H1: Future of Hybrid Marine Vessels

The growing implementation of hybrid systems in marine vessels is having a great impact on marine engineering and shipping technology. Big names like Rolls-Royce, Color Line, Ulstein, and major cruise lines such as Hurtigruten have all been working on launching new hybrid vessels, which promise to represent the world's latest best-in-class in the shipping industry. Hybrid ferries are already being operated in New York, San Francisco, and Taiwan. According to Frederic Hauge of environmental group Bellona, "Battery-powered propulsion in ships this size shows that batteries are onboard to stay." Bellona published a report along with Siemens in 2017 showing that 70% of the Norwegian ferry fleet had the potential to run on hybrid technology.

Behind all the recent hype, is it possible that these new hybrid systems are just a fleeting (pun intended) trend, or are they here for the long haul? Are we sailing towards a future of exclusively hybrid marine vessels sailing the ocean?

Hybrid Systems and Engines: An Overview

A hybrid vehicle, whether that be a boat, marine vessel, or a car, achieves propulsion through a mixture of technologies, which combine the normal internal combustion engine, with electric drive and electrical generation. The power source could come from a diesel engine, which is a fuelled source, or from a battery and electric motor, which is a stored energy source.

Although many variations exist, the three main hybrid configurations are diesel/petrol-electric hybrid, serial hybrid, and parallel hybrid. With diesel or petrol, the system is connected to an electric generator which transfers power electrically to the shaft via the motor hybrid. It is most common in trains and large ships. As there is no electric storage of energy, this method's status as a hybrid system may be debated. The serial hybrid works in a similar way, however it allows you to stop the engine and store extra energy in a battery bank, which means you don't have to always resort to the generator for large propulsions of power. With a parallel hybrid, the connection between the engine and the shaft is not broken, and the motor functions in a parallel system with the engine. It provides several ways of driving the propeller.

According to Narve Mjøs, DNV GL's director of battery services and products, "The most suitable vessels for hybrids are ferries," with the most recent increase in demand coming from the cruise and tourism sector. Previously, implementations of hybrid systems most often relied on combining electric propulsion and the mechanical shaft, but the recent conception of a battery system is receiving more attention.

The Rolls Royce of the Ocean

Contracts have been signed which promise the 2019 release of an impressive hybrid vessel named the Color Hybrid, which will be capable of transporting 2,000 passengers and nearly 500 passenger vehicles between Sweden and Norway, on the well-known Sandefjord-Ströstad route. It will replace the Bohus, while doubling the legacy vessel's capacity. It represents a new range of ships and ferries which are growing in popularity, which are battery powered and run on engines built on a hybrid system, via any of the configurations described above.

This type of vessel is designed to function almost like an electric car, by topping up its batteries at designated electric stations located on shores along the way. The necessary technology is currently being built and expanded at various locations to support these battery-powered hybrid vessels.

What makes hybrid configuration more efficient?

The main buzzword currently associated with hybrid engines is: efficiency. So, what exactly is the science and engineering theory behind hybrid configurations which translate to improved vessel efficiency?

According to mechanical engineering, hybrid engines ultimately allow for improved fuel consumption, which make vessels more efficient in their ability to turn fuel into energy and propulsion. This is achieved through either engine cycling, or energy buffering, and a hybrid engine is especially helpful in situations where a regular engine is carrying a light load, yet running with lower efficiency than it would do if carrying heavier cargo. Any of the three aforementioned hybrid systems allow you to disconnect the engine from the propeller, and adjust the engine speed as required by the load contained on the vessel, and match the energy which the shaft requires to propel it. Both engine cycling and energy buffering allow for increased fuel economy, storage of extra energy in a battery bank, and the ability to change gear and propeller speed depending on the power required.

The optimal hybrid configuration is very much dependent on the type of vessel or vehicle in use, and how it is intended to be used. In some cases, a hybrid may not always provide improvements, so it's important to check if the current engine system is already operating with high efficiency before committing to a switch. Serial hybrid systems can be very expensive, while parallel systems are less costly as they combine both motor and generator functions in one single unit, as is often more reliable than a serial system.

