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Simulink Model Design for The Ship Electrical Power System with Multi Load Analysis

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ABSTRACT: Electrically propelled ships are likely to play in the present conflict, and whether this is likely to have a great influence on the future of electrically propelled and Diesel-electric ships. Diesel generating power is used by number of coasters, not only for propulsion but also largely for winches, windlass and other additional principles. This paper emphases on the model that uses generator and the gas source. After supplying power to the different alternators used, will come to know about the various fluctuations arises at different loads. The proposed model will then be able to handle the multiple kinds of load and it will also check the stability of individual alternators with respect to the type of load applied.

KEYWORDS: Electric ship, diesel generator alternator, gas turbine alternator, dance club, casino of cruise ship.

I. INTRODUCTION

Latest technologies have afflicted the shipping industry in multiple means as related to the automotive industry. Out of these technologies, electric propulsion has created a significant change in the course of the shipping industry and becoming norm for propulsion in future ships. Additional ships are predicted to be fitted with electric propulsion systems as an outcome. Even though electric propulsion has the benefits like flexibility in engine placement, improved memorability and increased fuel efficiency, it suffers from the disadvantage of getting load transients propagated into the electrical power system [1].

Hybrid electric ships have appeared as an intervening step towards fully electric ships to fill the necessity of falling emissions caused by the ships of today. In hybrid electric ships, the traditional mechanical propulsion is united with electrical propulsion for improved fuel efficiency, thereby reducing emissions. The huge distinctions in voltage and frequency in the shipboard power system is the prevailing problem that has been recognized that occur in transient environments, where frequent and variable amounts of load-changes are added to the network. This effect has not been adequately studied in the hybrid propulsion based shipboard power systems. Due to the element that such power systems can work in multi-modes, this problem is even more intricate, because of the flexibility in using mechanical, electrical or both types of propulsion. In a hybrid electric ship, a comprehensive modelling of the electrical system would be required to analyse the transient behaviour of the power system. For the system under dissimilar modes of operations, the transient levels of frequency and voltage can be measured by applying the several load-change scenarios. Hence, the relationship between the magnitude of the load-change and the consequential voltage and frequency fluctuations for each mode of operation can be determined. As a result, control measures such as energy storage systems can be designed to supply or absorb active and reactive power at appropriate times to reduce the magnitude and duration of these fluctuations [1] [2].

Between 1980 and 2012, to evaluate the electric load of surface ships for the purpose of sizing electric generators, Design Data Sheet DDS 310-1 was used. DDS 310-1 offers a calculation process based on the associated load of all the ships' loads, and a connected load factor for each operating condition [3]. Created in a time when most loads were small as compared to the rating of the generators, and power systems could tolerate short-term overloads, this technique was adequate. More and more ships are engaging medium voltage distribution systems and zonal transformers and/or power electronics-based power conversion with the development in electric load. The inconsistency in load around the long-

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term average due to cycling loads, and the restricted overload proficiency of power electronics, called for enhanced approaches to estimate load for determining the rating of equipment[4][5]. Moreover, advances in modeling and simulation presents improved perception of the electric load expected for power generation and power conversion equipment.

The introduction of power electronic devices and converters has made it potential to re-design the entire architecture of shipboard power generation, distribution and utilization, entirely from scratch. This fact has brought relevant changes in the entire ship design, allowing room savings, fuel efficiency and increased flexibility without impairing reliability, so that, nowadays, 100% of new-built cruise liners are electrically propelled (and many older ships have been already retrofitted in the same way). All Electric Ships (AESs), in the sense that on board thermal engines (diesel and/or gas turbines) are used exclusively as prime movers of the synchronous generators [6].

