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STATIC CHARACTERISTICS ANALYSIS FOR TEXTURED FOIL THRUST BEARING BASED ON MULTIGRID METHOD

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Carefully designed compliant foil structure or surface texturing can both help improve bearings' performance. However, little research has been done on their combination: textured gas foil bearing. The modified compressible Reynolds equation, namely, Eq.(1), was adopted as the pressure governing equation of bump-type foil thrust bearing, and the influence of different slip models was discussed. The results indicate that the predicted axial load capacity agrees with the literature data. Furthermore, the reduction of the load capacity predicted by different slip models is almost the same (about 1~3%). Thus, the following contents mainly focused on the results of the first-order slip model. For handling the significant discretization effort introduced by texture, the execution time differences between various numerical methods[1], including the direct, iterative, and multigrid algorithms, see Table *1* and Fig. 1, were presented in Fig. 2. The results indicate that the multigrid algorithm performs best and the execution time is generally reduced by 50% compared to the traditional direct method under the same operating parameters. Besides, further analysis of the textures' effect on bearings' performance was carried out based on three distribution types[2]. The results indicate that textures affect all static characteristic parameters more when the relative texture depth increases. For the #1 texture distribution type, the maximum increment of load capacity could exceed 10% when the textures are assumed to be manufactured in the ramp of the top foil, see Fig. 3. In conclusion, the multigrid is an excellent solution that can balance computational accuracy and efficiency for textured foil thrust bearings. Furthermore, an appropriate arrangement of textures could improve foil thrust bearings' performance.

$$\frac{1}{\bar{r}^2}\frac{\partial}{\partial\theta}\left(\bar{Q}_{\mathrm{P}}\frac{\partial\bar{p}}{\partial\theta}\right)+\frac{1}{\bar{r}}\frac{\partial}{\partial\bar{r}}\left(\bar{r}\bar{Q}_{\mathrm{P}}\frac{\partial\bar{p}}{\partial\bar{r}}\right)=\Lambda\frac{\partial}{\partial\theta}\left(\bar{p}\bar{h}\right) \quad (1)$$

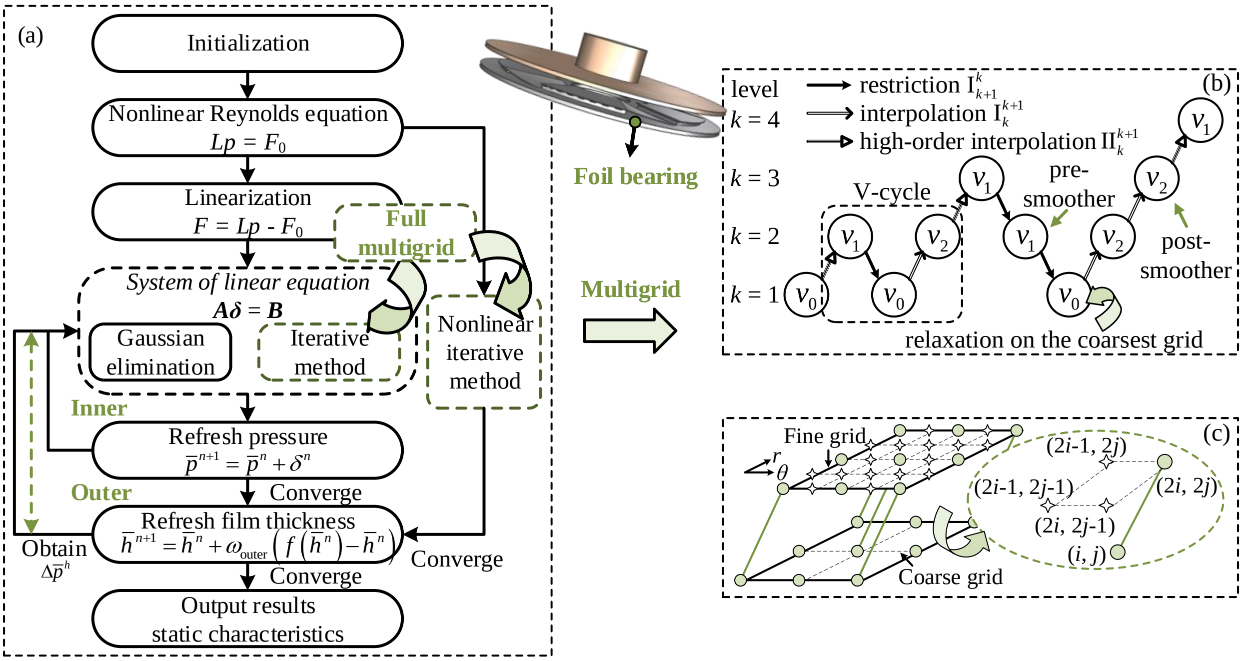

Fig. 1 – Multigrid algorithm using one V-cycle per refinement

Table 1 – Five methods adopted in this paper

Abbreviation	Numerical methods	Discretization Schemes
DS	direct method	

IS-MG	multigrid method	the first scheme based on the Newton-Raphson method and a long second-order accurate finite difference formula
N-IS	iterative method	the second scheme based on a short second-order accurate
N-IS-MG	multigrid method	finite difference formula

