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Modeling and Simulation Research on Power-split Hybrid Electric Vehicle

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Abstract

In this paper, a simulation model of power-split hybrid electric vehicle is established and a type of energy management strategy based on optimum-fuel-economy curve is proposed as well. The model contains blocks which can simulate the real physical components, so its accuracy is improved. Power performance and fuel economy are tested by simulation experiment at NEDC and HWYCOL cycle. The result shows the model is correct and effective. What's more, it uses the energy management strategy, so that the fuel consumption per 100km is 4.56 in NEDC cycle and 4.42 in HWYCOL cycle.

1. Introduction

In recent years, hybrid vehicle is the main development directions of new energy vehicles. Among all the structures of the hybrid vehicles, power-split ones can makes full use of the advantage of series and parallel[1]. Although the structure being more flexible and the energy management strategy requiring seriously considered, it could better balance the comprehensive requirements of vehicle power and economy. Thus, simulation study and energy management strategy of power-split hybrid electric vehicles should be well considered.

Among all the energy management strategy, Global optimization is the best choice for the control strategy. However, it is affected by the driving cycle and the time cost is large, which is difficult to get

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practical application. Therefore, the methods of engine-constant-operating-point and optimal-engine-working-curve are more practical [2].

When the vehicle starts or moves at lower velocity, the power is supplied by motor in case idle running. And when it moves at a higher velocity, the engine's working area is controlled at high efficiency area, so the fuel economy of engine would be better no matter in any driving cycle to test [3].

In this paper, a simulation model of Power split hybrid electric vehicle is established. It is a kind of forward simulation model and its energy management strategy is built on the basis of optimum-fuel-economy curve. According to the simulation experiment, the correctness of the model and the effectiveness of the control strategy are verified.

2. The power-split hybrid electric vehicle

2.1. Configuration

As the connection of three power components in PHEV, the power split device is a planetary-gear with two degrees of freedom, which achieve the purpose of the engine's power being split. The connection between the dynamic components and the planetary-gear is shown in figure 1.
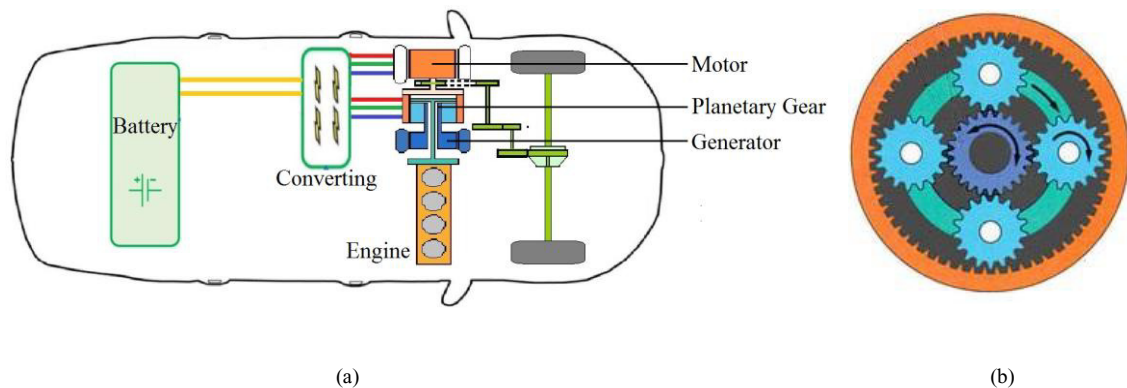

(a) (b)

Fig. 1. Configuration of power-split hybrid electric vehicle (a)Power Elements; (b) Planetary Gear;

Table 1. Main parameters

	Vehicle				Planetary Gear	
A_fr	C_d	Mass	R_wheel	Final ratio	Ring gear	Sun gear
2.5m^2	0.26	1300kg	0.287m	3.2	78	30

2.2. Modeling

The modeling method can be divided into two types, data-based model and physical model. For the traditional data-based simulation model, dynamic characteristics of the power elements can't be well reflected, while the pure physical model is too complex for simulation. So in this paper, a synthetic method is adopted. Each model of the power element can output torque through physical interface and get