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AN IMPLEMENTATION OF ADVANCED HYBRID TECHNOLOGY IN MARINE VESSELS

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ABSTRACT

This paper focuses on advanced hybrid marine vessel technology is a proposed idea that involves inculcating solar energy, wind energy and oxy hydrogen (HHO) for marine propulsion solutions. The objective and scope of this project is to propose an idea in hybrid marine vessel technology using renewable resources.

KEYWORDS: Hybrid Marine Vessel Technology (HMVT), Oxy-Hydrogen, Fossil Fuels, Generators, Propellers, Hydrofoil and Electronic Control Unit (ECU)

INTRODUCTION

The major need for fossil fuel to drive locomotives has caused pollution and its depletion. Fossil fuel demand has also made it expensive along course of time. Necessities being the mother of invention, several ideas are innovated and synergized in order to overcome the demands and drawback of the conventional fuel system. One of such innovative concept includes the hybrid marine vessel technology. Hybrid Marine Vessel Technology (HMVT) incorporates the use of generators that is used to supply power to the electric motors which in turn drives the propellers or other marine propulsion solutions. Along with this propulsion system, Solar panels, Wind turbines, Hydrofoils and Oxy hydrogen are combined and integrated using the Electronic Control Unit (ECU).

Solar Panels

A solar panel is a set of solar photovoltaic modules electrically connected and mounted on a supporting structure. A photovoltaic module is a packaged, connected assembly of solar cells. The solar panel can be used as a component of a larger photovoltaic system to generate and supply electricity in commercial and residential applications. Solar powered boats have mainly been limited to rivers and canals, but in 2007 an experimental 14m catamaran, the Sun 21 sailed the Atlantic from Seville to Miami, and from there to New York.

Japan's biggest shipping line Nippon Yusen KK and Nippon Oil Corporation said solar panels capable of generating 40 kilowatts of electricity would be placed on top of a 60,213 ton car carrier ship to be used by Toyota Motor Corporation. In 2010, the Tûranor Planet Solar, a 30 meter long, 15.2 meter wide catamaran yacht powered by 470 square meters of solar panels, was unveiled. It is set to circumnavigate the Earth and is so far the largest solar-powered boat ever built. Various demonstration systems have been made. Curiously, none yet takes advantage of the huge power gain that water cooling would bring. In 2007, the PV powered boat Transatlantic 21 successfully crossed the Atlantic Ocean power only by solar electricity. In 2012, Planet Solar became the first ever solar electric vehicle to circumnavigate the globe.

The low power density of current solar panels limits the use of solar propelled vessels, however boats that use sails (which do not generate electricity unlike combustion engines) rely on battery power for electrical appliances (such as refrigeration, lighting and communications). Here solar panels have became popular for recharging batteries as they do not create noise, require fuel and often can be seamlessly added to existing deck space.

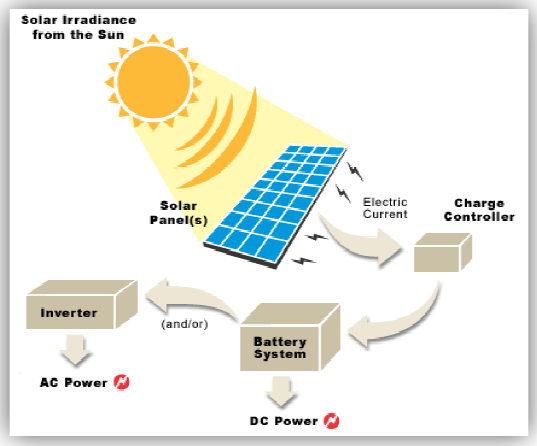

Figure 1: Solar Panel Power System

Wind Turbine

A wind turbine is a device that converts kinetic energy from the wind into electrical power. A wind turbine used for charging batteries may be referred to as a wind charger. A windmill ship, wind energy conversion system ship or wind energy harvester ship propels itself by use of a windmill to drive a propeller.

They use wind power through a mechanical or electrical transmission to the propeller. Where transmission is electric, storage batteries may also be used to allow power generated at one time to be used for propulsion later on. Several types can be made; these include windmill-only ships as well as hybrid ships which store wind power from the windmill when the ship does not need to be propelled. To reduce the energy required to propel the boat, windmill ships are often equipped with low-friction hull designs, such as multihull, or they are hydrofoils. Boats without low-friction hulls or hydrofoils can be equipped with windmills, but often the force generated by the windmills alone is not sufficient to propel the craft. In this case, the windmills only provide supplemental force to conventional sails or other propulsion systems. At present, research is still going on and the best types of bladed rotors still needs to be determined. For example, high horizontal axis wind mills are proven to make the ship less stable. Therefore, vertical axis wind mills (e.g. Savonius turbines) are sometimes preferred. Also, the wind mill needs to be highly durable as marine environments tend to degrade windmills more quickly than what is common on land.