Greener Vessels for a Greener World

The marine vessel industry is paying close attention to environmental performance and eco practices. According to a spokesman for Cruise Lines International, “Being environmentally conscious and proactive is not just a need for the industry, it’s a deep desire that is fundamental to how we do business...From the most stringent wastewater treatment policies in the global maritime community to continuous reductions in air emissions, CLIA members work with regulators and various industry stakeholders to deliver on their commitment to the environment."

Given the current climate of environmental crisis and the visible impacts of global warming (according to the UN, we have 12 years to limit climate change catastrophe), the main attraction of hybrid marine vessels is in their proposed sustainability. Increased efficiency resulting from an economy of fuel means less energy is wasted in the production of power needed to propel the vessels in question, whether ships or cruise boats.

The claims for reduction in fuel consumption, carbon footprint, and CO2 emissions are substantial, estimated as high as 20%. Hauge says that their battery-power capabilities represent “huge reduction in emissions from shipping,” and this new technology and engineering “is only the beginning” of improvements in this area to come. Investment in this technology currently sits at around $15m, and governments are also acting upon these advancements - the first electric ferry in Asia was launched earlier this year in Taiwan by Kaohsiung City Government. So hybrid marine vessels have been met with positivity, and initiatives to increase their production are being encouraged by the top officials.

Hurtigruten is at the forefront of hybrid vessel construction, and are planning for cruise ships to make journeys as far as the Arctic and Antarctic fuelled by these new engine configurations. According to the CEO, Daniel Skjeldam, their new design promises to be the most advanced and environmentally friendly expedition ship ever built." This is no small statement and represents massive improvement and advancements in environmentally friendly marine engineering practices. The battery functionality plays a central part in this, as in the long run it reduces fuel costs and reduces vessel emissions. Also, if these hybrid systems replace diesel, this could potentially result in cleaner oceans, seaports and harbors.

Support for Long-term Hybrid Marine Power

Manufacturers of this technology also speak to its advantages. Eco Marine Power claims that hybrid marine power "lowers consumption, reduces airborne pollution, and is energy efficient." They have developed specific technologies which are powered by renewable energy sources, and it's encouraging to see that companies are focusing not only on the reduced cost

assets of hybrid engines, but also on making them as environmentally friendly as possible, all while ensuring a return on investment for operators.

EMP fosters an innovative approach which bodes well for future inventions, adaptations, and improvements, citing their Tonbo Solar-Electric HMP Ferry, and the Medaka Eco Ferry, which is powered by solar design. They make the important point that these systems are especially beneficial when it comes to ferries which travel to places which are already suffering from noise and pollution issues. In this way, as well as reducing fuel costs and making vessels more environmentally friendly, hybrid technologies also have the potential to have knock-on positive effects for the cities they frequent. EMP are confident in the future of this technology, and state that “they will also play an important role in assisting ship owners/ operators meet the requirements of operating in Emission Control Areas (ECA) & marine parks.”

This represents a pioneer attempt to drastically reduce CO2 emissions in the shipping manufacturing industry, and is tapping into a vital area of the market whose growth does not seem to be slowing any time soon. The European Commission lists innovation in climate change, energy and the environment among their priorities, and has stated that new and innovative low carbon technology development “is essential to enable us to meet our EU and global climate change objectives,” and “help to reduce greenhouse gas emissions.” Not only this, but these developments also have the potential to “create new employment and growth” within the job sector. Even in 2015, the market for low-carbon technologies was estimated to fall at around $5.5 trillion. The EU has developed multiple initiatives to support low carbon technologies, including the NER 300 funding programme, the European Economic Recovery Programme, and the Strategic Energy Technology Plan. The Commission is also committing to introducing cleaner technology in developing countries.

