ASEC 2024 Conference

The 5th International Electronic Conference on Applied Sciences

04–06 December 2024 | Online

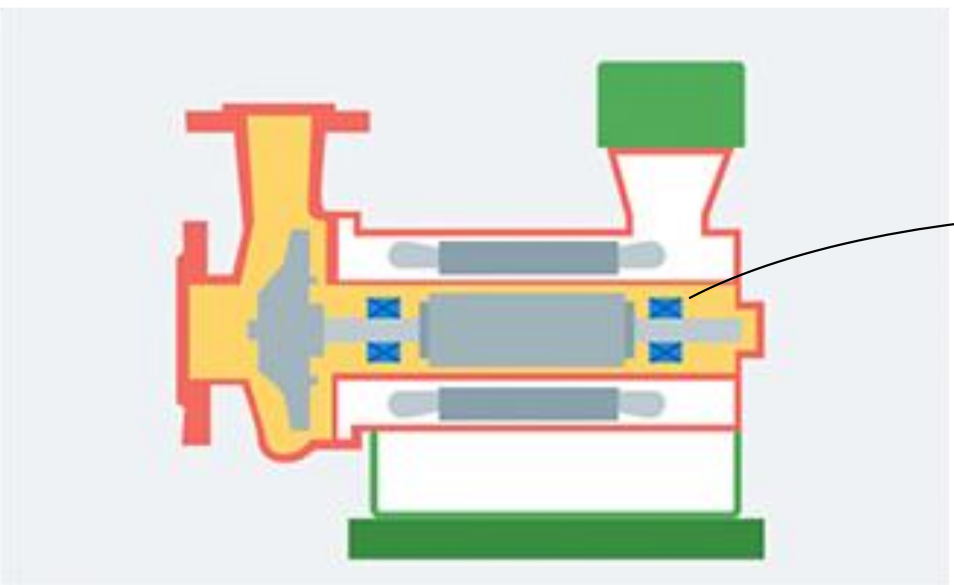
MDPI

Numerical Study on Film Pressure in a Helical Grooved Plain Bearing of a Canned Motor Pump

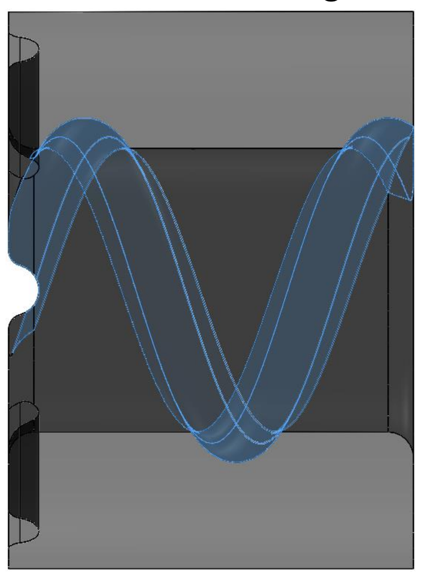
Shinichiro EJIRI, PMP, Nikkiso Co., Ltd., Japan shinichiro.ejiri@nikkiso.co.jp

INTRODUCTION & AIM

Canned motor pumps are a type of turbopump that features a non-leakage seal-less structure that integrates the pump and the motor to transport such as hazardous or expensive liquids. It differs from a typical turbopump in that the pumping liquid also serves as the cooling liquid for the motor and the lubricating liquid for the sliding surfaces. A grooved plain bearing is generally used in canned motor pumps to supply sufficient cooling liquid to the motor. However, there is no external lubricant supply system for canned motor pumps which means that the design guidelines for standard grooved plain bearings cannot be applied without modification. The purpose of this study is to obtain knowledge to develop design guidelines for helical grooved plain bearings for canned motor pumps. Therefore, the film pressure, which is one of the important indices in bearing design, was analyzed by Computational Fluid Dynamics (CFD).