Few windmill ships have been built to date; these include

- Jim Bates' Te whaka
- Lindsay Olen's Thrippence
- Peter Worsley's windmill-driven boat
- Jim Wilkinson's Revelation 2

Hydrofoils

The term "hydrofoil" can have one of two basic meanings. Firstly, a hydrofoil is a foil which operates in water. They are similar in appearance and purpose to airfoils. Second, the term "hydrofoil" is often used to refer to boats using hydrofoil technology. Most of this article is about this meaning of hydrofoil.

Hydrofoils let a boat go faster by getting the hull out of the water. When a normal boat moves forward, most of the energy expended goes into moving the water in front of the boat out of the way (by pushing the hull through it). Hydrofoils lift the hull out of the water so that you only have to overcome the drag on the foils instead of all of the drag on the hull. The foils on a hydrofoil boat are much smaller than the wings (foils) on an airplane. This is because water is about 1000 times as dense as air. The higher density also means that the foils do not have to move anywhere near as fast as a plane before they generate enough lift to push the boat out of the water.

The hydrofoils generate lift only when they are in the water; if they leave the water, the boat will crash down onto the surface of the water (and thus submerge the foils) until the foils generate enough lift to lift it back out. Like an airplane, a hydrofoil must be controllable in terms of pitch, roll, and yaw. Unlike an airplane, a hydrofoil must also maintain a consistent depth. Whereas an airplane has a range of about 40,000 feet in which to maintain its altitude, a hydrofoil is limited to the length of the struts which support the boat above the foils. Most commercial hydrofoils are boats with ladder foils (wings stacked one above another with space between them). This configuration is analogous to a biplane.

But the reason for stacking hydrofoils is different than the reason for stacking two wings on an airplane. Ladder foils make the boat easier to control when the water is not flat. If the boat is flying through waves, the wings will generate lift only in the crests; when the boat hits a trough the wings will leave the water and the boat will crash down. When a stack of ladder foils moves through the waves, chances are that some of the foils will be submerged even if some leave the water (unless the waves are really big).

There are two particularly persistent problems faced by designers of hydrofoils: Cavitation and ventilation. Ventilation occurs when part of a hydrofoil pierces the surface of the water and air gets sucked down the lifting surface of the foil. Since air is much less dense than water, the foil generates much less lift and the boat crashes down. Ventilation can occur at any air-water interface.

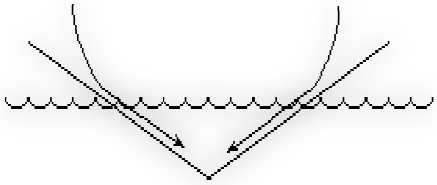

Figure 2: Shape of Hydrofoils

Ventilation occurs when air gets sucked down to the lifting surfaces. Although ventilation can occur on vertical struts, 'V' foils are particularly prone to this problem because of the shallow angle the foil makes with the water surface. Cavitation occurs when the water pressure is lowered to the point where the water starts to boil. This frequently happens with propellers. When a propellor is turned fast enough, the blades generate so much lift (i.e. the pressure on the lifting surface of the blades goes down) that the water flowing over the propellor blades begins to boil. When cavitation occurs, the foil no longer generates enough lift and the boat crashed down onto the water. Note that a

hydrofoil is not a hovercraft. Hydrofoils fly on wings in the water that generate lift whereas hovercraft floats above the water on a layer of air. In both cases the boat's hull leaves the water, but the mechanisms by which this is achieved are completely different.

Oxyhydrogen (HHO)

Oxyhydrogen is a mixture of hydrogen and oxygen gases, typically in a 2:1 atomic ratio; the same proportion as water. When bought to auto ignition temperature, oxy hydrogen will combust, turning into water vapor and producing energy. The energy sustains the reaction. This ignition temperature is approximately 570°C (1065°F). At standard temperature and pressure, oxy hydrogen can burn when it is between about 4% and 95% hydrogen by volume.

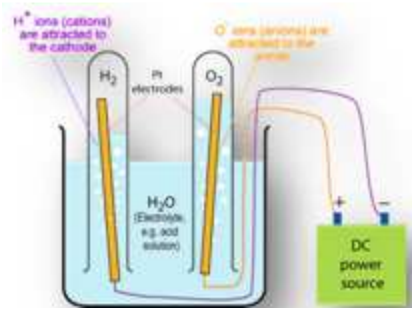

Figure 3: Electrolysis of H_2O

Electronic Control Unit (ECU)

In automotive electronics, electronic control unit (ECU) is a generic term for any embedded system that controls one or more of the electrical system or subsystems in a motor vehicle. The ECU consists of the following components.

- Controllers
- Invertors
- Charging unit
- Batteries
- Variable frequency drives

Depending up on the motor used, i.e., AC or DC type and the power are sent from the ECU.

Controllers

A motor controller is a device or group of devices that serves to govern in some predetermined manner the performance of an electric motor. A motor controller might include a manual or automatic means for starting and stopping the motor, selecting forward or reverse rotation, selecting and regulating the speed, regulating or limiting the torque, and protecting against overloads and faults.

A power inverter, or inverter, is an electronic device or circuitry that changes direct current (DC) to alternating current (AC). The input voltage, output voltage and frequency, and overall power handling, are dependent on the design of the specific device or circuitry. A power inverter can be entirely electronic or may be a combination of mechanical effects (such as a rotary apparatus) and electronic circuitry. Static inverters do not use moving parts in the conversion process.

