Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)

Cite this as: Yanzhong WANG, Yaping ZHANG, Kai YANG, Boji LU, Hao GAO, 2023. Dynamics of buoyancy-driven microflow in a narrow annular space. *Journal of Zhejiang University-SCIENCE A (Applied Physics & Engineering)*, 24(12):1131-1139. https://doi.org/10.1631/jzus.A2200617

Dynamics of buoyancy-driven microflow in a narrow annular space

Key words:

Liquid floated gyroscope, Annular channel, Roughness feature, Fluid drag

Model and method

Fig. 1 reveals the process of extracting flow channel features, constructing theoretical models, and CFD models for the liquid floated gyroscope.

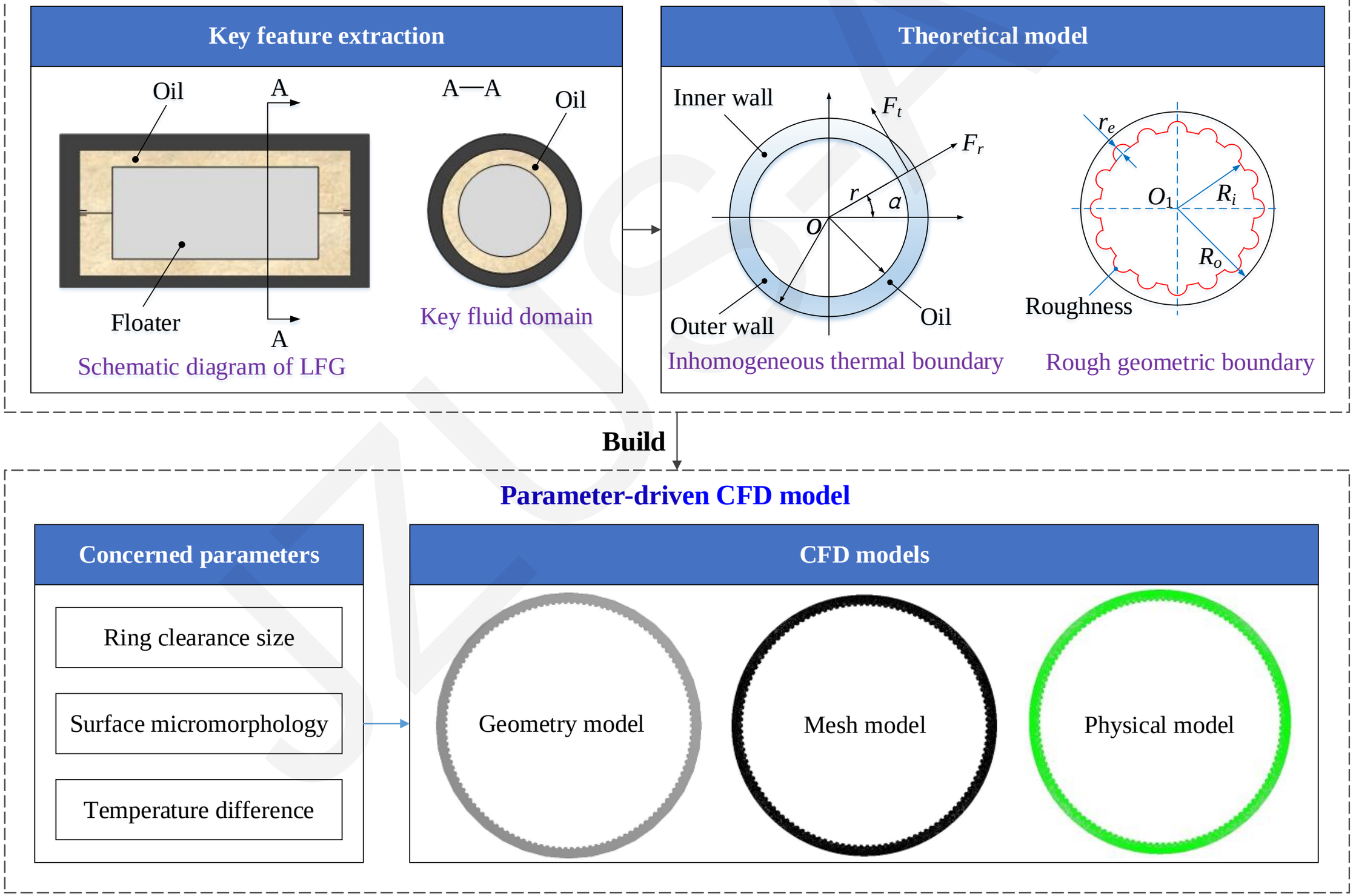
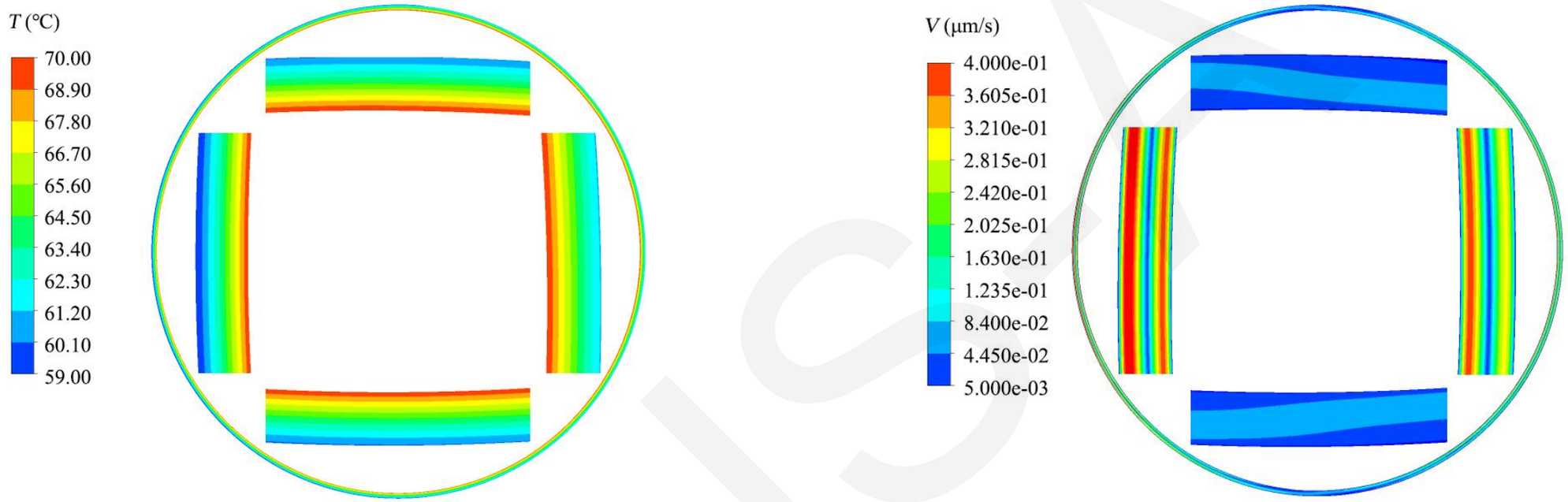


