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DEVELOPMENT OF AN ACCELERATED LIFE TEST PROCEDURE FOR COOLING FAN MOTORS

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ABSTRACT−Reliability of automotive parts has been one of the most interesting fields in the automotive industry. Especially, a small DC motor was issued because of the increasing adoption for passengers' safety and convenience. For several years, small DC motors have been studied and some problems of a life test method were found out. The field condition was not considered enough in the old life test method. It also needed a lot of test time. For precise life estimation and accelerated life test, new life test procedure was developed based on measured field condition. The vibration condition on vehicle and latent force on fan motor shaft were measured and correlated with each other. We converted the acceleration data into the load data and calculated the equivalent load from integrated value. We found the relationship which can be used for accelerated life test without changing the severity by using different loading factors.

KEY WORDS : Fan motor, Reliability, Life test procedure, Vibration condition, Bearing load, Acceleration life test, Brushless DC motor, Field condition

1. INTRODUCTION

Today, to help resolve any possible trade barrier issues emerged with the launch of World Trade Organization (WTO), we need to put the highest priority on developing new products using advanced technology and improving the reliability and quality of products to ensure prolonged service life. Recently, consumers' understanding of and interest in the product quality have been significantly increased. However it still entails quite a lot of difficulty to evaluate the life distribution and long-term performance of high reliability products. An accelerated life test (Nelson, 1990) which forces product to fail in a shorter period of time than it would have under normal use condition is required (Rabinowicz *et al*., 1970; Bolla, 2002).

The purpose of accelerated life test is to quickly produce the analysis data and the information related to the life or performance of the product by adopting appropriate models. This requirement is also quite important in the automotive industry. It is needed to develop a accelerated life test for high reliability to meet the customers' requirements for safety and convenience of their vehicles (Lu *et al*., 2003; Krasich, 2004).

As modern vehicles incorporate ever increasing number of electric and electronic components (Chin and Soulard, 2003), the number of failure of those parts is also getting higher compared to the other parts. Small DC motors used for vehicles are also on line with this trend. Therefore, in this study, we would like to develop an accelerated life test procedure for cooling fan motor which drives cooling fan to remove heat from the radiator installed inside the engine bay of motor vehicle. The previous life test method for DC motors used powder brake to produce wear on the brush of motor by applying constant load at the centre of motor shaft. The disadvantages of this old method are that the brush is forced to wear and eventually fail without taking into account of the field conditions, and the test duration is considerably long (Toliyat and Kliman, 2004; Humphrey *et al*., 2002; Hu *et al*., 1993; Hu, 1994).

The failure mode of the motors includes brush wear-out, bearing damage, burnt coil, etc. However, we will only focus on the damage of bearing due to the eccentric load acting on the brushless DC motors. And to accomplish this, we will measure the vibration condition of actual vehicle driven on the real road, and the inherent load of fan motor shaft. And we obtain the equivalent load, which is then applied to the accelerated life test. The main objective of this thesis is to develop the life test procedure for cooling fan motor as summed up above.

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