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Performance Analysis on EV Mode of the 2012 Toyota Hybrid

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Abstract

Hybrid vehicle utilizes electric motor as one of the prime mover in its system. One of the hybrid vehicles available in the Indonesian market today is the 2012 Toyota Camry Hybrid. Camry Hybrid uses PMSM (Permanent Magnet Synchronous Motor)as the main electrical drive for the vehicle's drive system. In this paperit will be investigated the performance of PMSM in Camry Hybrid's drive system, including torque and speed output of PMSM, and how much power required for the PMSM in EV (Electric Vehicle) Mode of the Camry Hybrid. Performance testing of the vehicle on EV mode, was conducted by performing dyno test . Also simulation using Advisor software was done toverify the characteristics of the motor during EV mode.

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Keywords: The 2012Toyota Hybrid; EV Mode; PMSM; Dyno test; Advisor Simulation.

1. Introduction

The advance in technology today has enabled human to travel with electrical energy source (i.e. electric cars), or combination between fossil fuel and electric energy (i.e. hybrid cars). Electric cars and hybrid cars is mass produced and marketed in advanced countries and other developing countries. The existing technology is also continuously developed to achieve optimum performance. Indonesia has started the development of electric and hybrid cars. There are already several prototypes developed by universities and other institutions, which includes ITB (Institut Teknologi Bandung) as part of this development program. This program is aimed to create national-scale electric car. With this program, Indonesia is expected to be able to produce its own electric cars which can be used by Indonesian public in the future.

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At present time the technology for electric propulsion of hybrid cars is still developed. One of them is PMSM (Permanent Magnet Synchronous Motor). The explanation that follows is consistent to the main focus of this research, which is Camry Hybrid that utilizes hybrid technology and uses PMSM in its system. The goal of this research is to understand torque and speed output of the PMSM that is used in Camry Hybrid 2012, and also the power required by the PMSM in the vehicle's EV (electric vehicle) mode.

2. EV Mode In Camry Hybrid 2012 and Simulation

Toyota has developed its own hybrid system that is used in all of the company's hybrid vehicles, called Hybrid Synergy Drive (HSD). This system is a series-parallel hybrid system, which is shown by Fig. 1.

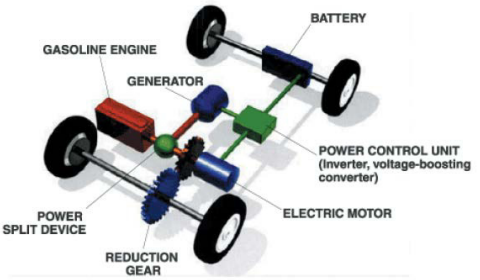

Fig. 1.Toyota's Hybrid Synergy Drive configuration [1]

There are two main operation modes in Camry Hybrid: EV mode and full hybrid mode. In full hybrid mode, the electric motor and ICE works together; while in EV mode, only the electric motor drives the vehicle. EV mode in Camry Hybrid can be used only if the vehicle is traveling up to 45 km/h [2]. Above that speed, the system's computer will start the ICE and the vehicle enters full hybrid mode.Fig. 2 shows how HSD works during start and low to mid-range speeds. In these conditions, the engine stops when in an inefficient range, such as start-up and in low to mid-range speeds. The vehicle runs on the motor alone [1].

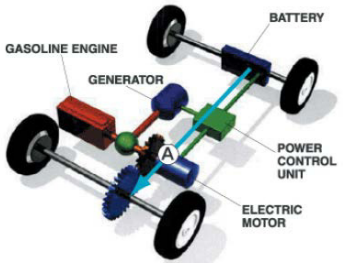

Fig. 2.Hybrid Synergy Drive operation in EV mode [1]

The electric motor used in Hybrid Synergy Drive is PMSM (Permanent Magnet Synchronous Motor).PMSM is one of the electric motors that utilize permanent magnet in its structure, thus the elimination of brush usage as seen in brushed DC motors. It gives a great advantage in terms of motor maintenance, because there is no more brush that needs to be looked after. Other advantages by using PMSM are high efficiency, high torque-current and torque-volume ratio, compact motor structure, and fast response. The high efficiency comes from the elimination of the brush and also the utilization of permanent magnet which eliminates copper losses in rotor [3].