[1] https://www.nikkiso.co.jp/products/pump/canned.html



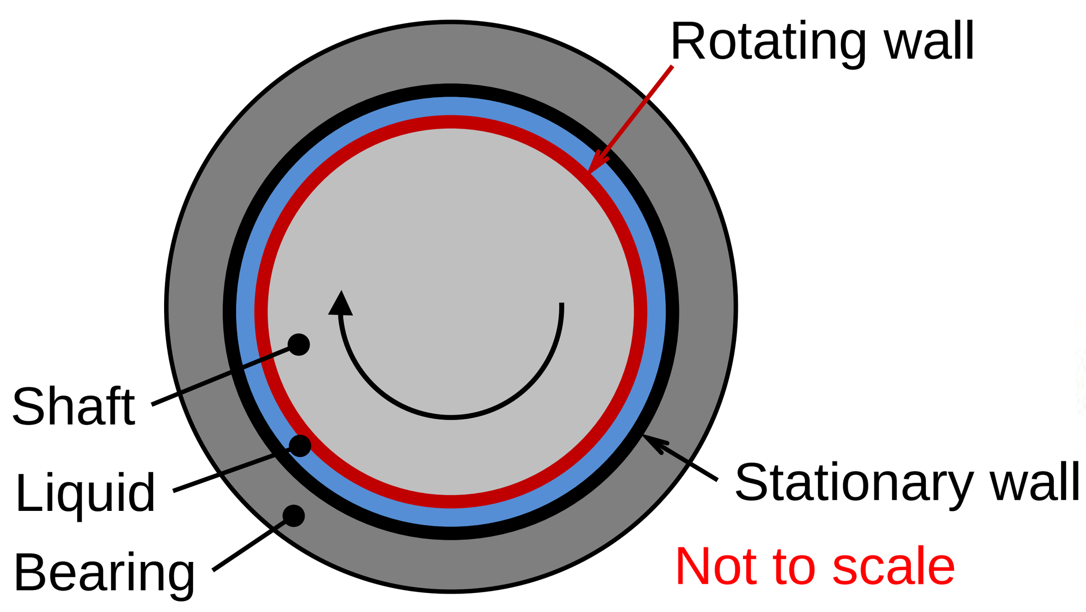
METHOD

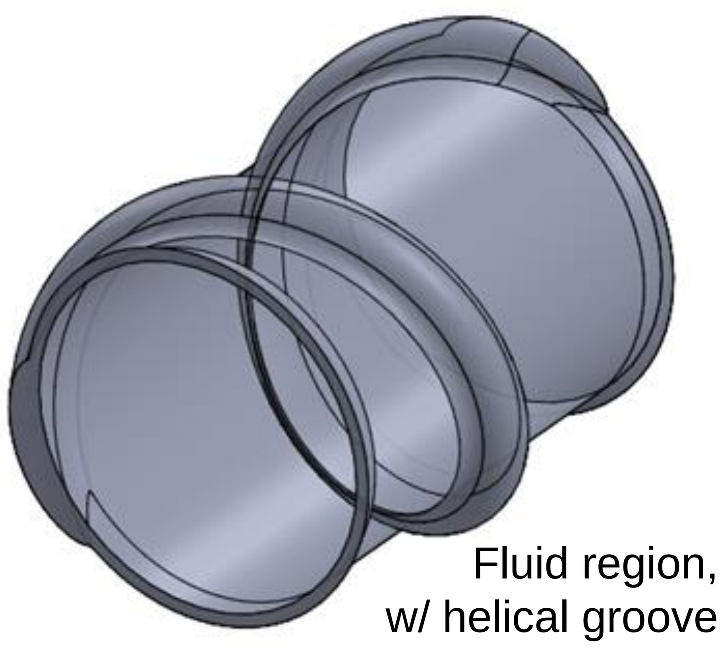
◆ Simulation parameters

w/o helical groove.	
Bearing diameter [mm]	28.1
Bearing length [mm]	40
Helical groove number	0
Shaft diameter [mm]	28.0
Eccentricity	0.5
Rotational speed [rpm]	3000
Mesh number	88,200

w/ helical groove.	
Bearing diameter [mm]	28.1
Bearing length [mm]	40
Helical groove number	1
Shaft diameter [mm]	28.0
Eccentricity	0.5
Rotational speed [rpm]	3000
Mesh number	378,662