Typical applications for power inverters include

- Portable consumer devices that allow the user to connect a battery, or set of batteries, to the device to produce AC power to run various electrical items such as lights, televisions, kitchen appliances, and power tools.
- Use in power generation systems such as electric utility companies or solar generating systems to convert DC power to AC power.
- Use within any larger electronic system where engineering need exists for deriving an AC source from a DC source.

Battery

An electric battery is a device consisting of one or more electrochemical cells that convert stored chemical energy into electrical energy. Each cell contains a positive terminal, or cathode, and a negative terminal, or anode. Electrolytes allow ions to move between the electrodes and terminals, which allows current to flow out of the battery to perform work.

Charging Unit

The charger has three key functions

- Getting the charge into the battery (Charging)
- Optimizing the charging rate (Stabilizing)
- Knowing when to stop (Terminating)

The charging scheme is a combination of the charging and termination methods.

Variable-Frequency Drive (VFD)

Variable-frequency drive (VFD) (also termed adjustable-frequency drive, variable-speed drive, AC drive, micro drive or inverter drive) is a type of adjustable-speed drive used in electro-mechanical drive systems to control AC motor speed and torque by varying motor input frequency and voltage.

OPERATING PROCEDURES

All the power sources which been described above possess own advantages and disadvantages. Using an ECU the power generated from Solar panel, Power generated from Solar panel, Wind turbine, Oxy hydrogen electric generator is channelized and optimized using controllers. The power is transmitted to the inverter which charges the battery and uses the power to drive Variable frequency drive (VFD) which propels the marine vessel.

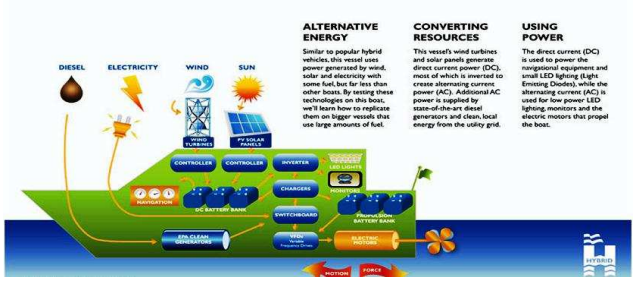

Figure 4

CONCLUSIONS

Hybrid marine vessel technology is a versatile concept that involves effective application of renewable energy that is cost effective and does not variably depend on fossil fuel that is expensive depleting, and a major cause for residual pollution. Thus, this idea has been proposed to be economically and environmentally stable and effective.

Foot Notes

Oxy Hydrogen

Oxy hydrogen is a mixture of hydrogen (H_2) and oxygen (O_2) gases. This gaseous mixture is used for torches to process refractory materials and was the first gaseous mixture used for welding. Theoretically, a ratio of 2:1 hydrogen: oxygen is enough to achieve maximum efficiency; in practice a ratio 4:1 or 5:1 is needed to avoid an oxidizing flame.

Fossil Fuels

Fossil fuels are fuels formed by natural processes such as anaerobic decomposition of buried dead organisms. The age of the organisms and their resulting fossil fuels is typically millions of years, and sometimes exceeds 650 million years. Fossil fuels contain high percentages of carbon and include coal, petroleum, and natural gas. They range from volatile materials with low carbon: hydrogen ratios like methane, to liquid petroleum to nonvolatile materials composed of almost pure carbon, like anthracite coal. Methane can be found in hydrocarbon fields, alone, associated with oil, or in the form of methane clath rates.

Generator

A Generator is a machine that converts one form of energy into another, especially mechanical energy into electrical energy, as a dynamo, or electrical energy into sound, as an acoustic generator.

Propeller

A mechanical device for propelling a boat or aircraft, consisting of a revolving shaft with two or more broad, angled blades attached to it.

Hydrofoil

Hydro foil is a boat whose hull is fitted underneath with shaped vanes (foils) which lift the hull clear of the water at speed. The term "hydrofoil" is commonly used for the wing-like structure mounted on struts below the hull, or across the keels of a catamaran in a variety of boats (see illustration), which lifts the boat out of the water during forward motion, in order to reduce hull drag. Hydrofoils can be artificial, such as the rudder or keel on a boat, the diving planes on a submarine, a surfboard fin, or occur naturally, as with fish fins, the flippers of aquatic mammals, the wings of swimming seabirds, or other creatures like the sand dollar.

Electronic Control Unit (ECU)

In automotive electronics, electronic control unit (ECU) is a generic term for any embedded system that controls one or more of the electrical system or subsystems in a motor vehicle. The types of ECU include electronic/engine control module (ECM), power train control module (PCM), transmission control module (TCM), brake control module (BCM or EBCM), central control module (CCM), central timing module (CTM), general electronic module (GEM),

body control module (BCM), suspension control module (SCM), control unit, or control module. Taken together, these systems are sometimes referred to as the car's computer. (Technically there is no single computer but multiple ones.) Sometimes one assembly incorporates several of the individual control modules (PCM is often both engine and transmission).

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