EFFICIENCY OF GENERATOR SET ON CHANGES IN ELECTRICAL LOAD ON FISHERY VESSELS

Fahmi Yahya Saputra[1], Rama Arya Sobhita[1], Anggara Trisna Nugraha[1,*], Akhmad Azhar Firdaus[2]

[1]Department of Ship Electrical Engineering, Surabaya State Shipping Polytechnic, Indonesia
[2]Bio - Industrial Mechatronics Engineering, National Chung Hsing University, Taiwan

*Correspondence Author: anggaranugraha@ppns.ac.id

Abstract

Electrical energy is an essential requirement for fishing vessels, and it is primarily generated by diesel-driven electric generators. This energy is utilized for various purposes onboard such as lighting, navigation, and supporting fishing activities including loading and unloading. The efficient operation and longevity of the electric generator onboard depend on ensuring that the load imposed on it does not surpass its capacity. Researchers conducted several phases in this study, including identifying the electrical power distribution system, determining the generator capacity and the electrical load it receives, and calculating the electrical load under various operational conditions. Additionally, the study examined the operational efficiency of the generator under four different conditions. The findings reveal that the fishing vessel employs a radial electrical distribution system and is equipped with two electric generators, each having a capacity of 225 kVA. The generators demonstrate efficient performance across all operational scenarios, with load factors ranging from 79.70% to 83.08%.
.

Keywords: electric load, electric generator, generator efficiency, fishing vessel

1. Introduction

The use of electrical power in fish storage facilities is a crucial requirement to support the operations of fishing vessels. Thus, there is a need for a power source to drive these facilities. The electrical system on board comprises power generation equipment, distribution systems, and various electrical appliances. Electrical energy is utilized to drive motors for various auxiliary machines, lighting, navigation equipment, and room cooling devices. Continuous electricity supply is fundamentally necessary for safe vessel operations; hence, the availability of adequate generator power capacity is crucial (Alamsyah, 2017; Andreas et al., 2020; Ayom et al.,2020). This is particularly associated with vessel conditions during sailing, necessitating the presence of emergency power generation systems to handle vessel emergencies. Generators serve as essential primary power sources to meet all electrical needs on fishing vessels (Cahyono et al., 2017; Danyal, 2013; Darma et al.,2019). However, in most cases on board, the largest needs are ideally met by the onboard generators. This leads to power accumulation in the vessel's electrical installations. Such power accumulation is typically used at certain times when several vessel equipment is in use, and the selection of generators as power sources is determined by a method accessible to the vessel's generators. Therefore, excessive electrical load on the generator must be avoided, as overloading can lead to fatal consequences (Anggara et al.,2021; Agung et al., 2021;Apriani et al., 2022). To understand the usage of electrical load installations and recognize the importance of electricity on vessels, there is a need for research to analyze the usage of electrical loads against generator power on fishing vessels (Naufal & Aswin, 2022; Nugraha et al 2022a,2022b,2022c). This research aims to identify electrical loads on fishing vessels and determine the efficiency of the generator power used for vessel electrification (utomo et al.,2022; Cahyono et al.,2022). The hope of this writing is to identify electrical loads on fishing vessels and understand the efficiency of the generator power used for vessel electrification.

2. Material and methods

This study examines the electrical load usage data on a Fishing Vessel. The research was conducted on the fishing vessel KM. Okishin 07 owned by PT. Okishin Flores. This vessel is a modified ship that was previously used for longline fishing and was later converted into a fish transportation vessel. The vessel operates in the waters of Flores and serves as both a transporter and processor of the catch from plasma vessels collaborating with PT. Okishin Flores, as well as other fishing vessels. To obtain the electrical load on KM. Okishin 07, several systematic steps were taken. The first step involved observing and identifying the electrical distribution system on board, from the generator to the loads. The second step was to identify and determine the electrical power available as a power source to operate the equipment and electrical machinery to support the vessel's operations. The third step was to calculate the electrical load used(Luqman et al.,2022; Nugraha et al.,2022; Achmad & Anggara, 2022). In collecting the electrical load used, it was categorized into four types of operational conditions

of the vessel, as each condition involves different tasks and the use of different machinery and electrical equipment. These operational condition groups are:
1) when the vessel is sailing to the port to load supplies
2) when the vessel is operating to unload supplies and receive fish from fishing vessels
3) when the vessel is sailing to PT. Okishin
4) when the vessel is unloading cargo at PT. Okishin.
The object used as the research material for this electrical load is the generator set with a diesel engine drive as shown in Figure 1.

