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Evaluation of electric motor and gasoline engine hybrid car using solar cells

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Abstract

We evaluated the utility of a hybrid car in which both power sources of an electric motor and a gasoline engine are used and solar cells are settled on the roof and the bonnet. An array of 1.6 kW solar cells was installed on the top of a building to charge the batteries by solar energy. Though the capacities of the electric motor and batteries are half compared with conventional electric vehicles, we confirmed that this hybrid car has sufficient utility for practical use. The whole electric energy consumed in a day can be supplied by a 1.6 kW solar cell system.

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Keywords: Hybrid car; Electric motor; Gasoline engine; Solar cell

1. Introduction

Electric vehicles (EVs) have been energetically researched and developed to depress the air pollution caused by consumption of the fossil fuels. However, they have some problems such as a short travel distance, insufficient charge stations, a high cost, and so on. Because of these problems, EVs have not widely spread to the general public. We have been developing the more practical hybrid car equipped with an electric motor, a gasoline engine and solar cells [1]. The purpose of this paper is to evaluate the traveling performance and the energetic utility of this hybrid car.

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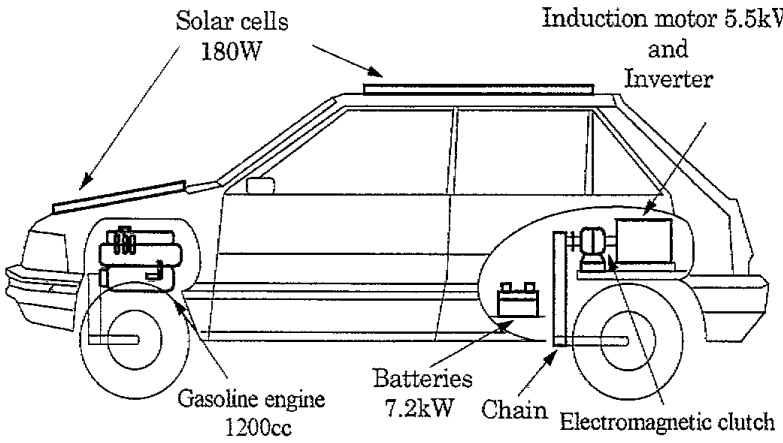

Fig. 1. Structural diagram of the hybrid car.

2. The concept and the structure of the hybrid car

This hybrid car has two power sources of an electric motor and a gasoline engine. The two power sources can be automatically changed according to the set conditions for driving. For example, this car moves as an electric car in the low-speed zones such as urban areas and moves as a gasoline engine car in the high-speed zones such as suburbs or highways. The structural diagram of the hybrid car is shown in Fig. 1. This hybrid car, which was remodeled from a gasoline car on the market, was equipped with a gasoline engine of 1200 cc, an induction motor of 5.5 kW, lead batteries of 288 V and 25 Ah, and solar cells of 180 W. The weight of this car increased by 350 kg after remodeling and the gross weight became 1200 kg. In order to supply the total electric energy with solar energy, an solar array of 1.6 kW was set on the top of a building.

3. Experimental and results

First, the performance in hybrid traveling was tested. The travel distance as an electric car was also evaluated by driving only with the electric motor. Secondly, the total electric energies obtained in a day from the solar cells equipped on the hybrid car and the solar array installed elsewhere were measured and the energetic utility of this hybrid car was evaluated.

3.1. Traveling performance

The typical result of a driving test for the hybrid car is shown in Fig. 2. The power source was automatically changed from an electric motor to a gasoline engine at a speed of 20 km/h and changed from a gasoline engine to an electric motor at 15 km/h. From this result, it was confirmed that the two power sources could be changed very smoothly. The acceleration obtained as an electric car is about 1.1 m/s^2

and this value becomes no problem in practical use. Next, we carried out a driving test as an electric car on the assumption that this car travels in urban areas where acceleration and deceleration happen repetitiously. The test result is shown in Fig. 3. The total travel distance in this test became 1.74 km. The power consumed by the electric motor and the power regenerated by it were estimated to be 325 and 20 Wh, respectively. Thus, the net power consumed in the travel becomes 305 Wh. As the battery capacity is 7.2 kWh, this car can travel about 40 km as an electric car by charging the batteries fully. This travel distance is sufficient for practical use.

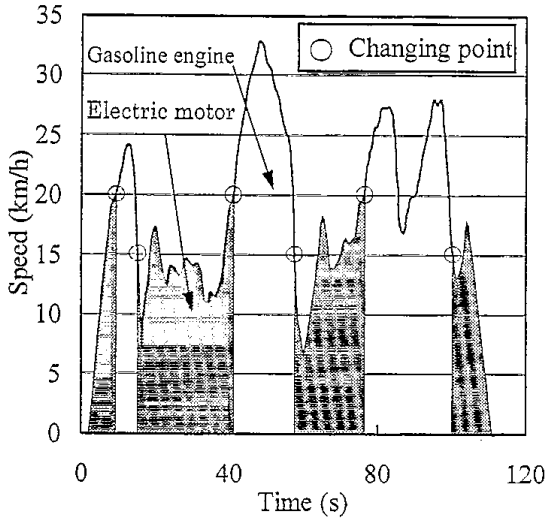

Fig. 2. Traveling performance of the hybrid car.