Global Greenhouse Warming also points to low emission technologies as the answer to reducing greenhouse gas emissions, “emissions levels, air-borne pollutants, and other environmental impacts." They list hybrid powered vehicles as a vital low emission technology, and note that diesel and gas-powered vessels "expel noxious gases such as unburned hydrocarbons and particulates into the air." With this high-level rate of awareness comes a sense of responsibility, where hybrid engines will play an important role in the future not only for powering cruise ships, but for filling a necessary need for an alternative power generator.

Serving the Entire Marine Industry

Hybrid engines aren’t only reserved for vessels such as ships, ferries, and cruise boats, but are being used with positive results in the aeronautical and aviation fields. Aircrafts powered by similar battery systems are being reported to have flown distances of up to 300 miles. Harry Valentine notes that there is likely "scope to adapt future technology developments in hybrid

and battery-powered aeronautical propulsion to ground effect maritime technology involving wing ships that could occupy a unique future market niche."

Wing ships are currently being built and tested in Germany, South Korea, Australia, and Singapore, and “consume about a third of the amount of energy as equivalent size and weight of short-haul airplanes.” This has the potential to drastically improve future transportation service between coastal airports, “on links such as Palermo – Rome, Brisbane – Sydney, Rome – Barcelona, Boston U.S. – Bermuda and Singapore – Penang.” Further research and development is being carried out to further maximize efficiency, improve fuel economy, reduce energy costs, and minimize harmful environmental effects. Battery power and the availability of recharge stations will also play a vital part, as "for winged ships, lifting off from coastal runways would consume less energy than lifting off from water runways."

H2: Outnumbering the Disadvantages

Today, almost 100 ships worldwide are running on this new battery power system. With all the signs, statistics, studies, and initiatives backing alternative power generators such as hybrid engines, thanks to their economic and environmental benefits, are there any downfalls, barriers, or caveats in acquiring or using this technology? Is it extremely niche, or will it become widespread and universal?

Mjøs is confident that the benefits outweigh any disadvantages, which may include the need to retrain existing crew to use the new system. According to Marine Insight, “Different and improved training for ship’s crew as the system is completely different from mechanical system and involves major automation.” However, this could also equate to new job openings and education opportunities. As for hybrid engines completely replacing any legacy system, this may not occur across all marine segments, for example with big tankers and container ships. But that's just the short term situation - further innovation in the field will most probably lead to battery systems with greater power and output to fuel these more demanding marine vessels. Even in the aeronautical field, “Ongoing research seeks to develop superior batteries that offer lighter weight, higher energy storage density, quicker recharge capability, greater service life involving several thousand deep-cycle recharges and superior temperature tolerance.”

The success of battery powered marine crafts also depends on the success of the infrastructure behind shore-side charging stations, which are essentially an extension of the hybrid engines system. As for long-term developments, Mjøs believes that "all-electric" is the answer, "as the energy density increases and costs come down."

However, until those costs do come down, despite the economic benefits of many hybrid installments, many can be costly, too, especially if the switch does not yield any tangible

advantages in efficiency, output, and CO2 emission decrease. Nevertheless, the experts are putting their bets on the future of this technology, despite initial investment costs, which they believe “will definitely pay-off at a later stage.”

H2: Electric and Hybrid Marine World Expo

Hybrid system enthusiasts can stay up to date with all the latest developments by following the events held at the Electric and Hybrid Marine World Expo, which takes place annually in Amsterdam. The exhibition positions itself as "showcasing the very latest and next-generation electric and hybrid marine charging and propulsion technologies, components, and solutions." The 2018 event hosted almost 4,500 attendees, and featured battery technology from BMW, Torqeedo’s electric propulsion systems, and Japan’s Yanmar’s new marine generator prototype.

From research to exhibitions, and environmental benefits to fuel and cost economy, the future of hybrid marine vessels promises to be an exciting and innovative one, if not a highly influential sector with significant and positive knock-on effects.