Abstract

Traction motors, specifically in underground shuttle vehicles, often operate in harsh conditions including steep grades, heavy payloads and high ambient temperatures. These motors require maximum torque density as well as cool and robust operation in order to optimise the overall process and to avoid the current requirement for a duty cycle. The contribution of this research is the design of a new traction motor, a Reluctance Synchronous Machine (RSM), via the 2-D Finite Element Method (FEM) as the primary engineering design tool to replace the commonly used Induction Machine (IM). The electromagnetic and mechanical design of the RSM are performed in commercially avaliable FEM software packages FLUX and ANSYS respectively. The electromagnetic design uses the PyFLUX command language and Python scripting to vary five rotor geometric parameters in a linear progression to find where maximum average torque and minimum torque ripple occurs for each parameter. The mechanical strength of the RSM rotor is defined by two geometric parameters whose final values are chosen via a case study based design in ANSYS. The newly designed RSM runs much cooler than the original IM and develops only 8.4% less torque than the IM. As a result, it should not require a duty cycle and will be capable of a higher rating and thus more torque can be delivered to the end process (up to 42% more) while the motor remains in the same motor frame size. Furthermore, there is a large area of research pertaining to the overall electromagnetic design method used. This includes the use of optimisation algorithms, integrated rotor-stator design, mechanical support placement and grading, various torque ripple reduction techniques and the inclusion of permanent magnets or composite powder metals for the RSM rotor.