

Power Transmission Characteristics Testing Machine for High-Speed, High-Output, and High-Reduction-Ratio Traction Drives

Natsuki Morita, Takeshi Yamamoto

Department of Mechanical Engineering, Graduate School of Engineering, Tokai University
〒259-1207 4-1-1 Kitakaname, Hiratsuka-shi, Kanagawa, Japan

KEY WORDS: Power transmission, Electric vehicle, Traction drive, Transmission mechanism (A2)

1. Introduction

To reduce electric vehicle system size, drive motors are reaching ultra-high speeds (up to 50,000 rpm), making conventional gears problematic due to churning loss and noise. Traction drives, which transmit power via friction, offer a vibration-free alternative. This study develops a power-circulation testing machine to clarify the traction characteristics under high-speed and high-reduction-ratio conditions equivalent to those for an actual vehicle (50,000 rpm, 50 kW).

2. Structure of Proposed Testing Machine

To reproduce a 50-kW load using a low-output motor, a power-circulation test rig was developed. It forms a closed circuit with test rollers and gears. A forced slip is generated by a slight difference in their reduction ratios, producing a traction force. An external motor compensates for the mechanical loss (approx. 6 kW), maintaining the 50-kW load.

To evaluate performance at a reduction ratio of 6.0, which is the geometric limit without pinion interference in a three-pinion planetary unit, the machine was redesigned by expanding the low-speed roller diameter and modifying the upper housing.

3. Experimental Results

Tests were conducted at 50,000 rpm and 50 kW. An offset correction was applied to remove apparent traction forces detected under no-load conditions.

A comparison of the corrected data for reduction ratios of 3.5 and 6.0 confirmed that equivalent traction coefficients were maintained up to 50,000 rpm. Moreover, under a high-output condition (maximum Hertzian contact pressure of 3 GPa), no significant decrease in the traction coefficient was observed due to the increased reduction ratio.

4. Conclusion

A power-circulation testing machine was developed for traction drive evaluation at 50,000 rpm and 50 kW. With offset correction, it was confirmed that the traction coefficient does not decrease even at actual-vehicle-equivalent outputs. At the geometric limit of a reduction ratio of 6.0, no significant decrease in traction coefficient was observed. Further improvements are needed to resolve measurement abnormalities caused by disturbances under certain high-speed conditions.

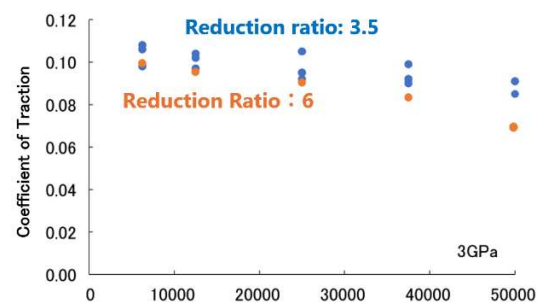


Fig. 1 Traction coefficient measurement results for reduction ratios of 3.5 and 6

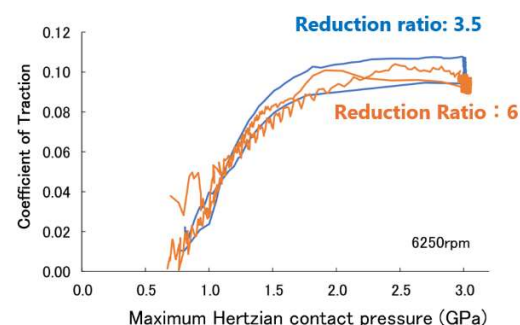


Fig. 2 Relationship between maximum Hertzian contact pressure and traction coefficient