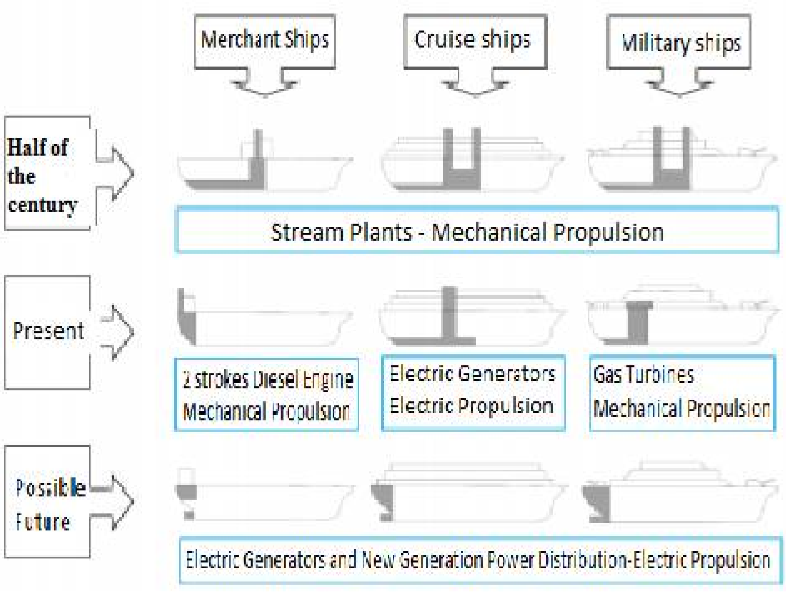

Figure 1. Ship Configuration

II. BACKGROUND

Ship electric propulsion is a new generation of propulsion method that propellers are driven by electric motor directly instead of traditional diesel engines. Compared with traditional pattern, electrical power has many advantages such as flexible control, fast response and less pollution, etc. Many researchers have made innovative models in this field to achieve the enhanced system but mostly the work is done for the single type of load in the system. No system is capable of providing efficient power for the multiple type of load no need to develop a system in which multiple loads can be considered. Also need to develop a system which will be generalized for multi loads.

III. PROPOSED WORK

As need of system design which will work on the multiple load categories and capable to work on different types of system. So a proposed model will be developed in the paper which will have capability for the multiple type load handling. For this the input sources will have generators and gas source also so can work if anyone will not be capable to work also then the advanced system will analyze the results with different load categories to analysis the performance over the power for different loads.

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IV. METHODOLOGY

The methodology for the proposed work is given below in which two different Alternators has taken and multiple loads have applied on the individual system to evaluate the performance and stability of each. The steps are followed as:

1. Initially, power has applied to the individual Alternator i.e. Diesel Generator Alternator and Gas Turbine Alternator.
2. As power has applied, fluctuations will be start and heads to the marine system where different loads will be applied.
3. Multiple loads have applied to the marine system in order to check the stability of the individual alternator with respect to different power second. Fewer fluctuations will lead to the more constant and high stability results.

