Temasek Defence Systems Institute

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Concept Development and Operational Analysis of Using Hydrogen as a Single Naval Fuel

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Content:

objectives of thesis

This thesis will focus on using liquid hydrogen (LH_2) technologies as a single naval fuel onboard a seagoing vessel. The case study in this thesis is a 1000 twenty-foot equivalent unit (TEU) catamaran container vessel (CV) as a proxy to the United States (U.S.) Navy's Spearhead Class vessel. These 2 vessels are both built with catamaran hulls, and both have similar tonnage.

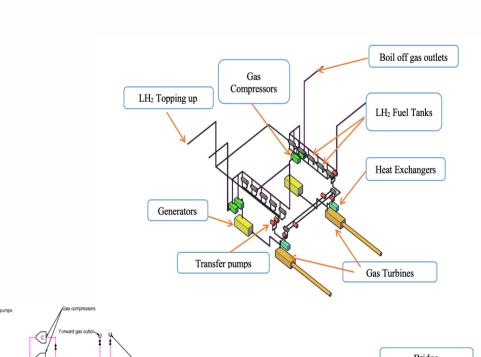
main research ideas

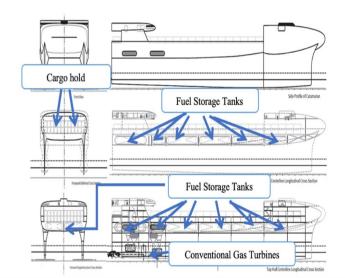
- The thesis was split into two portions, namely a design portion supplemented with an analysis portion
- The design portion was proposed thru meeting estimated requirements of ocean-going routes and the list of proposed design changes are as follows:
 - Use of GE LM6000 gas turbines as main propulsion, ullet
 - Modifications to be done on existing fossil fuel tanks to hold LH₂ fuel, •
 - Replacement of current compressors to Hydro-Pac C-12-40-7000LX/SS hydrogen compressors, •
 - Use of GE10-1 gas turbines as generators, •
 - Replacement of current fuel transfer pumps to Becker VFD vacuum pump, •
 - Modifications to be done on existing heat exchangers to allow LH₂ operation, •
 - Replacement of current valves to WEKA PK-TZV LH₂ valve ۲

research results

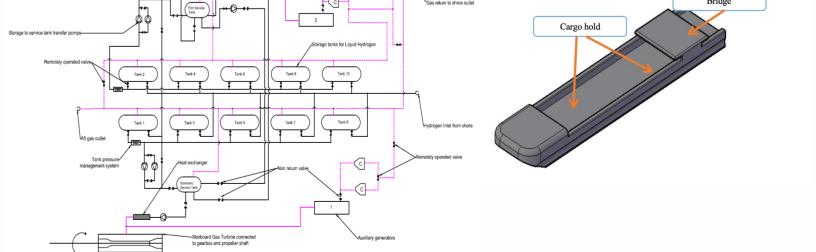
- For the analysis portion, RetScreen and Microsoft Excel were used to evaluate the proposed system based over a 20-year project life. The following were calculated:
 - Green house gas (GHG) emissions expected to decrease by $5.37 \times 10^5 \text{ tCO}_2$ (equivalent to 98,479 cars not used)
 - NPV of \$2.21M. •
 - Positive IRR of 1.3% •
 - Initial costs of \$37.85M. \bullet
 - Payback period of 16.2 years; and \bullet
 - Cumulative cash flow of \$4.62M after a 20-year project life •

benefits/potential applications of the research





- The benefits for this thesis will provide the following:
 - Reduction in PM, NOx and SOx emissions
 - The removal of equipment for fuel oil treatment ullet
 - Lower manpower, maintenance, and operating costs; and •
 - The reduction of risk for fire and oil spills •



- follow-up research activities etc
 - To separately look at hydrogen fuel cells, and if hydrogen technologies can be coupled together with existing renewable energy sources for military vessels
 - To verify if hydrogen technologies can be extensively used in tropical climates such as Singapore

