STUDY OF CAVITATION PRESSURE ON TEXTURED SURFACE IN MECHANICAL SEALS

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Hydrodynamic Lubrication; Texturation; Experiments in tribology; Cavitation pressure

ABSTRACT
It is necessary to know pressure of cavitation for the design of bearings and seals, but it is very difficult to estimate it [1]. It is often believed that the cavitation pressure depends on the type of fluid, environment sliding conditions, etc. This study investigates cavitation pressure in the sealing film of a mechanical seal with micro machined patterns on the sliding surface. The reversed Rayleigh-step was formed on the sliding surface as shown in Fig. 1 to generate negative pressure to ensure certain sealing performance.

In our previous studies [2, 3], the pressure in the cavitation region was directly measured using a pressure sensor installed under a pinhole on the sliding surface. Water and various lubricating oils were used as experimental sealing fluid. It was confirmed that the cavitation pressure depended on the vapor pressure of the sealing fluid and that the pressure varied with the sliding speed.

Additional experiments with various geometry of the reversed Rayleigh-step were carried out to investigate the effect of reversed Rayleigh-step geometry on cavitation pressure. Water was used as sealing fluid. It was confirmed that the cavitation pressure varied with the depth of reversed Rayleigh-step in addition to the sliding speed. Figure 2 shows the relationship between reversed Rayleigh-step groove depth, sliding velocity, and cavitation pressure.

Furthermore, observation of the cavitation confirmed that fine bubbles separated from the main large cavitation bubble and flowed to downstream intermittently at the inside region of reversed Rayleigh-step groove. The experimental results implied that the cavitation pressure depended on the balance of the diffusion of the dissolved gas and discharged gas. A model of diffusion and transportation of the dissolved gas was proposed based on the advection equation.

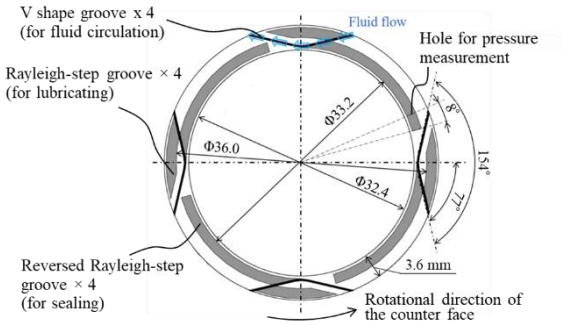

Fig. 1 Dimensions of micro machined patterns

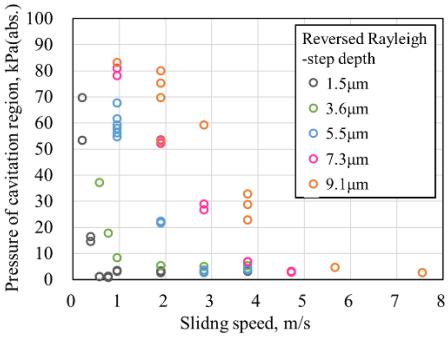

Fig. 2 Relationship between cavitation pressure and sliding speed

REFERENCES
[1] Sun, D.C., Brewe, D. E., Abel, P. B., 1993, "Simultaneous Pressure Measurement and High-Speed Photography Study of Cavitation in a Dynamically Loaded Journal Bearing," Journal of Tribology, Vol. 115, pp. 88-95.
[2] Itadani, M., Uemura, N., and Sugimura, J., 2020, "Observation and pressure measurement of cavitation region in mechanical seal," Proceedings of the 25th International Conference on Fluid Sealing 2020 Manchester, pp. 45-53.
[3] Makishima, S., Itadani, M., and Sugimura, J., 2023, "Variation of cavitation pressure with liquid and operating conditions in mechanical seals," Tribology Online, pp. 436-443.