Figure 1. Power Generator

Meanwhile, the power generation on the ship utilizes an electrical generator, and the specifications of this generator engine are determined (Fahmi & Anggara, 2022; Reza & Anggara, 2022; Sugianto & Nugraha). To distribute electricity on the ship, the electrical load paths are identified starting from the generator to the loads present on the electrical distribution panel. The identified electrical load includes all equipment using electricity from the ship's generator.

The maximum power of the generator engine on the ship is influenced by the generator's output capacity in kVA and the power factor of the engine. By knowing these two parameters and using equation
1) the available electrical power can be determined: $P=S\times\cos\phi$
2) The efficiency of electrical energy usage generated by the generator is employed to ascertain how much electrical energy generated by the generator is utilized.

To support the ship's operations, it is necessary to determine the efficiency of electrical energy usage generated by the generator, which requires knowing how much electrical energy is used and how much electrical energy the generator generates. The efficiency of the generator is calculated using equation (2):
$\eta=$ total power usage/ power generator supply × 100%

3. Results and discussion

The electrical power distribution system aboard the ship utilizes a radial distribution system, where electrical panels receive power from the main panel directly connected to generators one and two. To synchronize these generators, the main panel is equipped with a synchroscope. This distribution system was chosen for its simplicity and relatively lower cost compared to other distribution systems, aligning with Danyal's (2013) observation that radial systems are commonly used due to their simplicity and cost-effectiveness. The distribution of electrical current begins with generators one and two as the power sources, then the electrical energy is directed to the main distribution board. From there, the electrical energy is distributed to distribution panels equipped with safety devices such as circuit breakers, magnetic contactors, overcurrent relays, Marine Transformers, and safety fuses. Subsequently, these distribution panels are routed to users, including lighting installations, electrical equipment, navigation systems, and auxiliary equipment, with much of the energy used to operate electric motors.

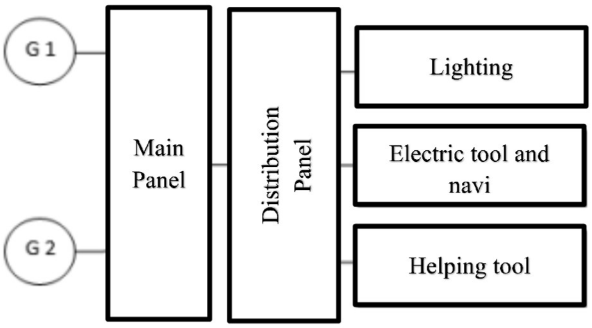

Figure 1. Power Distribution

The available electrical power on the ship can be calculated by multiplying the power factor of the engine by the power generated by the generator (1), then multiplied by the number of generators on the ship. Based on the data obtained and observations on the ship, the total electrical power consumption can be met by the power of one generator unit, and only one generator unit is operated. Therefore, the available electrical power from one generator unit is:

$$P = 225kVA \times 0.8$$

$$P = 180kW$$

During its operations, KM. Okishin 07 consumes a significant amount of electrical energy. This electrical energy is used for lighting accommodation areas from the engine room to the navigation room. The power required for lighting varies, as it is adjusted according to the lighting needs and the size of the room. Electrical distribution for navigation equipment is used for navigational purposes, while the load from electric motors is used to operate auxiliary equipment to assist in onboard activities. The electrical load usage is obtained by observing and recording the data of the electrical load consumed. From TABLE III, the total electrical load consumption from various installations is 168,495 Watts. Therefore, the overall efficiency of electrical power usage from one generator unit is calculated using (2).

$$\eta = 168.495\ W / 180.000\ W \times 100\%$$

$$\eta = 93.6\%$$

From the above calculation, the overall efficiency of electrical power usage is 93.6%, which is deemed inefficient as it exceeds the generator's load factor of approximately 60% - 86% (Ricesno & Nandika, 2020).