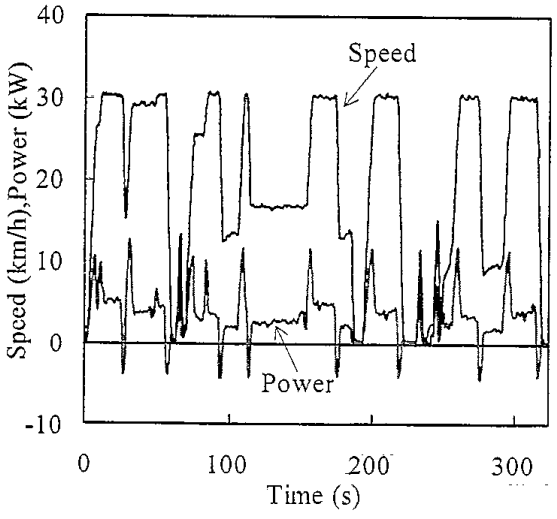

Fig. 3. Traveling performance of the hybrid car as an electric car.

3.2. Charging of the batteries by solar cells

The batteries were charged by using the solar cells of 180 W settled on the car and the solar array of 1.6 kW installed on the top of a building. The measured results of the solar irradiance, the generated power by the solar cells and the charged power in the batteries are shown in Figs. 4 and 5. The power of 0.8 kWh, which corresponds to about 10% of the battery capacity, was obtained from the solar cells on the car, and the power of 6.5 kWh from the solar array of 1.6 kW. These results suggest that by

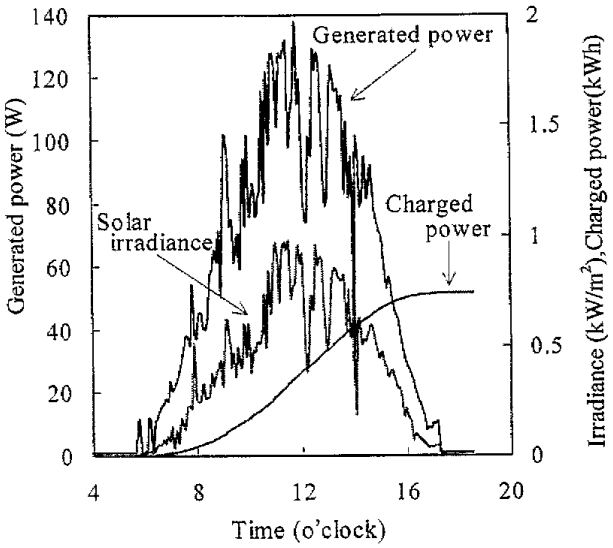

Fig. 4. Power generation characteristics in the solar cells of 180 W on the hybrid car.

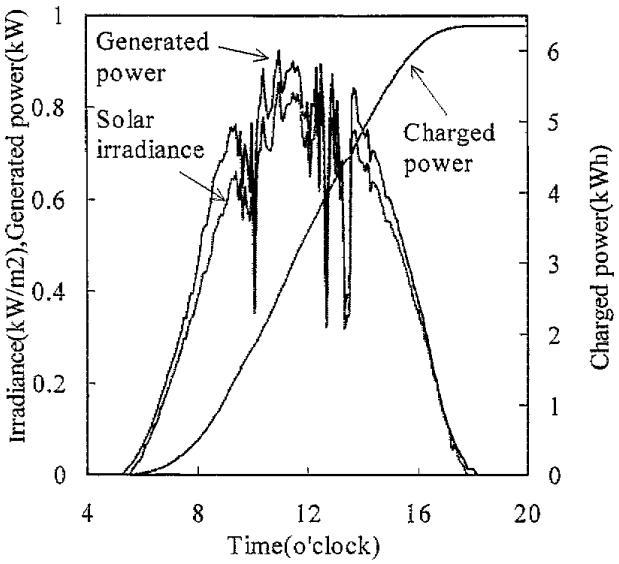

Fig. 5. Power generation characteristics in the solar array of 1.6 kW set on the roof of a building.

using such a scale of solar systems, the total electric energy consumed in a day can be supplied by solar energy.

4. Conclusions

The utility of a hybrid car equipped with a gasoline engine, an electric motor and solar cells was evaluated. Though the capacities of the electric motor and batteries are half the size compared with conventional electric vehicles, it was confirmed that this car is sufficient for practical use. The total electric energy consumed in a day can be supplied by a 1.6 kW solar array which can be easily set on the roofs of common houses or parking lots. Such a hybrid car must contribute to depression of the air pollution in urban areas.

References

[1] T. Horigome, Sci Technol. Japan, (1993) 37–39.