Framework of the proposed work

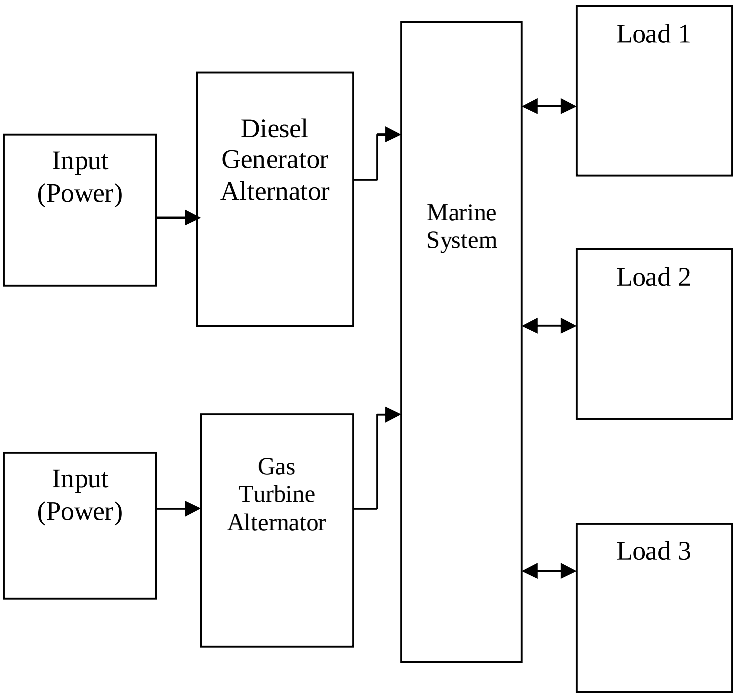

Figure 2. Block Diagram for the proposed work

V. RESULTS AND DISCUSSION

This section of the paper represents the experimental analysis and shows the result obtained after performing simulation. Both diesel generator alternator and gas turbine alternator's output power has compared with each other to evaluate the performance.

Figure 3 represents the output power of diesel generator alternator in power with respect to time. The above graph represents that it produces lesser power but less number of fluctuations.

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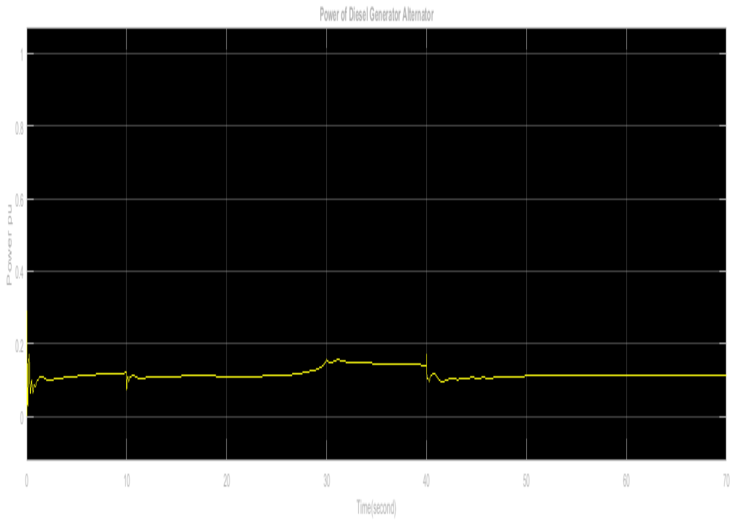

Fig 3. Output Power of Diesel Generator Alternator (in pu)

The below figure 4 shows the output power of Gas turbine Alternator in power with respect to time. The numbers of fluctuations in the Gas turbine are higher as compared to the output power of diesel generator alternator. But on the other hand, it produces high amount of power.

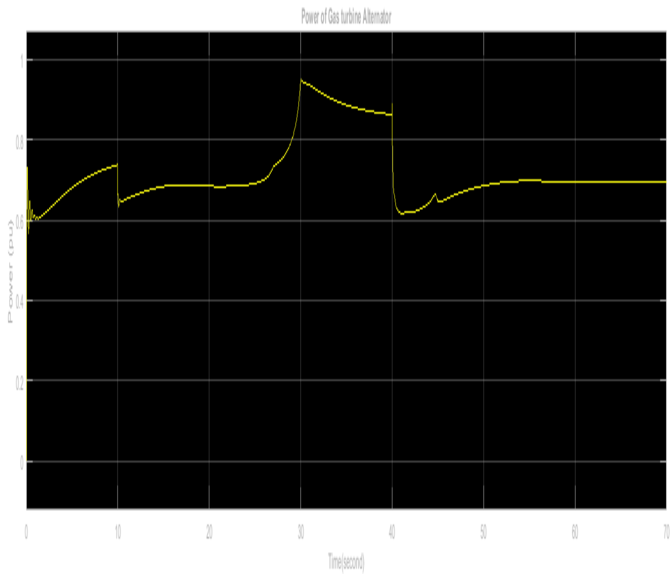

Fig 4. Output Power of Gas Turbine Alternator (in pu)

Curves in the figure 5 show the output power of both Gas turbine and diesel generator. There are some fluctuations in both the cases but in the case of Diesel Generator number of fluctuation is less. Although fluctuation is less in diesel generator but the amount of output power is also less as compared to Gas Turbine. Gas Turbine produces output power between 0.6 to 1 pu but Diesel Generator produces power between 0 to 0.2 pu.