◆ Simulation model





Fluid region, w/ helical groove

- ☐ Inlet & Outlet condition : empty
- ☐ Laminar flow
- ☐ Room temperature water

◆ Software

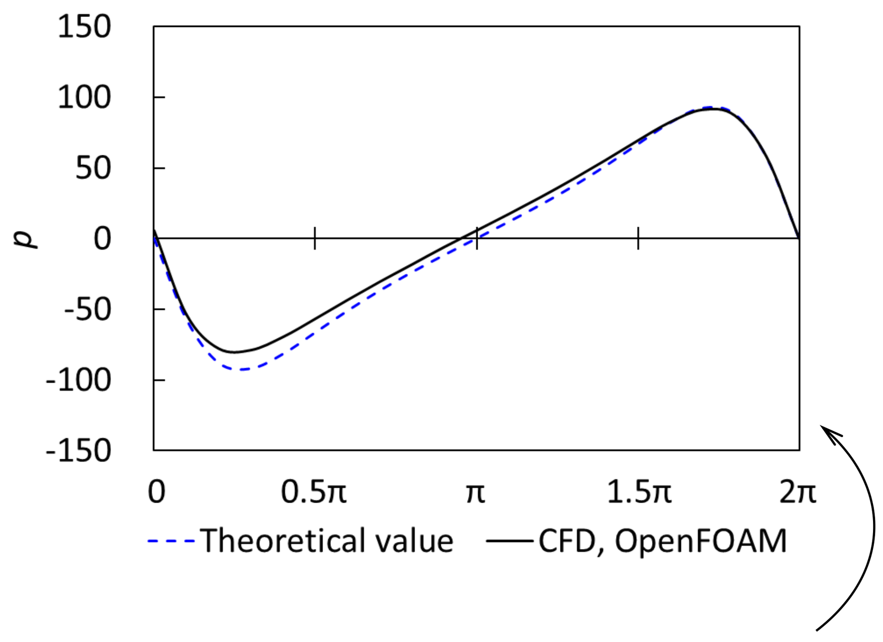
- ☐ 3D-CAD: SOLIDWORKS 2023SP3
- ☐ Mesher: ANSYS Meshing 2022R2
- ☐ Prep & Solver: OpenFOAM v1906
- ☐ Post: ANSYS Ensight 2022R2

RESULTS & DISCUSSION

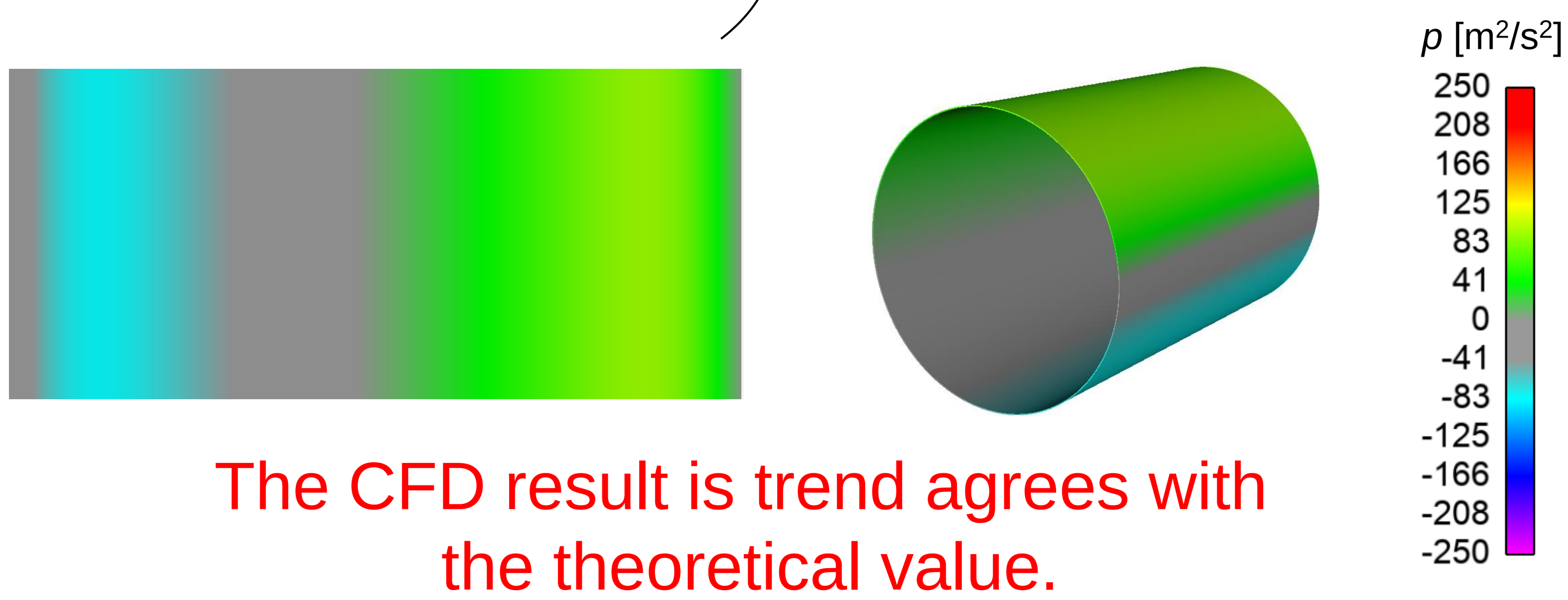
w/o helical groove

Theoretical solution by Reynolds' equation

$$p = \frac{\eta U r}{C_r^2}\left(\frac{6\varepsilon(2+\varepsilon\cos\Phi)\sin\Phi}{(2+\varepsilon^2)(1+\varepsilon\cos\Phi)^2}\right)+p_0$$