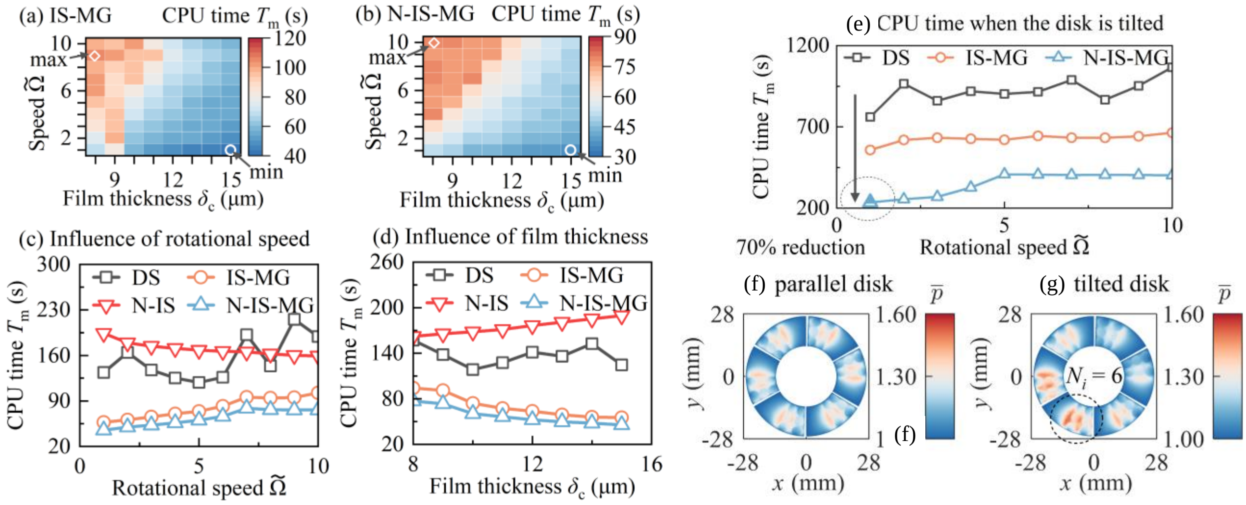

Fig. 2 – CPU time versus operating parameters

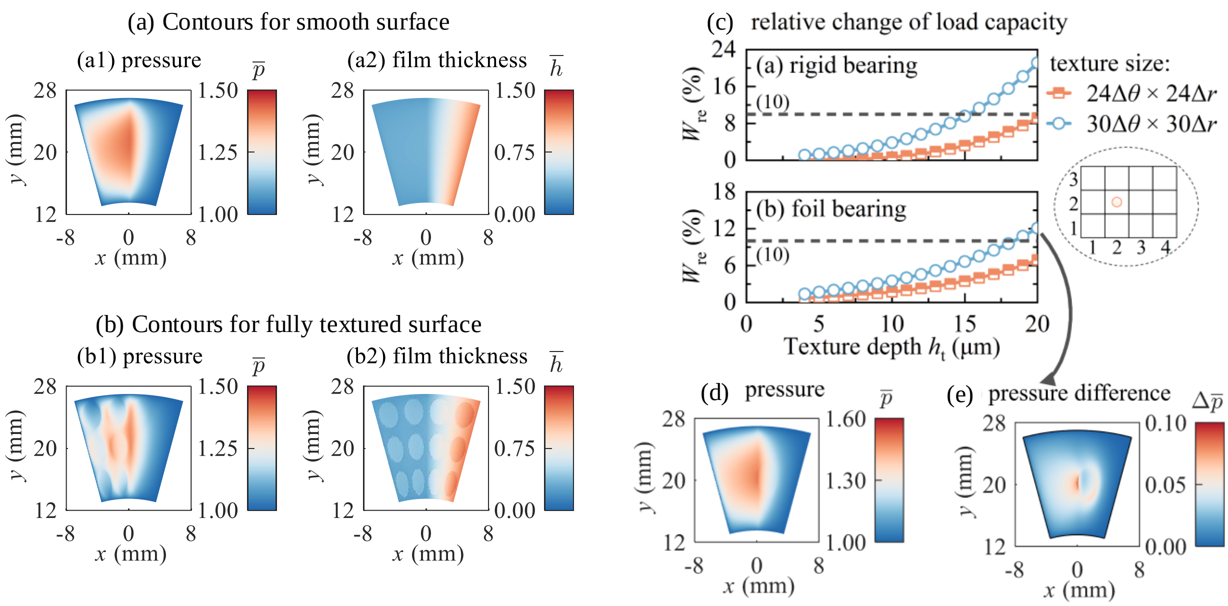

Fig. 3 – The influence of surface texturing

Reference

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