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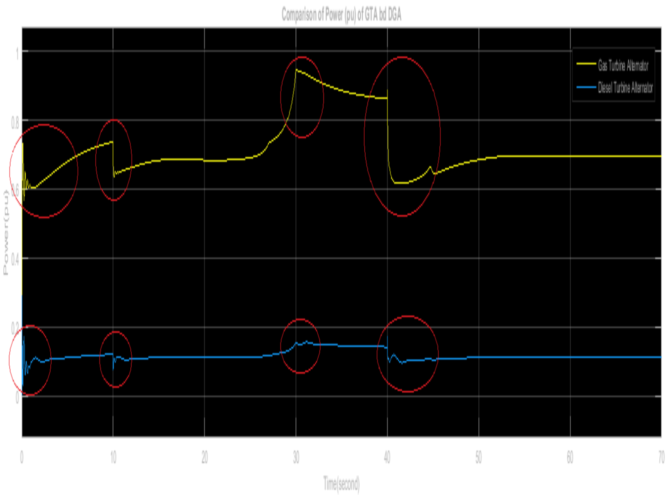

Fig 5. Comparing Output power of Gas turbine and Diesel Generator

The number of fluctuations with respect to power is acquired, which shows the stability of individual in figure 6. At 10 second power of Gas turbine reaches to 0.8 pu and experiences a sudden fall to 0.6 pu but there is less variation of power in Diesel Generator. With time power of Gas Turbine reaches going to increase but Diesel Turbine maintains a constant power of near about 0.2 pu. At 30 second power of Gas Turbine starts decreasing to a level of 0.8 pu. On other hand, power of Diesel generator is constant. At 40 second power of Gas Turbine falls to 0.6 but Diesel generator again on constant power supply.

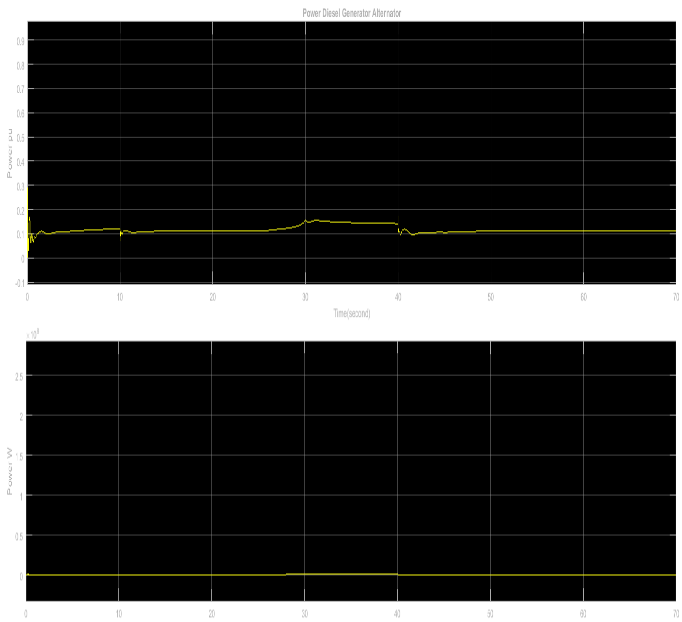

Fig 6. Power of Diesel Generator Alternator in pu (axes 1) and in Watt (axes 2)

Figure 7 represents the power of Gas Turbine Alternator in terms of power and watt. As compared with the diesel generator alternator, constancy is less as the number of fluctuations is complex in amount.

