper* such that Λ_{SFLR} and ε prescribe the steady-state operating condition. Λ_{SFLR} is computed from ε, ambient Knudsen number Kn_a and the conventional compressibility number Λ.

Both the steady state and the dynamic (frequency-dependent) perturbation of **SFLR** are solved by concatenation of closed form formulas for each computation mesh element. Observation of the **Mass Content Rule** (**MCR**), which is derived in the companion paper, is required to compute the solutions. Due to the linear character of **SFLR**, the steady state solution is calculated in a single pass without the need to iterate.

The dynamic perturbation analysis requires the complex algebraic representation. Stability analysis involves converting the reaction matrix components into a pair of eigenvalues that are again complex. Because the condition of $\varepsilon > 0$ disrupts rotational symmetry, it is necessary to establish lineage identity so that each can be examined over the whole spectrum for the determination of threshold points and their compilation into threshold maps. Each threshold point may represent either an onset condition, designating an upper bound, or an exit condition, designating a lower bound for the rotor mass for stable operation.

At fixed (ε, Λ_{SFLR}), there may be one or more onset conditions, each representing a distinct mode. Corresponding to each onset condition, the exit condition does not always exist. Threshold maps are constructed for $\varepsilon = 0.2$ and 0.8. For the range of Λ_{SFLR} explored, there is at least one onset condition at $\varepsilon = 0.2$ while there is an upper bound of Λ_{SFLR} for unconditional stability at $\varepsilon = 0.8$.

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* Pan, Coda H. T., Kim, Daejong, and Bryant, Michael D., "Steady-state Analysis of the Long Plain Journal Bearing in the Nanotechnology Environment," Second International Symposium on Stability Control of Rotating Machinery (ISCORMA-2), Gdansk, Poland, 4-8 August 2003.