

Development of Single Tooth Pinion Gear to Achieve High Efficiency and High Speed Reduction (Third Report)

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1. Introduction

Efforts to electrify automobiles and reduce fuel consumption are becoming more active with the policies of automobile CO2 emission regulations in each country. Among them, what is required of the electric component motor is a reduction in size, weight and power saving for the purpose of improving fuel consumption.

Electric component motor is composed mainly of the speed reducer and the electromagnetic circuit (motor). As the reduction gear, a worm gear or a spur gear and its derivative gears (a spur gear, a helical gear, a face gear, a bevel gear, etc.; hereinafter referred to as a spur gear) are often used. As a means of reducing the size and weight of the electric component motor and reducing the power consumption, there are high-efficiency and high-speed reduction of the reduction gear.

The worm gear is capable of a high reduction ratio in one step, but the gear meshing is in sliding contact and there is a problem in the low transmission efficiency. Further, the spur gear has high transmission efficiency because the gear meshing is in rolling contact, but the number of teeth of the pinion gear (input side gear) cannot be reduced. Therefore, there is a problem that it is difficult to achieve high speed reduction in one stage while maintaining the size.

Therefore, if a reduction gear capable of high efficiency and high speed reduction ratio, which has the characteristics of a worm gear and a spur gear, is considered to contribute to downsizing and weight reduction of the electric component motor and power saving.

In view of the above, we have developed a high-efficiency, high-speed reducer "Single Tooth Pinion Gear" that combines the features of a worm gear and spur gear.

In the future, it will be necessary to secure the gear strength of the helical gear while maintaining high efficiency in order to use it in electrical component motors. In the case of electrical component motors, the pinion gear is often made of metal and the helical gear is often made of resin for reasons such as cost reduction and noise control. In addition, since the helical gear (concave tooth profile) is used as opposed to the pinion gear (convex tooth profile), the tooth thickness of the helical gear is small, and there is a problem with the gear strength of the helical gear.

In this paper, we confirmed the gear strength level of the Single Tooth Pinion Gear helical gear and verified whether it is possible to improve the gear strength of the helical gear by changing the tooth profile.

2. Helical gear tooth profile (Non-circular tooth shape)

As shown in Fig. 1, the pinion gear bottom circle and arc tooth profile are set separately, and both circles are connected by tangents (Non-circular tooth shape). By doing so, we devised to increase the tooth thickness of the helical gear.

3. Damage torque and Transmission efficiency

Fig.2 and 3 show the torque and transmission efficiency of the non-circular tooth shape helical gear damage. By changing from the conventional tooth profile to non-circular tooth shape, it was possible to increase the tooth thickness of the helical gear. As a result, it was confirmed that the gear strength of the helical gear increased 2.7 times. In addition, the transmission efficiency is + 2.7pt compared to the conventional tooth profile. It was confirmed that it could be maintained.

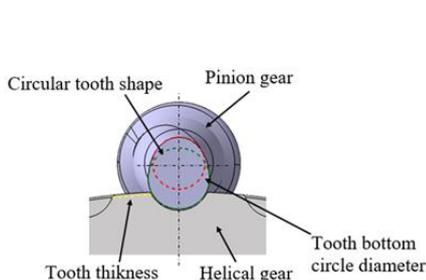


Fig.1 Non-circular tooth shape

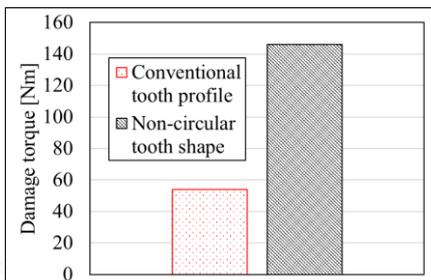


Fig.2 Damage torque

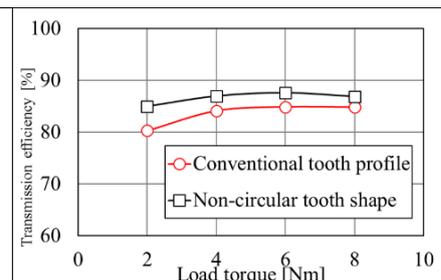


Fig.3 Transmission efficiency

4. Conclusion

we confirmed the gear strength level of the Single Tooth Pinion Gear helical gear and verified whether it is possible to improve the gear strength of the helical gear by changing the tooth profile.

It was confirmed that the helical gear tooth thickness can be increased and the gear strength is 2.7 times higher by changing from the conventional tooth profile to the non-circular tooth shape. In addition, the transmission efficiency is + 2.7pt compared to the conventional tooth profile. It was confirmed that it could be maintained.

In the future, by using non-circular tooth shape for the electrical component motor, it will be possible to secure the gear strength of the helical gear while maintaining the transmission efficiency.