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Electric Power Propulsion

We live in an era where the latest trend is “going green, “ whether it be electric cars or high-efficiency electronics or even clothing and furniture made from recycled plastic. Everyone is looking for better and more efficient technologies to lower our dependence on foreign oil and our consumption of fossil fuels. The US Navy has been developing the first generation of fully electric vessels that will hopefully replace gas turbines, with the first seven ships set to launch sometime in fiscal year 2012 (Wagner). The goal is to power anything and everything onboard electrically, which will run more efficiently and produce fewer harmful emissions.

The first electric devices were introduced to warships as far back as 1877 when 238 electric light sockets were installed on the USS Trenton. In 1913, the US Navy launched the first electrically-propelled ship, the USS Jupiter, which had a combined power of 4800 kW (Pazik). The new all-electric vessels would generate 78 megawatts, which would be enough to service approximately 70,000 homes by coal power plant standards (Toensmeier). Since 1977, the US Navy has been looking for ways to increase the efficiency of its fleet, but due to a large number of requirements and restrictions, they have been mostly unsuccessful. With 2008 came the launch of several diesel-electric hybrid vessels, with similar pros and cons of a hybrid car. Instead of running entirely on diesel engines, these ships ran the diesel engines on an as-needed basis, while trying to rely on electricity as much as possible (Aichele). Currently, the majority of ships are still run by two sets of generators: one that powers the ship’s propulsion and the other that powers everything else onboard, such as the computers, lights, and water purifiers (Wagner). With the new electric drive systems, the ship-propelling generators would also be able to convert the energy needed to power everything else onboard, thus eliminating the need for the second set of generators and reducing fuel consumption by 10 to 25 percent.

The main advantage to such technology is higher efficiency and thus less fuel consumption, but there seem to be many benefits. The Navy’s current gas turbine engines run at about 16 to 18 percent efficiency, as the ships generally move pretty slowly. The Office of Naval Research estimates that new fuel cell-powered ships could be as much as 37 to 52 percent efficient. With the price of oil in 2007, such changes would save the US Navy an estimated $1 million per ship per year, making today’s savings that much greater (Wagner). In addition, higher efficiency and less fuel would allow ships to refuel less, thus extending their time out at sea. With less fuel and more electric power come fewer emissions, which lowers what can be detected by infrared on enemy ships. While this would obviously lead to a loss of jobs for many, fewer traditional gas turbines lessens the need for a large crew onboard. The USS Zumwalt, or the lead in the DDG-1000 class of destroyers, is estimated to be finished construction in 2013 and would only require a crew of 142, compared to a 341-man crew on a similar ship of its size. Finally, electric engines would require less maintenance over a longer period of time, extending the life of the ship (Toensmeier).

Anytime we try to build something on a ship, we have to keep in mind that it has to be almost completely independent and self-sustaining, using nothing but the ocean, the sun, and the air. But unlike most other kind of ships, navy vessels, depending on what purpose they serve, have to be able to withstand a lot. Severe weather conditions, long periods of time without land, the weight of everything onboard plus a plane, if it is an aircraft carrier, the resistance to moisture, and most importantly, the impact of shooting and being shot at must all be accounted for. Every last thing on a navy ship must be ultra-reliable and goes through rigorous testing to make sure that, were the boat attacked, the only chance of injury comes from the attack itself and not, for example, from an exploding chair. All of this is proving to be the major disadvantage with the new electric engines. Starting in the late 90s, there were two frontrunners in the engine race: the Advanced Induction Motor (AIM) by Converteam and the Permanent Magnet Motor (PMM) from DRS Technologies. The PMM was more efficient, half the size, more powerful, and ran more quietly, making it an obvious choice. But in 2007, a failure to pass testing with flying colors led to the Navy choosing AIM instead, which has greatly slowed down development and has turned into somewhat of a controversy (Toensmeier).

Though this technology is largely mechanical and electrical, one could say there are some aspects of civil as well. Much of the future of civil engineering seems to lie in the environmental sector, which includes technologies such as this one that would decrease air and water pollutants and lower environmental impact. Electric power propulsion however is largely mechanical and electrical collectively. All of the internal workings of the engines as machines and the goal of maximum efficiency are mechanical engineering topics. Converting everything over on the ship from gas to electric and combining the two sets of generators into one is all mechanical. The fact that the machines can successfully power everything onboard the ship is the success of the electrical aspect. The turbines themselves and the wiring that allows the remnants of the propulsion engine power to feed the rest of the ship are all electrical.

This technology is already starting to make an impact on the commercial sector. Many newer cruise ships are already being built with electric-drive, which is the technology that uses the ship’s propulsion turbines to power everything electrical. Unlike naval ships, however, cruise ships do not require anywhere near as much power because they do not have the same physical impact requirements and do not have to power heavy weaponry. But at some point in the future, whatever technology is developed in the Navy will most likely carry over onto similar ships including cruise liners, offshore oil rigs (ironic, I know), and ferries.

Most technologies devised by the US government or military have proven to be greatly ahead of their time, often coming out decades before they are sold to companies for public use. Since 1977 the US Navy has been working to find a way to make its vessels more powerful with greater efficiency and fewer harmful emissions. Now in the final testing, the first vessel with electric power propulsion is supposed to set sail sometime next year. If all goes as planned, efficiency could increase from 16-25 percent to 37-52 percent. Engines will require less maintenance with half the crew onboard and are quieter with fewer emissions, making it less detectable by enemy ships. Overall, it could save the US Navy over $1 million per year per ship just in fuel expenses alone.

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