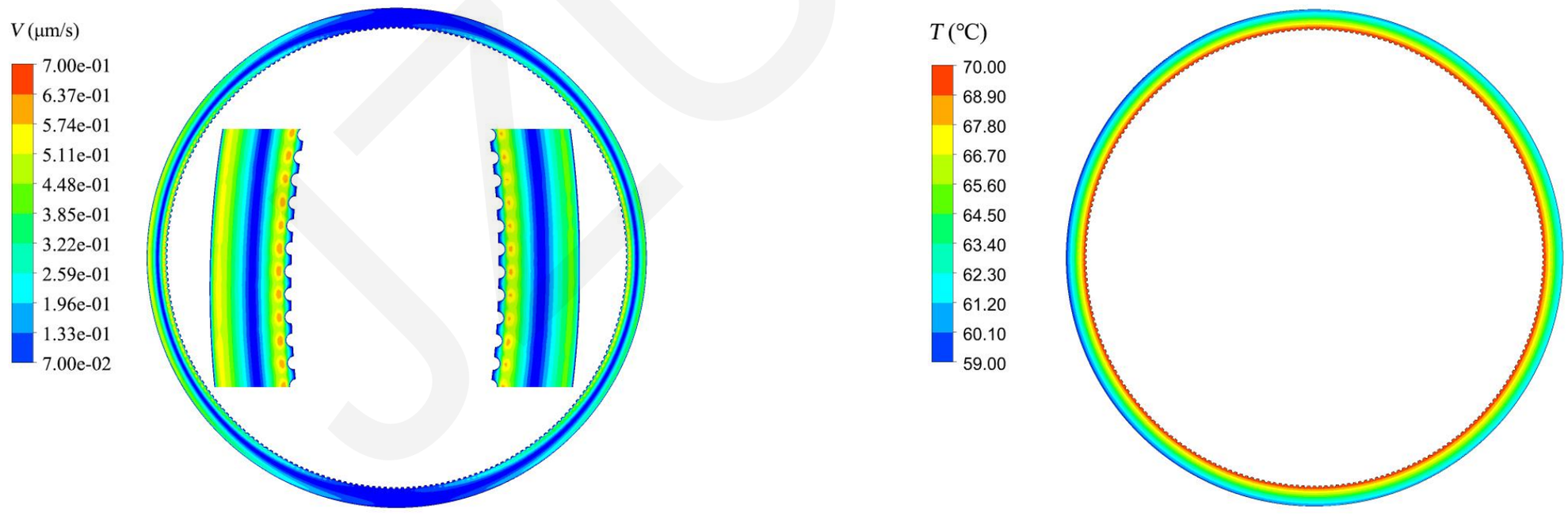
Fig. 1 Model and method of the paper

Major results

Fig. 2 shows the temperature and flow field distribution in an annular space under different clearances and roughness conditions



