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Performance and Voyage Analysis of Marine Gas Turbine Engine, Installed to Power and Propel an Ocean-Going Cruise Ship from Lagos to Jeddah

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Abstract : An aero-derivative marine Gas Turbine engine model is simulated to be installed as the main propulsion prime mover to power a cruise ship which is designed and routed to transport intending Muslim pilgrims for the annual hajj pilgrimage from Nigeria to the Islamic port city of Jeddah in Saudi Arabia. A performance assessment of the Gas Turbine engine has been conducted by examining the effect of varying aerodynamic and hydrodynamic conditions encountered at various geographical locations along the scheduled transit route during the voyage. The investigation focuses on the overall behavior of the Gas Turbine engine employed to power and propel the ship as it operates under ideal and adverse conditions to be encountered during calm and rough weather according to the different seasons of the year under which the voyage may be undertaken. The variation of engine performance under varying operating conditions has been considered as a very important economic issue by determining the time the speed by which the journey is completed as well as the quantity of fuel required for undertaking the voyage. The assessment also focuses on the increased resistance caused by the fouling of the submerged portion of the ship hull surface with its resultant effect on the power output of the engine as well as the overall performance of the propulsion system. Daily ambient temperature levels were obtained by accessing data from the UK Meteorological Office while the varying degree of turbulence along the transit route and according to the Beaufort scale were also obtained as major input variables of the investigation. By assuming the ship to be navigating the Atlantic Ocean and the Mediterranean Sea during winter, spring and summer seasons, the performance modeling and simulation was accomplished through the use of an integrated Gas Turbine performance simulation code known as 'Turbomach' along with a Matlab generated code named 'Poseidon', all of which have been developed at the Power and Propulsion Department of Cranfield University. As a case study, the results of the various assumptions have further revealed that the marine Gas Turbine is a reliable and available alternative to the conventional marine propulsion prime movers that have dominated the maritime industry before now. The techno-economic and environmental assessment of this type of propulsion prime mover has enabled the determination of the effect of changes in weather and sea conditions on the ship speed as well as trip time and the quantity of fuel required to be burned throughout the voyage.

Keywords : ambient temperature, hull fouling, marine gas turbine, performance, propulsion, voyage
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