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EVALUATING LUBRICATION REGIMES OF SPUR GEAR MESHING USING ELECTRICAL IMPEDANCE METHOD

A. Watanabe [a], H. Okubo [a], K. Nakano [a*]
nakano@ynu.ac.jp
[a] Yokohama National University,
79-7 Tokiwadai, Hodogaya, Yokohama 240-8501, Japan

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ABSTRACT

Recently, there has been a growing demand for high-speed electric vehicle (EV) motors to allow for smaller electric motors. In such a background, evaluating techniques for the lubrication regimes of rotating gears at high speeds have been required to develop a newly compact and high-efficiency gearbox. Various techniques have been proposed for evaluating the lubrication regimes between metal contacts. Previous studies has suggested an electrical impedance (EI) method as one of the most effective techniques for evaluating the contact and lubrication regimes [1,2]. The EI method successfully evaluates the lubrication regimes between a bearing ball and retainers in ball bearings [2].

In this study, we developed a test apparatus (Fig. 1) that can simultaneously quantify the oil film thickness and breakdown ratio to monitor the lubrication regimes at spur gear meshing using the EI method. This test apparatus consists of a mechanical unit (consisting of two motors, a gearbox, and two torque meters) and an electrical unit (consisting of a function generator, amplifier, and data logger). Using the apparatus, we tried to qualitatively assess the lubrication regimes at the gear meshing by analyzing the complex impedance during the gear test.

Figure 2 shows the behavior of the input voltage V_0 and measured voltage V_1 during the gear meshing. In Fig.2, the measured voltage V_1 changed in the range of 0 to 0.5 V depending on the test time although the input voltage V_0 didn't change, indicating that the oil film formation (near 0.5 V) and/or breakdown (near 0 V) occurred at the gear meshing. Figure 3 shows the fast Fourier transform (FFT) spectrum for the measured voltage V_1. From Fig. 3, the clear peak was observed at approximately 170 Hz corresponding to the gear meshing frequency in the system. This indicates that the apparatus successfully evaluates the time-dependent transition of the lubrication regimes corresponding to the gear meshing during the gear test by using the electrical impedance method.

In this presentation, the results of the dependence of the measured voltage V_1 behavior on oil viscosity and rotation speed in this system and the effectiveness of this system for monitoring the lubrication regimes of gears based on the results of this presentation will be presented.

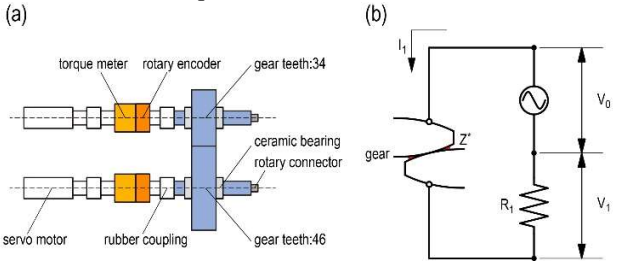

Fig. 1 (a) Schematic diagram of apparatus, (b) Electrical circuit for measuring complex impedance Z* of gear meshing.

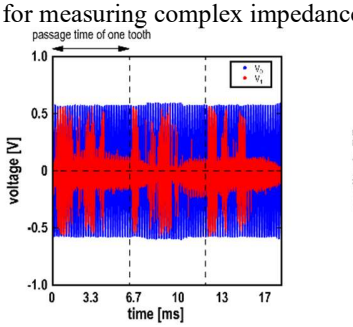

Fig. 2 input voltage V_0 and measured voltage V_1 during the gear meshing (300rpm)

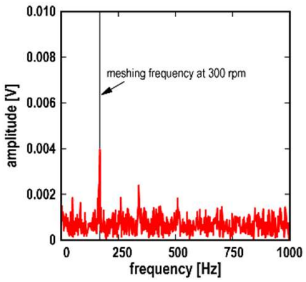

Fig. 3 FFT spectrum of the measured voltage V_1 (300 rpm)

ACKNOWLEDGMENTS
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REFERENCES

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