Summary of doctoral dissertation

(implementation doctorate)

Title : A system of construction solutions for designing electric motors with increased power density for electromobility applications

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The aim of the work was to propose a method for analyzing systems of design solutions for motors with increased power density intended for installation in a vehicle wheel hub.

The paper presents the history of electric vehicle drives with wheel hub motors. The main advantages of using this type of motors in car drives have been described. The advantages result from the elimination of mechanical elements that mediate the transmission of torque, which opens up new possibilities for designers in terms of vehicle control and the construction of innovative electric and hybrid drive structures. The work indicates that motors with increased power density intended for installation in the wheel hub are a response to the latest development trends in electromobility.

The doctoral dissertation describes in detail the challenges faced by designers of this type of motors. The main problems are related to the thermal aspects of motor operation, requirements resulting from the car's driving dynamics, motor size limitations dictated by the dimensions of the rim and the need for collision-free installation of the braking system and car suspension elements, and limiting the weight of motor in order to limit the unsprung mass. The motors should operate as generators ensuring regenerative braking, which, in accordance with the latest trends in electromobility, covers as much of the vehicle's braking period as possible, and the electric car's drive system must meet road requirements related to overcoming obstacles and driving dynamics depending on the class and purpose of the vehicle.

The author proposed a number of design solutions aimed at reducing the motor's weight and improving its thermal parameters. These include: changes in the length of the magnetic core, increased number of pairs of magnetic poles, the use of special materials that reduce the thermal resistance between the winding and the cooling system, and new design solutions of the cooling system.

The developed method for analyzing systems of design solutions for an wheel hub motor with increased power density uses:

a) analysis of the results of laboratory tests of the prototype motor with appropriately placed temperature sensors;

b) coupled electromagnetic and thermal-flow model prepared in the ANSYS Motor CAD environment, calibrated with measurements made on built motor prototypes;

c) analysis of motor simulation tests reproducing the actual operating conditions occurring in the car based on selected driving cycles.

The analysis of the motor design systems allowed for drawing a number of conclusions regarding the effectiveness of the proposed solutions, the technology of making prototype motors, and enabled the development of an motor with better electromechanical and thermal parameters.

The method was used to develop an motor with increased power density for use in a hybrid drive of a delivery vehicle and allowed for the analysis of the influence of motor power parameters on its operating temperature during vehicle driving cycles.