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AXIAL-FLUX PERMANENT-MAGNET MOTOR DESIGN FOR ELECTRIC VEHICLE DIRECT DRIVE USING SIZING EQUATION AND FINITE ELEMENT ANALYSIS

A. Mahmoudi*, N. A. Rahim, and H. W. Ping

UMPEDAC, Engineering Tower, University of Malaya, Kuala Lumpur, Malaysia

Abstract—The design process of a double-sided slotted TORUS axial-flux permanent-magnet (AFPM) motor suitable for direct drive of electric vehicle (EV) is presented. It used sizing equation and Finite Element Analysis (FEA). AFPM motor is a high-torque-density motor easily mounted compactly onto a vehicle wheel, fitting the wheel rim perfectly. A preliminary design is a double-sided slotted AFPM motor with 6 rotor poles for high torque-density and stable rotation. In determining the design requirements, a simple vehicle-dynamics model that evaluates vehicle performance through the typical cruising trip of an automobile was considered. To obtain, with the highest possible torque, the initial design parameters of the motor, AFPM's fundamental theory and sizing equation were applied. Vector Field Opera-3D 14.0 commercial software ran the FEA of the motor design, evaluating and enhancing accuracy of the design parameters. Results of the FEA simulation were compared with those obtained from the sizing equation; at no-load condition, the flux density at every part of the motor agreed. The motor's design meets all the requirements and limits of EV, and fits the shape and size of a classical-vehicle wheel rim. The design process is comprehensive and can be used for an arbitrary EV with an arbitrary cruising scenario.

1. INTRODUCTION

Protection of natural environments sparked interest in electric vehicle (EV), a non-polluting personal transport. EV first appeared in 1870 but was for many years not further developed.The past 10 years, however, have seen developmental progress of EV [1]. Battery, electric

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* Corresponding author: Amin Mahmoudi (amaminmahmoudi@gmail.com).