4. Conclusion

From the analysis discussed above, it can be concluded that the electrical distribution system on KM. Okishin 07 employs a radial distribution system where the electricity generated by the generator is distributed to the main panel, then to distribution panels, and further to electrical equipment. The electrical power generated by one generator unit available on the ship is 180 kW. The total electrical power usage during voyages to the loading and unloading areas is 145,005 Watts, with an efficiency of 80.56%. During the operation of fish collection, the total electrical power usage is 149,545 Watts, with an efficiency of 83.08%. The total electrical power usage when heading to PT. Okishin Flores is 145,005 Watts, with an efficiency of 80.13%. Lastly, during loading and unloading operations at the port owned by PT. Okishin Flores, the total electrical power usage is 143,470 Watts, with an efficiency of 79.70%.

Credit authorship contribution statement

Fahmi Yahya Saputra: Conceptualization, Writing – review & editing. **Rama Arya Sobbhita**: Supervision, Writing – review & editing. **Anggara Trisna Nugraha**: Conceptualization, Supervision, Writing – review & editing. **Akhmad Azhar Firdaus**: Conceptualization, Supervision, Writing – review & editing.

References

Alamsyah, F. (2017). Studi Kinerja Generator Pembangkit Listrik Tenaga Air Ubrug Sukabumi. Jurnal Online Mahasiswa (JOM) Bidang Teknik Elektro, 1(1).

Andreas, K., Suastiyanti, D., & Rupajati, P. (2020). Peningkatan Daya Listrik Pada Generator Putaran Rendah Melalui Peningkatan Sifat Magnetik Magnet Permanen Bafe12o19. Jurnal Teknik Mesin ITI, 4(1), 12–16

Ayom, B., Shanty, M., & M Alfath, E. (2020). PERHITUNGAN KEBUTUHAN ENERGI LISTRIK UNTUK PENERANGAN PADA KAPAL IKAN 30 GT DAN 10 GT YANG BEROPERASI DI PANTAI SELATAN PULAU JAWA. Jurnal Sains & Teknologi Fakultas Teknik, 10(3), 32–39.

Cahyono, A., Hidayat, H. K., Arfaah, S., & Ali, M. (2017). Rekonfigurasi Jaringan Distribusi Radial Untuk Mengurangi Rugi Daya Pada Penyulang Jatirejo Rayon Mojoagung Menggunakan Metode Binary Particle Swarm Optimization (BPSO). SAINTEK II-2017, UB, Malang, 103–106.

Danyal, A. (2013). Pemodelan Sistem Distribusi Radial Untuk Studi Aliran Daya Harmonisa Tiga Fasa. Jurnal Teknik ITS, 2(2), B128–B130.

Darma, I. K. B. S., Mudjiono, U., Setiyoko, A. S., & Poetro, J. E. (2019). ANALISIS KAPASITAS GENERATOR PADA KAPAL IKAN 15 GT. Altar: Applied Electrical Engineering Letters, 1(2), 37–42.

Anggara Trisna Nugraha, Dwi Sasmita Aji Pambudi, Agung Prasetyo Utomo, and Dadang Priyambodo, "Design of Charger Controller on Wind Energy Power Plant With Arduino Uno Based on Pi Controller," vol. 3, no. 4, Nov. 2021.

Agung Prasetyo Utomo, M. Apriani, Ruddianto Ruddianto, Luqman Cahyono, Anggara Trisna Nugraha, and Mochammad Ilham Nugroho, "PELATIHAN PEMBUATAN TERUMBU BUATAN BERBASIS ECO-FRIENDLY SEBAGAI SARANA REHABILITASI TERUMBU KARANG DI DAERAH PANTAI WISATA PASIR PUTIH, SITUBONDO," Integritas, vol. 5, no. 2, pp. 298–298, Nov. 2021, doi: https://doi.org/10.36841/integritas.v5i2.1340.

M. Apriani, L. Cahyono, A. Utomo, A. Nugraha, and A. Cahya Ningrum, "Preliminary Investigation of Bioplastics from Durian Seed Starch Recovery Using PEG 400 for Reducing Marine Debris," Journal of Ecological Engineering, vol. 23, no. 2, pp. 12–17, Jan. 2022, doi: https://doi.org/10.12911/22998993/144824.

Naufal Praska Zakariz and Aswin Nugraha, "The Effect of Inlet Notch Variations on Turbine Speed in Pico-hydro Power Plants," vol. 4, no. 1, pp. 35–41, Jan. 2022, doi: https://doi.org/10.35882/jeeemi.v4i1.4.