(a) temperature field and flow field with h=0.5 mm

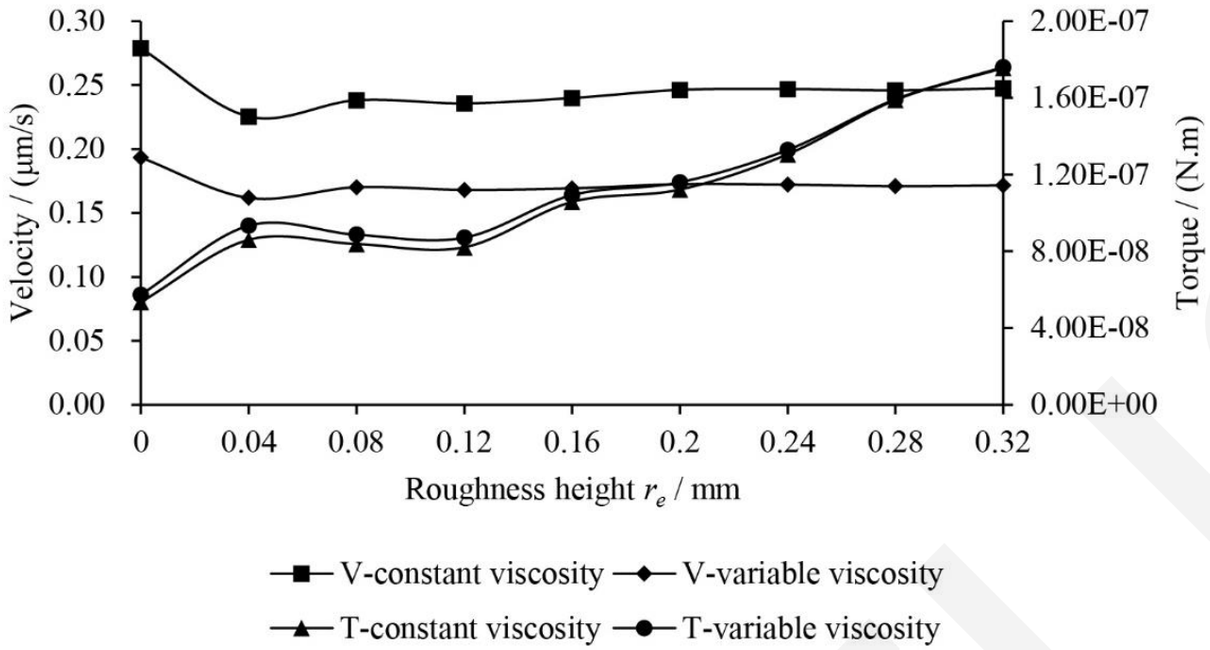


(b) temperature field and flow field with r_e=0.16 mm

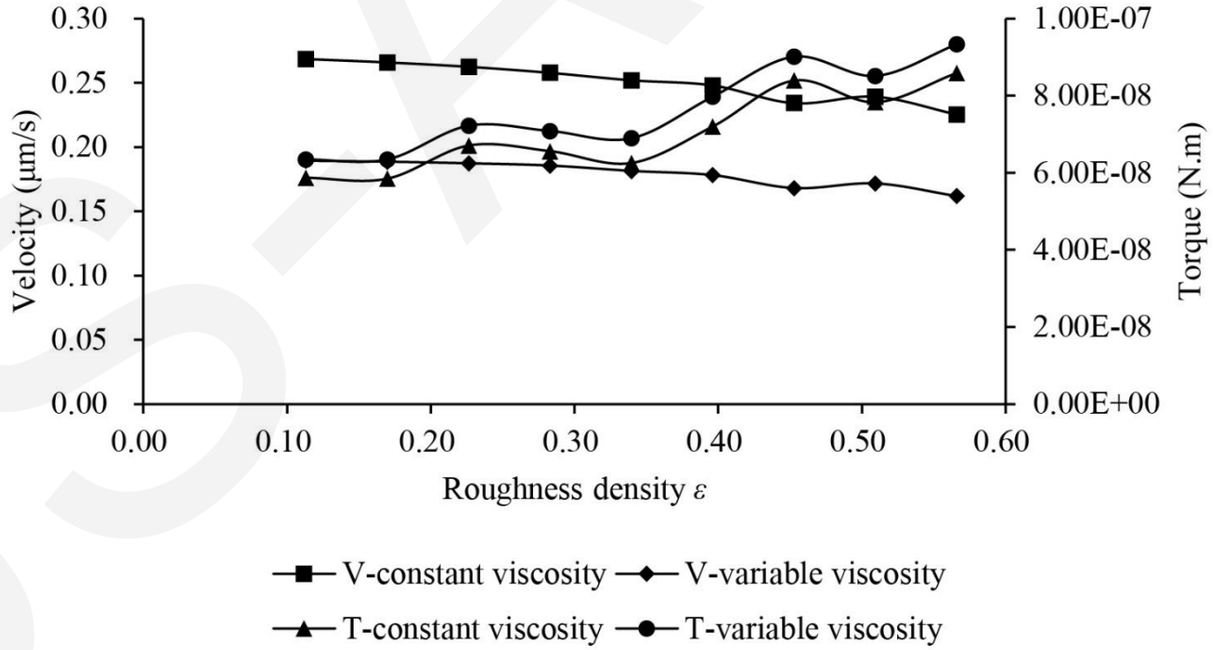
Fig. 2 Temperature and flow field in the annular space

Major results

Fig. 3 shows the effect of wall roughness feature on the dynamic characteristics of the floating oil, and roughness feature parameters include roughness height r_e and roughness density ε



(a) roughness height r_e



(b) roughness density ε

Fig. 3 Variation of oil velocity and drag torque with roughness feature parameters

Conclusions

1. Two-dimensional flow-heat coupling models of the annular fluid domain inside LFGs were established.
2. The clearance effect has a greater influence on the drag torque than the viscosity-temperature effect, and the torque first increases, then decreases, and finally tends to be stable with the increase in the clearance size.
3. The roughness of the channel walls significantly affects the oil dynamics, and the effect of roughness height on drag torque is greater than that of roughness density.