Research and Development of Injection-Molded-Plastic-Gear Filled with Rice-Hull-Silica-Carbon

Miyamoto Yuki
m08137@inc.kisarazu.ac.jp
Department of Mechanical Engineering
Kisarazu National College of Technology

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1. Introduction

The fatigue life of injection molded plastic gear is greatly affected by the plastic material and temperature. Because the plastic physical properties are greatly different in each plastic material, and the stiffness varies depending on temperature. Therefore, the plastic gears are filled with the reinforcing materials for keeping strength even in high temperature.

On the other hand, natural materials are used to focus on the ecological recycling [1]. The authors focused on using the rice-hull-silica-carbon (RHSC) as a reinforcing material in plastic. The RHSC is made from rice hull. The rice hull is a residual product of rice and it’s about 2.6 million tons are being produced in Japan every year.

In this study, two kinds, polyacetal (POM) and POM filled with RHSC, were used for the materials of test gears. The fatigue life and noise of test gears were investigated under fixed rotational speed and some torque. Therefore, the effects of RHSC were studied experimentally.

2. Experiments

All test gears are the injection molded plastic spur gears, and the geometrical dimensions are in the same value. The filling rate of RHSC is 7 wt%, and the median grain diameters of RHSC are 5μm and 60μm. The test gears molded by these materials are called RHSC5 and RHSC60, respectively, and the test gear molded by polyacetal is called POM. The pair of test gear is same material.

The experimental apparatus is the open type of gear-testing machine, which is shown in Fig. 1. Test gears were operated at a constant rotational speed (1000rpm), and the noise and temperature were measured.

Fig.1 Experimental apparatus and measuring system
3. Experimental results
The damage form of test gears is shown in Fig. 2. The damage form and the process of tooth wears differ in existence of RHSC. Fatigue life of the test gears is shown in Fig. 3. The fatigue life differs according to the median grain diameters of RHSC. Then, frequency Spectra of sound is shown in Fig. 4. The high-frequency noise of gear is reduced by the RHSC.

4. Discussions
Based on the experimental results, the relationships between the median grain diameters of RHSC and the gear’s fatigue and noise were discussed. The fatigue life and noise of gear is affected by the wear of tooth surface. Therefore, the RHSC has a beneficial effect on the filler of polyacetal. The efficacy of RHSC was especially examined.

5. Conclusions
From the discussions, it seems reasonable to conclude:
(1) The RHSC decreases the friction of tooth surfaces, and the process of tooth wears differs in existence of RHSC.
   The RHSC improved tribological property, and this effect is shown at the smaller median grain diameters of RHSC.
(2) Filling RHSC to plastic gear decreases the noise of sliding tooth surfaces.
(3) The damage form of plastic gear is melting, however the damage form of plastic gear filled with RHSC is breakage.
(4) Filling RHSC to plastic gear improves heat-resisting. Therefore, the test gears don’t break in higher average temperature.

6. References