ELECTRIC POWER GENERATION AND STORAGE BUOY

BACKGROUND

[0001] The disclosure relates to the generation and storage of electric power for use in autonomous marine applications.

[0002] Diesel engines have been used on buoys or barges at sea to provide electric power in remote areas, and marine diesel engine technology is mature. Diesel engines are reliable in marine environments when well protected and properly maintained. However, diesel engines may not be suitable for use in autonomous, long-duration applications, especially where the risk of heavy seas is high. For example, diesel engines require frequent maintenance, such as oil changes. Diesel engine maintenance every few weeks of operation would incur excessive costs. Further, since diesel engines use internal combustion, the combustion chamber is directly exposed to the marine air and salt contamination. If the engine air intake inflows sea water during heavy seas, the engine could be flooded and permanently damaged. Still further, a fuel leak (i.e., a diesel leak) could leave an oil slick or create an environmental hazard. Finally, diesel fuel is not suitable for long-duration deployments since the diesel fuel can degrade, gel, or clog injection nozzles over time. Biodiesel is also prone to bacteria growth issues when stored for long durations.

[0003] Solar panels have also been used at sea on buoys or barges to provide electric power in remote areas. However, the electric power generated by solar panels is limited during periods of cloudy weather and at night.

[0004] Wave energy converters (WECs) may produce too little electric power in deployment sites with poor wave energy potential or seasonal variations.

[0005] Therefore, there is a continuing need in the art for a system for the generation and storage of electric power that can be used in autonomous marine applications. The system would preferably be capable of generating electric power in remote marine environments in a clean, environment-friendly way. Also, the system would preferably be reliable and requires minimal maintenance.

SUMMARY OF THE INVENTION

[0005a] According to a first aspect of the present invention, there is provided a system for generating and storing electrical power in marine environments, comprising: a buoy having a

flotation line; a fuel burner disposed within the buoy; means for converting a temperature difference into a voltage, wherein said means comprises a thermoelectric generator having a hot side and a cold side, or electrical generator mechanically coupled to a heat engine having a hot side and a cold side; a battery system electrically coupled to said means; and a controller programmed to operate said means such that a temperature of the cold side is controlled approximately between sixty and eighty degrees Celsius, wherein the hot side is located inside the buoy in thermal contact with the fuel burner, and wherein the cold side is located outside the buoy below the flotation line, or wherein the cold side is thermally coupled to a heat pipe or heat exchanger, with the heat pipe or heat exchanger including a portion located outside the buoy below the flotation line.

[0005b] According to a second aspect of the present invention, there is provided a system for generating and storing electrical power in marine environments, comprising: a buoy having a flotation line; a fuel burner disposed within the buoy; means for converting a temperature difference into a voltage, wherein said means comprises a thermoelectric generator having a hot side and a cold side, or electrical generator mechanically coupled to a heat engine having a hot side and a cold side; and a battery system electrically coupled to said means; a combustion chamber in which the fuel burner is located; and a pump assembly configured to drain liquids out of the combustion chamber, wherein the hot side is located inside the buoy in thermal contact with the fuel burner, and wherein the cold side is located outside the buoy below the flotation line, or wherein the cold side is thermally coupled to a heat pipe or heat exchanger, with the heat pipe or heat exchanger including a portion located outside the buoy below the flotation line.

[0005c] According to a third aspect of the present invention, there is provided a system for generating and storing electrical power in marine environments, comprising: a buoy having a flotation line; a fuel burner disposed within the buoy; means for converting a temperature difference into a voltage, wherein said means comprises a thermoelectric generator having a hot side and a cold side, or electrical generator mechanically coupled to a heat engine having a hot side and a cold side; and a battery system electrically coupled to said means; a combustion chamber in which the fuel burner is located; an intake system configured to force air into the combustion chamber; and an exhaust pipe connected to the combustion chamber, wherein the exhaust pipe or the intake system comprises a self-sealing flap valve, wherein the hot side is located inside the buoy in thermal contact

with the fuel burner, and wherein the cold side is located outside the buoy below the flotation line, or wherein the cold side is thermally coupled to a heat pipe or heat exchanger, with the heat pipe or heat exchanger including a portion located outside the buoy below the flotation line.

[0005d] According to a fourth aspect of the present invention, there is provided a system for generating and storing electrical power in marine environments, comprising: a buoy having a flotation line; a fuel burner disposed within the buoy; means for converting a temperature difference into a voltage, wherein said means comprises a thermoelectric generator having a hot side and a cold side, or electrical generator mechanically coupled to a heat engine having a hot side and a cold side; and a battery system electrically coupled to said means, wherein the hot side is located inside the buoy in thermal contact with the fuel burner, wherein the cold side is located outside the buoy below the flotation line, or wherein the cold side is thermally coupled to a heat pipe or heat exchanger, with the heat pipe or heat exchanger including a portion located outside the buoy below the flotation line, and wherein the buoy comprises an outer shell, the outer shell comprises a plurality of hatches for closing a corresponding plurality of cavities, and wherein each cavity comprises a fuel tank.

