转速-力-热耦合下驱动电机轴承放电击穿特性研究㊀㊁

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【摘要】 电火花腐蚀是新能源汽车驱动电机轴承的主要失效模式，频繁的放电击穿引起轴承表面不断劣化，导致电驱动系统振动噪声增大和可靠寿命的降低。车辆行驶的动态工况下，放电击穿特性值（放电电压、放电电流、放电能量及放电电流密度值等）随轴承转速、温度及径向力不断变化，从而对轴承表面产生不同程度的电蚀损伤。本文通过建立驱动电机集中参数共模等效电路提取轴电压，依据弹流润滑理论确定最小油膜厚度下阈值电压，结合放电击穿模型分析轴承放电击穿特性，明确了不同转速、温度及受力情况下放电击穿特性的变化规律，结果表明随着转速的降低与温度、径向力的升高，放电击穿特性逐渐减小，同时转速、温度对轴承放电击穿特性影响明显高于径向力的影响。

【关键词】 电火花腐蚀，转速，温度，径向力，放电击穿特性

Study of Discharge Breakdown Characteristics of Drive Motor Bearings under Rotational Speed-force-thermal Coupling

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Abstract: Electrical spark corrosion is the main failure mode of new energy vehicle drive motor bearings. Frequent discharge breakdown causes continuous deterioration of the bearing surface, resulting in increased vibration and noise and reduced reliable life of the electric drive system. Under the dynamic conditions of vehicle driving, the discharge breakdown characteristics (discharge voltage, discharge current, discharge energy and discharge current density, etc.) change continuously with the bearing speed, temperature and force, thus producing different degrees of galvanic corrosion damage to the bearing surface. This paper extracts the shaft voltage by establishing a common mode equivalent circuit with concentrated parameters of the drive motor, determines the threshold voltage under the minimum oil film thickness according to the theory of elastic flow lubrication, analyses the discharge breakdown characteristics of the bearing in combination with the discharge breakdown model, and clarifies the variation law of the discharge breakdown characteristics under different rotational speed, temperature and force, the results show that as the rotational speed decreases and the temperature/load increases, the discharge breakdown characteristics gradually decrease, while The effect of speed and temperature on the breakdown characteristics of the bearing is significantly higher than that of load.

Key words: electrical corrosion, speed, temperature, radial forces, discharge breakdown characteristics

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