Extension of Grease Service Life for Induction Traction Motors for Railways

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1. Background

Since it takes significant amounts of time and effort to disassemble and inspect the traction motors of railway vehicles, there has been a need to extend the periodicity with which disassembly inspections are performed. However, now that the adoption of induction motors for traction has completely eliminated maintenance work for brushes and commutators in conventional DC motors, extending the service life of lubricating grease (which has the shortest life of all bearing components) remains an issue to be resolved.

Figure 1 shows the construction of a traction motor. To support the weight of the rotor, such motors contain cylindrical roller bearings and deep groove ball bearings, for which sealed grease is used as a lubricant.

2. Service life of grease

One way of extending the service life of this lubricant is to improve the performance of the grease itself. In recent years, grease and bearing manufacturers have developed a grease containing a synthetic material as a base oil (among other approaches), but this does not constitute a drastic solution to the problems seen with railway vehicles.

Another method of supplying additional grease without disassembling the bearing (a technique referred to as intermediate refilling) is currently applied to some railway vehicles. One limitation to be considered here is that the lack of additional greasing space around the bearings of traction motors shortens the service life of grease when it is sealed in the relevant space beyond the appropriate volume limit. To address this, it has been pointed out that the volume of grease initially sealed has been reduced in order to secure space for intermediate refilling.

Furthermore, appropriate design has been adopted for the bearing structure. It is a normally accepted view that the more grease is packed in or near the bearing, the longer the grease's service life. Since a suitable filling volume is determined for the bearing inner space (in consideration of leaving enough room to allow for the movement of the rolling elements and the cage), the injection of a much larger amount of grease is made possible by installing grease pockets (GPs) on both sides of the bearing. Figure 2 shows typical profiles of end-plate GPs. From a comparison of these, we propose the installation of outer GPs located on either side of the annular GP (types A and B, Fig. 2) - and the maintenance of a wide contact area between the annular and outer GPs as a guideline for GP configuration design with a high grease-oil supply capacity [1].

3. Improved sealing structure design and its effect

Figure 3 shows the results of a service-life comparison test for grease(*) between bearings with conventional GPs and those with GPs improved in accordance with the above guideline. In this test, we rotated full-scale bearings by simulating the actual running conditions of Shinkansen traction motors, with grease sealed to 30% of the inner space and the full capacity of GPs for both types of bearings. In the case of bearings with conventional GP configurations, the ball bearings and roller bearings brought about the end of the grease's lubricating service life as indicated by the temperature rise in the inner ring after a test period equivalent to a running distance of 1,460,000 km and the motor's inability to restart after stopping at a point equivalent to a running distance of 2,630,000 km. In this judgment, we referred to the life judgment criterion in ASTM D3336. In contrast, the bearings with improved GP configurations brought about the end of the grease's service life after being tested for a period equivalent to a running distance of 3,600,000 km or more [2] (Fig. 3). These results prove that the service life of grease for bearings can be extended simply by changing the GP configuration and the volume of sealed grease; it may therefore be possible to extend the periodicity of disassembly inspection as a result.

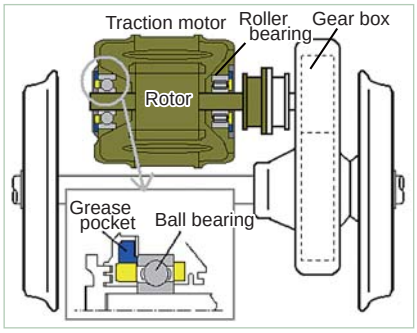

Fig. 1 Example of driving gear structure

4. Conclusion

Here we have reported on the improvement of grease sealing structures as a method of extending the maintenance periodicity of traction motors. In order to further extend the service life of grease, the development of a new lubricating system is required with consideration of improved grease performance, intermediate refilling operation and the like.

(*)The service life comparison test was conducted as a joint study with Toshiba Corporation.

References

[1] Hibino, S. and Suzuki, M., "A Proposal of Grease Pocket Structure in Consideration of Base Oil Migration," Japn. Journal of Tribology, Vol.50, No.1, pp.1-12, 2005.

[2] Hibino, S., Hosoya, T., Nakamura, K., Matsuoka, K., Nagayama, T., Kitamura M. and Sunohara, T., "A New Grease-Pocket Shape to Extend the Service Life of Grease," Tribology Online, Vol. 3, No. 2, pp.54-58, 2008.

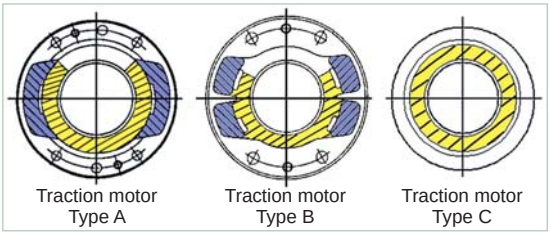

Fig. 2 Typical configurations of end-plate GPs in practical use / Grease is inserted into the annular GP (yellow) and the outer GP (blue).

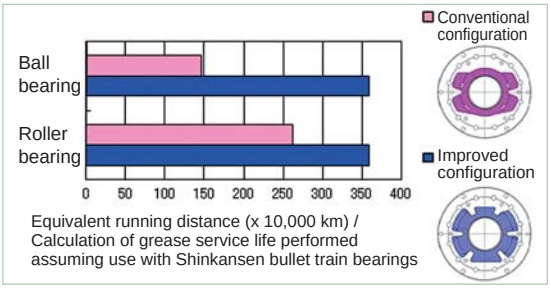

Fig. 3 Comparison of the service life of grease between bearings with conventional and improved GPs