BRIEF DESCRIPTION OF THE DRAWINGS

[0006] For a more detailed description of the embodiments of the disclosure, reference will now be made to the accompanying drawings, wherein:

What is claimed is:

1. A system for generating and storing electrical power in marine environments, comprising:

a buoy having a flotation line;

a fuel burner disposed within the buoy;

means for converting a temperature difference into a voltage, wherein said means comprises a thermoelectric generator having a hot side and a cold side, or electrical generator mechanically coupled to a heat engine having a hot side and a cold side;

a battery system electrically coupled to said means; and

a controller programmed to operate said means such that a temperature of the cold side is controlled approximately between sixty and eighty degrees Celsius,

wherein the hot side is located inside the buoy in thermal contact with the fuel burner, and

wherein the cold side is located outside the buoy below the flotation line, or wherein the cold side is thermally coupled to a heat pipe or heat exchanger, with the heat pipe or heat exchanger including a portion located outside the buoy below the flotation line.

2. The system of claim 1, wherein the cold side is thermally coupled to a heat pipe or heat exchanger, the system further comprising:

a pump; and

a circuit for circulating a working fluid through a first heat exchanger thermally coupled to the cold side of said means, and through a second heat exchanger located outside the buoy below the flotation line,

wherein the controller is capable of driving the pump, the controller being programmed to regulate a temperature of the second heat exchanger by adjusting a circulation flow rate of the working fluid.

3. A system for generating and storing electrical power in marine environments, comprising:

a buoy having a flotation line;

a fuel burner disposed within the buoy;

means for converting a temperature difference into a voltage, wherein said means comprises a thermoelectric generator having a hot side and a cold side, or electrical generator mechanically coupled to a heat engine having a hot side and a cold side; and

a battery system electrically coupled to said means;

a combustion chamber in which the fuel burner is located; and

a pump assembly configured to drain liquids out of the combustion chamber,

wherein the hot side is located inside the buoy in thermal contact with the fuel burner, and

wherein the cold side is located outside the buoy below the flotation line, or wherein the cold side is thermally coupled to a heat pipe or heat exchanger, with the heat pipe or heat exchanger including a portion located outside the buoy below the flotation line.

4. The system of claim 3 wherein the fuel burner comprises an electronic ignition and a flame-out detector.

5. A system for generating and storing electrical power in marine environments, comprising:

a buoy having a flotation line;

a fuel burner disposed within the buoy;

means for converting a temperature difference into a voltage, wherein said means comprises a thermoelectric generator having a hot side and a cold side, or electrical generator mechanically coupled to a heat engine having a hot side and a cold side; and

a battery system electrically coupled to said means;

a combustion chamber in which the fuel burner is located;

an intake system configured to force air into the combustion chamber; and

an exhaust pipe connected to the combustion chamber,

wherein the exhaust pipe or the intake system comprises a self-sealing flap valve,

wherein the hot side is located inside the buoy in thermal contact with the fuel burner, and

wherein the cold side is located outside the buoy below the flotation line, or wherein the cold side is thermally coupled to a heat pipe or heat exchanger, with the heat pipe or heat exchanger including a portion located outside the buoy below the flotation line.

6. The system of claim 5 wherein the intake system comprises a blower.

7. The system of claim 5 further comprising a heat recuperator chamber surrounding at least a portion of the combustion chamber or at least a portion of the exhaust pipe.

8. The system of claim 5 wherein the exhaust pipe comprises the self-sealing flap valve.

9. The system of claim 5 wherein the exhaust pipe is arranged next to a portion of the intake system and is aligned with the portion of the intake system.

10. The system of claim 5 wherein the intake system comprises the self-sealing flap valve.

11. A system for generating and storing electrical power in marine environments, comprising:

a buoy having a flotation line;

a fuel burner disposed within the buoy;

means for converting a temperature difference into a voltage, wherein said means comprises a thermoelectric generator having a hot side and a cold side, or electrical generator mechanically coupled to a heat engine having a hot side and a cold side; and

a battery system electrically coupled to said means,

wherein the hot side is located inside the buoy in thermal contact with the fuel burner,

wherein the cold side is located outside the buoy below the flotation line, or wherein the cold side is thermally coupled to a heat pipe or heat exchanger, with the heat pipe or heat exchanger including a portion located outside the buoy below the flotation line, and

wherein the buoy comprises an outer shell, the outer shell comprises a plurality of hatches for closing a corresponding plurality of cavities, and wherein each cavity comprises a fuel tank.

12. The system of claim 11 wherein each fuel tank is coupled to the fuel burner, wherein each fuel tank comprises ethanol, or wherein each fuel tank comprises propane.

13. The system of claim 11 further comprising solar panels electrically coupled to the battery system.

14. The system of claim 11 wherein said means comprises an electrical generator mechanically coupled to a heat engine, wherein the electrical generator comprises an alternator and an AC-to-DC converter, and wherein the heat engine comprises an external combustion heat engine.

15. The system of claim 14 wherein the external combustion heat engine is a Stirling-cycle engine.

16. The system of claim 11 wherein said means comprises a thermoelectric generator, and wherein the thermoelectric generator comprises an array of pairs of dissimilar semiconductors configured to generate a voltage by Seebeck effect.

17. The system of claim 11 wherein the outer shell is constructed using flat plates.

18. The system of claim 13 further comprising foam buoys below the solar panels.