7th World Tribology Congress, WTC 2022
July 10-15, 2022, Lyon, France

Tribology Testing Challenges in Developing Greases for Electric Vehicles

Dr Richard Baker[1]

[1)]TriboTonic Ltd, UK, London

The global growth in electric vehicles (EVs) and hybrid electric vehicles (HEVs) is accelerating. One of the constants between an Internal Combustion Engine (ICE) and the different types of EVs and HEVs on sale is the requirement for a similar quantity of grease in the vehicle, however, the demands of the grease very significantly between the different types of vehicles. This presentation will highlight the main differences required form the grease and how tribology testing can help optimize the grease placed into vehicles both now and in the future.

Keywords : Tribology, Testing, Grease, EV's

1. Introduction

The growth in electric vehicles (EVs) and hybrid electric vehicles (HEVs) is climbing and it is projected that by 2025, EVs and HEVs will account for an estimated 30% of all vehicle sales. Comparatively, in 2016 just under 1 million vehicles (1%) of global auto sales came from plug-in electric vehicles (PEVs)[1].

2. Current Status

The main differences between Internal Combustion Engines (ICE's) and HEVs for greases are in the starter motor and bearings on the electric drive motor.
Starter motors will no longer require extreme pressure or shock load resistance greases. In Stop-Start vehicles, the starter motor can be permanently engaged and act as a generator when not re-starting the engine. Transmission electric motor bearings may be grease or oil lubricated when incorporated in the gearbox or differential.
Bearing greases for the main electric drive motors will need to be low noise and prevent arc erosion of the bearing surfaces, with all critical grease lubricated components likely requiring longer life, lower noise greases in the medium term.
This projected uptake in EV's, and hence electric motors, will increase grease volumes in a vehicle. A basic model vehicle may possess approximately 16 electric motors powering various functions. A modern, high-end vehicle, could employ upwards of 40. Combined grease volumes could equate to approximately two kilograms per vehicle, and Lubrizol estimates 5,000 tonnes of grease could be required simply to lubricate electric motors in new vehicles each year[2]

3. Testing Methods and Results

Currently there are a lot of standard ASTM, DIN and ISO grease tests (see table 1), but to date, there are no standard tests for greases for electric vehicles, where the conditions are significantly different to those in a standard ICE.

Characteristics	Test	Designation
Apparent Viscosity	ASTM D1092	Apparent Viscosity of Lubricating Greases
Bleed Resistance	ASTM D6184	Oil Separation from Lubricating Grease by Conical Sieve Method
	ASTM D1742	Oil Separation from Greases During Storage
Corrosion	ASTM D1743	Corrosion Preventive Properties of Lubricating Greases
	ASTM D6138	Corrosive Preventive Properties of Greases by Emcor Test
	ASTM D4048	Copper Corrosion from Lubricating Grease
Antiwear	ASTM D2266	Wear Preventing Characteristics of Lubricating Grease (Four-Ball Method)
	ASTM D5707	Friction and Wear Properties of Lubricating Grease Using a High-Frequency, Linear-Oscillation (SRV) Test Machine
Extreme Pressure	ASTM D2596	Extreme Pressure Properties by Four Ball Method
	ASTM D2509	Load Carrying Capacity of Grease by Timken Method
	ASTM D5706	Extreme Pressure Properties of Lubricating Greases Using a High-Frequency Linear Oscillation (SRV) Test Machine
Oxidation Resistance	ASTM D942	Oxidation Stability
	ASTM D5483	Oxidation Induction Time of Lubricating Greases by Pressure Differential Scanning Calorimetry
Dropping Point	ASTM D2265	Dropping Point
	ASTM D566	Dropping Point
Grease Life	ASTM D3336	Life of Lubricating Greases in Ball Bearings at Elevated Temperatures
	ASTM D3527	Life Performance of Automotive Wheel Bearing Grease
Shear Stability	ASTM D217	Cone Penetration
	ASTM D1831	Roll Stability of Lubricating Grease
Water Resistance	ASTM D1264	Water Washout Characteristics of Lubricating Greases
	ASTM D4049	Resistance of Lubricating Grease to Water Spray
Low Temperature	ASTM D4693	Low-Temperature Torque of Grease Lubricated Wheel Bearings
	ASTM D1478	Low-Temperature Torque of Ball Bearing Grease

Table 1 - ASTM Standard lubricating grease tests

Each of the main testing methods for greases will be examined and compared to the EV testing required – highlighting the current testing that can be performed and showing the opportunity for new test equipment to better replicate the conditions in EV's.
Results from recent testing on EV greases will be presented showing the difference between previous automotive greases and the new formulations that are currently being developed.

4. References

[1] https://www.jpmorgan.com/insights/research/electric-vehicles
[2] F+L Magazine, October 9, 2018
[3] STLE TLT Magazine September 2021, 'New and in-service grease testing', Page 39