A. T. Nugraha, M. F. Ramadhan, and M. J. Shiddiq, "Distributed Panel-based Fire Alarm Design," JEEMECS (Journal of Electrical Engineering, Mechatronic and Computer Science), vol. 5, no. 1, pp. 07-14, Feb. 2022, doi: https://doi.org/10.26905/jeemecs.v5i1.6030.

A. T. Nugraha, D. Priyambodo, and S. T. Sarena, "Design A Battery Charger with Arduino Uno-Based for A Wind Energy Power Plant," JPSE (Journal of Physical Science and Engineering), vol. 7, no. 1, pp. 23–38, Apr. 2022, doi: https://doi.org/10.17977/um024v7i12022p023.

A. P. Utomo, A. T. N. Angga, D. S. A. Pambudi, and D. Priyambodo, "Battery Charger Design with PI Control Based on Arduino Uno R3," Applied Technology and Computing Science Journal, vol. 4, no. 2, pp. 78–90, May 2022, doi: https://doi.org/10.33086/atcsj.v4i2.2398.

A. T. Nugraha, O. D. Pratiwi, R. F. As'ad, and V. A. Athavale, "Brake Current Control System Modeling Using Linear Quadratic Regulator (LQR) and Proportional integral derivative (PID)," Indonesian Journal of Electronics, Electromedical Engineering, and Medical Informatics, vol. 4, no. 2, pp. 85–93, May 2022, doi: https://doi.org/10.35882/ijeeemi.v4i2.6.

L. Cahyono et al., "Pelatihan Pembuatan Lilin Aromaterapi dari Minyak Jelantah Sebagai Sarana Peduli Lingkungan Perairan dan Implementasi Konsep Ekonomi Sirkular Warga Bumi Suko Indah," Dharma Raflesia : Jurnal Ilmiah Pengembangan dan Penerapan IPTEKS, vol. 20, no. 1, pp. 53–67, Jun. 2022, doi: https://doi.org/10.33369/dr.v20i1.19271.

Luqman Cahyono, M. Apriani, Anggara Trisna Nugraha, and Agung Prasetyo Utomo, "POTENSI RISIKO WAKTU PELAKSANAAN PROYEK SWAKELOLA DI KABUPATEN PASURUAN MELALUI PROGRAM KOTAKU KEMENTERIAN PUPR," Jurnal Spektran, vol. 10, no. 2, pp. 118–118, Jul. 2022, doi: https://doi.org/10.24843/spektran.2022.v10.i02.p08.

A. T. Nugraha, R. F. As'ad, Adianto, and V. H. Abdullayev, "Design And Fabrication of Temperature and Humidity Stabilizer on Low Voltage Distribution Panel with PLC-Based Fuzzy Method to Prevent Excessive Temperature and Humidity on The Panel," Journal of Electronics, Electromedical Engineering, and Medical Informatics, vol. 4, no. 3, pp. 170–177, Jul. 2022, doi: https://doi.org/10.35882/jeeemi.v4i3.241.

I. Achmad and Anggara Trisna Nugraha, "Implementation of Voltage Stabilizers on Solar Cell System Using Buck-Boost Converter," Journal of Electronics, Electromedical Engineering, and Medical Informatics, vol. 4, no. 3, pp. 154–160, Jul. 2022, doi: https://doi.org/10.35882/jeeemi.v4i3.246.

Fahmi Ivannuri and Anggara Trisna Nugraha, "Implementation Of Fuzzy Logic On Turbine Ventilators As Renewable Energy," Journal of Electronics, Electromedical Engineering, and Medical Informatics, vol. 4, no. 3, pp. 178–182, Jul. 2022, doi: https://doi.org/10.35882/jeeemi.v4i3.236.

Reza Fardiyan As'ad and Anggara Trisna Nugraha, "Rancang Bangun Penstabil Kinerja Panel Hubung Bagi Tegangan Rendah," Journal of Computer, Electronic, and Telecommunication, vol. 3, no. 1, Jul. 2022, doi: https://doi.org/10.52435/complete.v2i1.187.

Moh. G. P. A. Sugianto and A. T. Nugraha, "Implementasi sensor cahaya sebagai level bahan bakar pada tangki harian kapal," Journal of Computer Electronic and Telecommunication, vol. 2, no. 1, Jul. 2022, doi: https://doi.org/10.52435/complete.v2i1.191.