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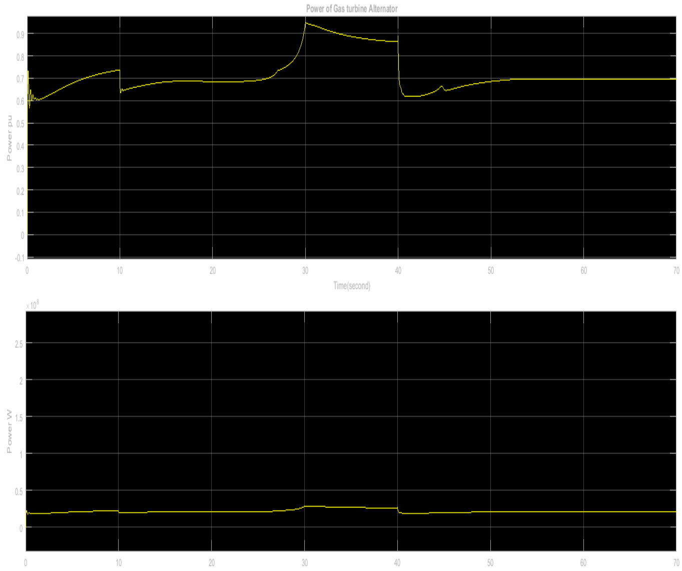

Fig 7. Power of Gas Turbine Alternator in pu (axes 1) and in Watt (axes 2)

In the below figures, power has been analyzed with respect to time. As the system starts, in both Diesel Generator and Gas Turbine, power is going to fluctuate so thus the stability starts increasing. Figure 8 represents the power of Diesel Generator alternator in terms of time and per unit voltage. Simulation has performed to check the stability of particular alternator.

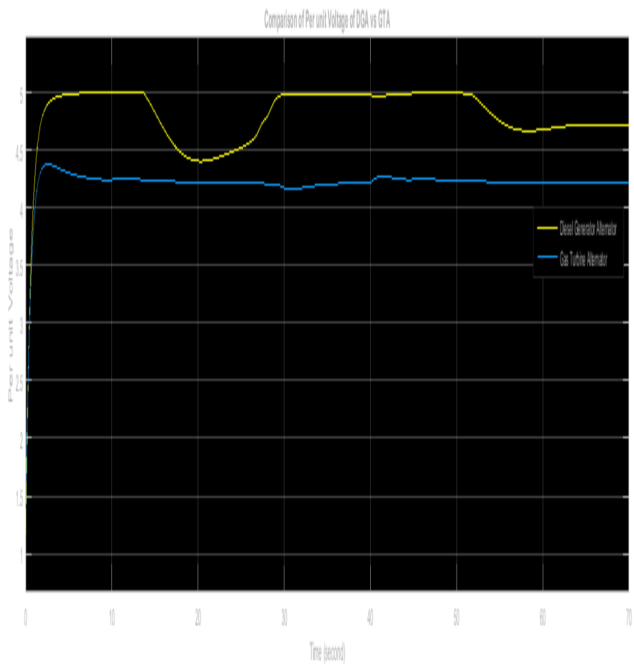

Fig 8. Per unit Voltage of Gas Turbine and Diesel Generator

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VI. CONCLUSION AND FUTURE SCOPE

An integrated power system is all-electric architecture for future ships, providing electric power to the total ship (propulsion and ship service) with an integrated plant. Electric ships are beneficial in improving the survivability and stealth, improved war fighting and reduced cost of ownerships. The traditional designed ship systems were capable of handling a single load due to which a new system has proposed that can handle multiple loads. At different power speed diesel generator and Gas turbine alternators are simulated. The numbers of fluctuations in the Gas turbine alternators are higher as compared to the diesel generator alternator but on the other hand, output power generated by the Gas turbine is higher as compared to the diesel generator. Thus, diesel generator provides high level of stability as it remains constant against number of fluctuations. Alternatively, Gas Turbine alternator provides high level of stability in terms of output power as it generates high amount of power in comparison with Diesel Generator alternator. The experiments have performed in different loads such as Dance club, casino of cruise Ship etc to ensure the performance of the individual alternators.

In future, other different loads can be applied to the system with different alternators to evaluate their performance and make sure how they will perform in different loads.

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