

FRICION OF HYBRID BALL BEARINGS OPERATING IN MIXED LUBRICATION

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ABSTRACT

Hybrid ball bearings with rolling elements made of silicon nitride show important friction, temperature, and power loss benefits compared to full steel bearings under mixed lubrication. This is of particular interest for Automotive EV range extension, where hybrid bearings are used in the electric traction motor with integrated gearbox to avoid electrical current damage.

In this study bearing temperatures and system torque are measured in a modified FZG gearbox for both hybrid and steel bearings (test box). The gear set was designed with a small helix angle 6° to create an axial pre load to a set of 6306 deep groove ball bearings. To reach mixed lubrication conditions, a low viscous ester oil Nycobase 5750 was used, with the initial oil bath level just touching the teeth of the large gear wheel (65cm). To protect the shaft seals a temperature limit of 100°C was imposed. The FZG system is schematically shown in Figure 1.

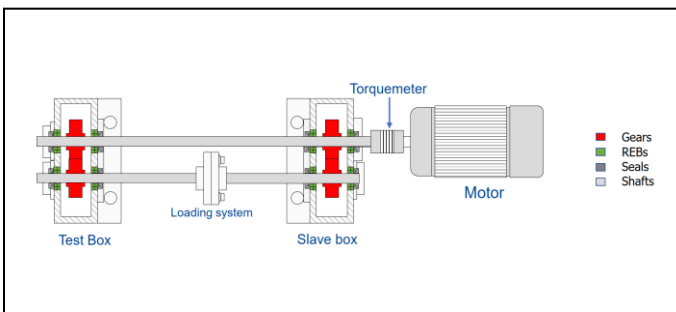


Fig.1: Schematic overview of the FZG test rig at INSA Lyon.

The operating conditions for results in case S2L3H1 shown in Figure 2 are 302 Nm applied torque resulting in 4500 N radial load on the bearings (450 N axial load), 1800 rpm for the low speed driven shaft, and 2700 rpm for the high speed shaft.

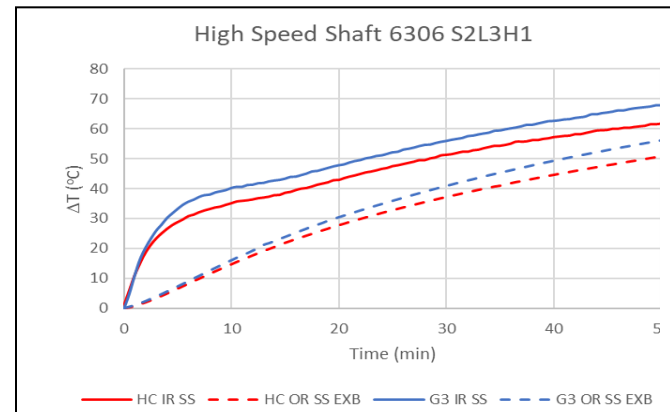


Fig.2: Temperature increase of the inner and outer ring of the external high speed shaft bearing (HC=hybrid, G3=steel).

Other results with different operating conditions show a consistent lower temperature (2 to 4°C) and power loss (2 to 5%) for the layout with hybrid bearings. The improved performance of hybrid bearings is mainly due to higher stiffness (smaller contacts), lower boundary friction coefficient of ceramic to steel, and lower roughness of silicon nitride balls. In application conditions also operating clearances are beneficial due to different thermal expansion.

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