Evaluation of Transient Temperature Rise of MY1016 DC Motor in Standard Cycle

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Abstract. The MY1016 DC motor is a popular choice among hobbyist for electrification of bicycle and scooter. With frequent acceleration and deceleration, the fluctuating current drawn from the power supply increases the motor temperature. In this study, we develop a temperature-integrated motor controller that allows us to control the speed profile of the motor and evaluate several motor components' temperature when it is operated in several standard electric motor cycles, IEC. It was shown that the highest temperature inside the motor is the brush, followed by the bearing and the permanent magnet. SI which is the steady state IEC cycles generates the highest temperature on the brush at 81°C, while S5 which is an intermittent periodic with electric braking cycle generates the lowest temperature at 45°C. Any abrupt acceleration with a duration less than 10 seconds has no consequence on the temperature of the machine.

1. INTRODUCTION

Temperature rise in a motor poses risk to the permanent magnet and winding insulation. Temperature approaching Curie temperature would demagnetize the permanent magnet, and a temperature exceeding the temperature class of a conductor insulation would melt down the insulation, leading to short circuit and irreversible damage [1,2]. Therefore, it is important that the temperature of a motor to be evaluated before choosing it to drive any application. Added to the fact that there is more and more highly dynamic application with repetitive transient cycle of accelerating, decelerating, and even regenerative braking, the current-generating losses may increase the temperature to a dangerous level [3,4].

Small brushed dc machine has been the machine of choice for electrification of simple and less powerful application ranging lower than 1kW. This is due to the simplicity of its control and the cost and availability of the machine and its driver [5]. It has been proposed in conversion kit for bicycle, scooter, and other small mobility application. However, the lack of awareness on the limitation of this machine may bring the user to overestimate its robustness, especially in terms of temperature due to transient high current [6]. The machine such as the MY1016 dc motor that are currently used is a permanent magnet dc motor [7]. The low-cost motor is built of a ferrite magnet that has a relatively low Curie temperature, and its winding is made of Class A insulation which is the less resistant [8].

In this study, we develop a dc motor controller integrated with temperature monitoring system that allow us to observe the temperature of several components and then evaluate the temperature when the motor is subjected to several International Electrotechnical Commission (IEC) standard cycle [9].