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Performance of a newly developed plug-in hybrid boat

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Abstract

We have produced a new-type of plug-in hybrid boat. This boat has excellent environment characteristics running by electricity, while having the ability of long-distance cruising and long distance reliability because of the diesel engine. The excellent performances of this plug-in hybrid boat system are described.

Keywords: electric boat, plug-in hybrid, PHEB

1 Introduction

We have already made a plug-in hybrid boat (length of 22 ft) driven by an electric motor and a diesel engine [1]. We have named this proto-type boat as "Plug-in hybrid electric boat-1" or PHEB-1.

The PHEB-1 system was produced based on our past feasibility studies and experimental researches [2, 3, 4]. This system shows good performance of silence, little vibration and no pollution characteristics as well as the reliability of diesel engine. A block diagram of this boat (PHEB-1) is shown in Figure 1. This hybrid boat has 10kW of electricity power using stored battery of 10 kWh and can utilize external electric energy from a grid. One single propeller is driven by either electric motor or diesel engine (65 kW). The electric motor can be used as a generator also.

2 PHEB-2

In principle, to spread this type of PHEB-1, it is necessary to modify used boat instead of new one, because the quantity is important to contribute to the energy saving and clean the environment. The way to utilize used boats results better cost merit than new boat. Recently in Japan, only about 2000 new boats are released per year in the market. Japan has about 200,000 small boats to be modified as PHEB.

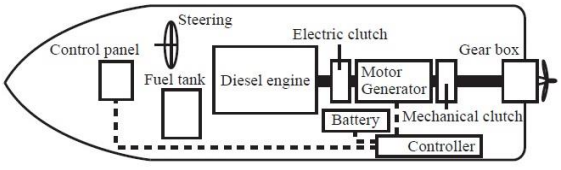

Figure 1 A block diagram of PHEB-1

This prototype PHEB-1 was superior because a trial manufactures boat has enough room to install an engine and the electric motor. Most of small diesel boat to be modified as a PHEB is not easy, because the propeller axis distance (such as 20 cm) between the engine and the stern drive where an electric motor is installed is too short. To modify a boat to be the PHEB-1 type system, the distance of almost 1 m is required.

To solve the issue, a new type of PHEB system has been developed. As shown in Figure 2, an electric propulsion system is installed independently with the previously installed diesel engine propulsion system. This system can be applied for different boat propulsion systems. To show the performance of PHEB-2, a 4 tons of existing 38ft diesel (140kW at maximum output power) inboard propeller fishing boat is used. The specifications of the PHEB-1 and PHEB-2 are shown in Table 1. An electric motor driving system with a stern drive, a propeller, and helm station are installed. By such a method, the electric motor system (an induction motor of 50 kW at maximum and an inverter) does not influence the performance of diesel engine system installed previously. A photograph of the stern electric propulsion system is shown in Figure 3. A Photograph of the installed electric motor is shown in Figure 4. A photograph of PHEB-2 is shown in Figure 5. A photograph of the control room of PHEB-2 is shown in Figure 6.

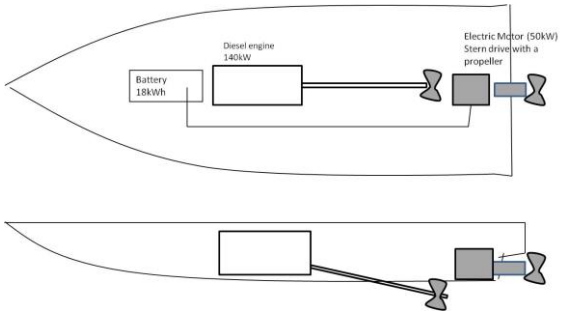

Figure 2 A block diagram of the PHEB-2

Figure 3 A photograph of the stern electric drive of PHEB-2

Table1: Specification of PHEB-1 and PHEB-2

	PHEB-1	PHEB-2
System of PHEB	Motor and engine are connected together	Motor and engine run independently
Length	22 ft	38 ft
Engine Power	65 kW	150 kW
Motor Power	10 kW	50 kW
Type of Motor	Shunt DC	Induction
Battery type/ Voltage	Li-ion/ 96 V	Li-ion/ 96 V
Battery Energy	10kWh	20 kWh
Charging	Plug-in/ on board motor/ generator	Plug-in/ on board independent generator 10kW

Figure 4 A photograph of the electric motor

Figure 5 A photograph of PHEB-2

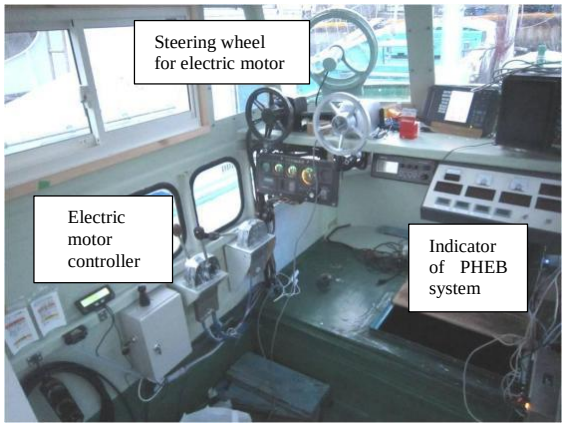

Figure 6 A photograph of the control room of PHEB-2.

A performance test has conducted to investigate the power consumption during a fixed point cruising. It is found that the power consumption of the PHEB-2 under the wind velocity of 5m/s is 0.35 kW in average as shown in Figure 7.

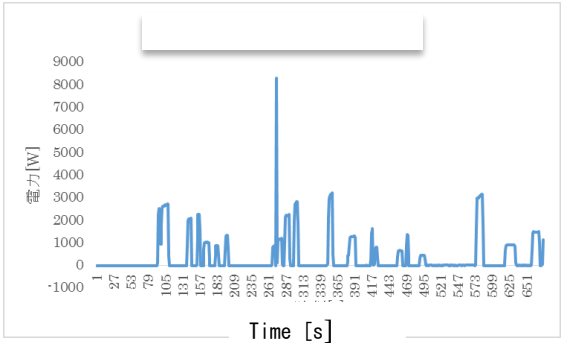

Figure 7 An example of the power consumption during a fixed point cruise

This resutls show that the energy used during the 6 hours fixed cruise operation for professional fishing is only about 2 kWh. Such high performace can be performed because of high efficincy of electric motor system and the idling stop function.

3 Conclusion

If only battery is used to run the boat for the higher velocity or the long distance cruising, a huge quantity of batteries will be needed. In contrast, the operation mode of the PHEB-2can be selected as required, such as running it on the engine or running it only by the battery stopping the engine. The batteries can also be charged by the on-board generator. The PHEB also contributes to the quietness and energy saving while providing reliability. When long-distance travel is required, this is also possible. In addition to the merit, we have newly developed PHEB-2 with electric motor and propeller independently to the previously installed diesel engine system with another propeller. This new type of plug-in hybrid boat is produced and it is found that the performances is excellent and expected to spread widely because of easy modification from conventional diesel engine boat. This system is appropriated for river cruising

boat as well as fishing boat. This type of fishing PHEB makes it possible to travel for a long distance manoeuvring to the fishing point and return navigation by diesel engine and people can enjoy the advantages of quietness, vibration less, and lack of toxic gas during fishing because of electric motor.

References

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