Experimental Evaluation of Temperature Distribution in Armature of a Brushed DC Machine Using Thermal Imaging

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2022 International Conference on Electrical Machines (ICEM) | 978-1-6654-1432-6/22/$31.00 ©2022 IEEE | DOI: 10.1109/ICEM51905.2022.9910586

***Abstract*—Monitoring the temperature on a rotating armature is necessary to ensure that the maximum temperature permissible by the conductor's insulation class is not exceeded. In a brushed dc machine, the closest location in direct contact with the armature that can be instrumented using thermocouples are the brush and bearing. However, the temperature measured is lower compared to the armature temperature. This paper presents an evaluation on the temperature distribution of an armature of a 250W brushed DC machine using thermal imaging. Using the blocked-rotor test, the temperature was raised to a steady state temperature. The thermal images are taken on the then unmounted armature winding. The temperature distribution was analyzed by identifying the maximum, minimum, and average temperature of each component. The winding, the brush, the armature core, and the commutator are the hottest components. Non-homogenous components, especially the commutator exhibits large temperature range.**

Keywords—thermal analysis, armature winding, thermal image

I. Introduction

Armature winding in a brushed DC motor is the component that generate losses, thus heat in the machine. Unlike the steady-state operation, in dynamic application where they are more and more employed today such as for light electrical mobility such as scooter and electric bicycle, frequent acceleration is necessary. BY consequence, the maximum current is drawn regularly. This dynamic acceleration draws high current, generating high losses and thus high temperature.

It is important to be able to monitor its temperature to ensure that the machine is always operating below the maximum temperature that may damage the winding insulation. As the temperature increases, the winding insulation lifetime is heavily reduced by the thermal-aging degradation effect [1], [2], [3]. In general, as the temperature rises, the longevity of the insulation decreases. As a result, thermocouple and thermal images may be used to identify an overheated motor [4], [5], [6], [7], [8].

While obtaining the stator temperature is simple, estimating the machine's rotor temperature has been a major difficulty for decades. As described in [9], [10], [11], [12], [13], [14], major efforts have been devoted in recent years in the creation of thermal models that can forecast rotor temperature with high precision, particularly for induction motors. Due to inaccessibility to the armature for thermocouple implementation, the usual method employed is the estimation of its temperature. To get the accurate value of the armature temperature, thermal imaging is here proposed to identify overheated zones of an armature of a brushed DC motor.

There are two objectives of the study. The first one is to evaluate the temperature distribution inside a brushed dc motor armature: finding the hot spot, the average temperature and the range of temperature in different armature part. The second objective is to identify the difference between the temperature of the winding with the temperature of the brush and bearing. This will allow us to conclude on the adequateness of observing the bearing and brush temperature to estimate the armature winding temperature.

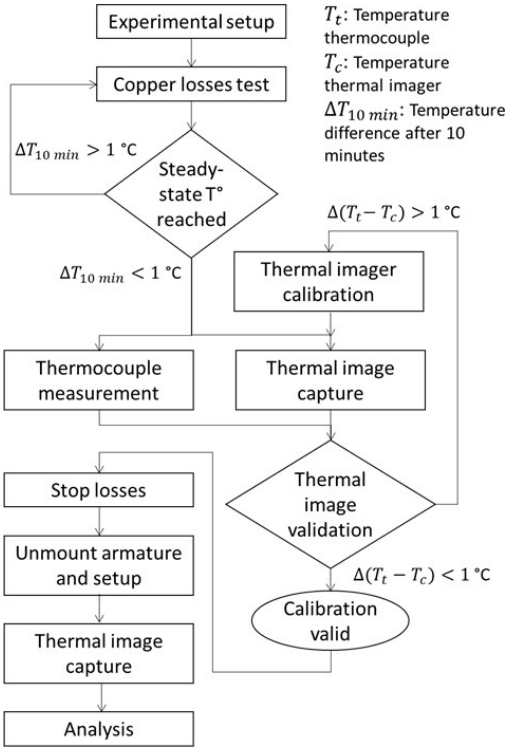

Fig. 1. The flow process to obtain the armature temperature distribution.

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