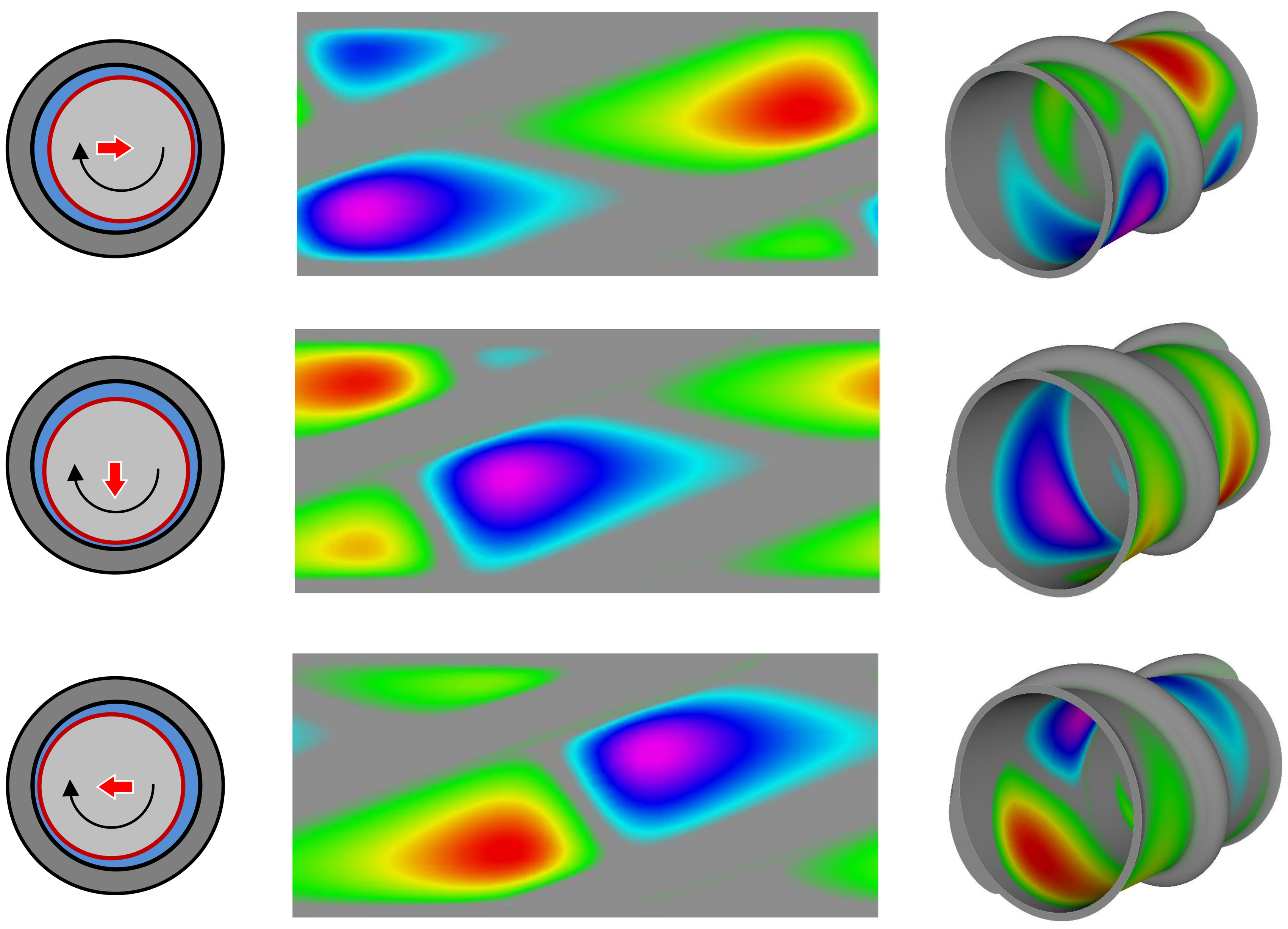


p - oil film pressure,
η - dynamic viscosity,
r - bearing radius,
r_j - journal radius,
C_r - radial clearance $C_r = r - r_j$,
ε - eccentricity ratio $\varepsilon = e/C_r$,
e - absolute bearing eccentricity,
p_0 - initial pressure $p_0 = 0$ in this calculation,
ω - rotational speed,
U - peripheral velocity $U = \omega r$,



The CFD result is trend agrees with the theoretical value.

w/ helical groove



The effect of the helical groove increases the peak values of both positive and negative pressure, changing the pressure field into a complex one.

CONCLUSION & FUTURE WORK

It was clarified that helical grooves have a significant effect on the film pressure of a plain bearing. However, this study focused on fundamental analysis thus simplifying the real phenomena. Therefore, it is planned to conduct an analysis that takes into consideration cavitation, fluid flow in and out, shaft misalignment, and other factors. In addition, it is also planned to analyze the effect by the shape of the helical groove.