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Analysis Cause of Automatic Voltage Regulator Damage to the Genset in KP Hiu 06 Owned the Ministry of Marine and Fisheries

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ABSTRACT

AVR on an electric generator is a device that serves to maintain the stability of the generator output voltage. KP Shark 06 suffered AVR damage twice in 2017 which affected the operations of the ship so it is necessary to analyze the cause of the damage. The steps to analyze the causes of AVR damage starts from the factor of overload on the electricity generator, the working condition of the electric generator and the motor driving factor of the electric generator. Based on observations and calculations of the ship's electricity load, it is known that there is no overload of electric generators, ie the average per day/hour of power used is 6,009.75 Watt, where the available power is 17,600 Watt (generator efficiency 34.14%). While the work of the generator is observed normally based on the results of the measurement of the electric current produced by the generator. It was concluded that the cause of AVR damage was due to the generator driving motor which experienced a decrease in performance so that when subjected to electric load the engine rotation experienced instability which caused voltage fluctuations where this caused the AVR to work abnormally resulting in AVR damage. After repairs to the generator drive engine during ship docking, the engine rotation of the electric generator drive motor becomes more stable and the working function of the AVR becomes more normal.

INTRODUCTION

Fishery supervision (KP) Hiu 06 is one of the patrol vessels owned by the Ministry of Maritime Affairs and Fisheries (KKP) that functions as law enforcement at sea in the fishery sector by protecting marine and fisheries resources. KP Hiu 06 in 2017 experienced generator disruptions which required AVR units to be replaced twice a year. If there is damage to the AVR, the electricity generator will not produce electricity as a result the entire work and operational processes of the ship are hampered so that the efficiency of the ship as a supervisor is disrupted.

The electrical power requirements on a ship will be met by a generator installed where the work of the generator must remain stable when there is a fluctuation in the electrical load. The voltage stability of the electric power system is the ability of the system to return to normal work after experiencing a change in load, while the instability of the system means the loss of system synchronization so that the system works abnormally after experiencing changes in electric current loading [1]. AVR (automatic voltage regulator) is a device that

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functions as a regulator (voltage) automatically due to changes in electrical load with the aim of maintaining the voltage in a constant state at a predetermined value [2-6]. AVR will regulate the reactive power distribution during parallel work, provide an excitation current regulation in a fault condition so that it does not come out of synchronization and will reduce the voltage rapidly when the generator is released from the load which will result in over voltage [3]. When the generator terminal voltage drops due to load changes, the voltage regulator will automatically increase the field generation so that the voltage returns to normal, when the generator terminal voltage increases. The generator is equipped with an excitation system, which is a direct current supply system as a reinforcement to the electric generator, so that it produces electric power and the output voltage depends on the amount of excitation current. The amount of the excitation value is influenced by rotation speed and motor load.

This research aims to analyze the causes of damage to the AVR unit on a generator so that the generator's operations run smoothly so that the ship can function properly. The steps to do damage analysis starts from the simple activities of taking data directly (in situ) to activities that require the dismantling of the generator set.

EXPERIMENTAL METHOD

The research was conducted from September 2018 to December 2018 on the Hiu 06 supervisor ship at the UPT PSDKP Batam. Data collection was carried out on 3 cruise trips namely trip I and trip II for 16 days, while trip III for 13 cruise days where trip III was carried out after the ship underwent ship repair docking. Data is collected on the generator set on the ship for sail operations and port docks. Generator specifications can be seen in table 1.

Table 1. Genset Specifications at KP Hiu 06

Merek	:	Perkins
Serial number	:	0151085/02
Start system	:	Elektric
Round	:	1500 RPM
Number of Cylinders	:	3 pieces
kVA Base Rate	:	22 kVA
kW Base Rate	:	17,6 kW
Herzt	:	50 Hz
Ampere Base Rate	:	33,4 Ampere
Power Factor	:	0,8
AVR	:	MX341
Excitation system	:	brushless

Fig. 1. Genset on KP. Hiu 06

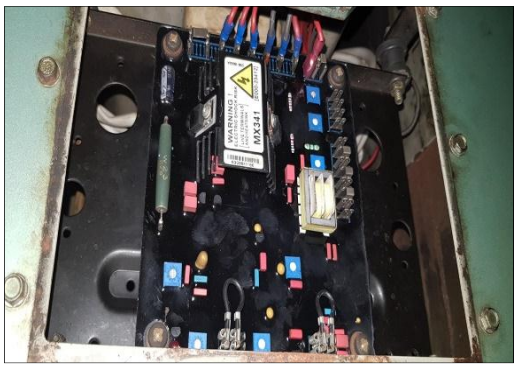

Fig. 2. AVR type MX341

To find out the cause of the damage to the AVR, an analysis of the factors that resulted in damage to the AVR on an electric generator on the ship. Factors resulting from the analysis are based on literature studies and direct observations on board and by looking at the history of the electrical system in the engine journal books, three factors cause AVR damage, namely:

1. Electricity overload factor on the electric generator
2. The working conditions of electric generators
3. Factors driving the electric generator.

The data analysis method used is a quantitative analysis by applying data that has been obtained in the field with the formula used to calculate the electric generator power contained in the title of the final practice scientific work, among others:

Generator power

$$P = V \, x \, I \, x \sqrt{3} \, x \, \cos \emptyset \qquad (1)$$

Generator power efficiency

$$Efficiency\ (n) = \frac{Power\ Used}{Available\ Power}\ x\ 100\% \quad (2)$$

RESULTS AND DISCUSSION

Electricity Overload Factor

To analyze the electrical overload factor in the generator, data collection is done by measuring the amount of electric current (Ampere), voltage using a clamp meter, and the frequency (Hz) generated by the generator by observing the frequency meter on the electrical panel.

Fig. 3. Measurement of electric current and voltage

The measurement results are then analyzed using the generator power equation to determine the electrical load used (see table 2). The average value of the electricity load is 7,046.87 Watt (7.04 kW) where the biggest load occurs in the 12.00 - 16.00 range. While the magnitude of the electricity load per day on the trip I for 16 days can be seen in Figure 3, with an average of 6,179.5 Watts.

Table 2. Electric load on the generator

No	Jam	V (Volt)	I (Amper)	√3	Cos Ø
1	00.00 - 02.00	380	12	1,73	0,8
2	02.00 - 04.00	380	12	1,73	0,8
3	04.00 - 06.00	380	12	1,73	0,8
4	06.00 - 08.00	380	11,5	1,73	0,8
5	08.00 - 10.00	380	12,5	1,73	0,8
6	10.00 - 12.00	380	13	1,73	0,8
7	12.00 - 14.00	365	18	1,73	0,8
8	14.00 - 16.00	365	18	1,73	0,8
9	16.00 - 18.00	370	16	1,73	0,8
10	18.00 - 20.00	380	12	1,73	0,8
11	20.00 - 22.00	380	12	1,73	0,8
12	22.00 - 24.00	370	14	1,73	0,8

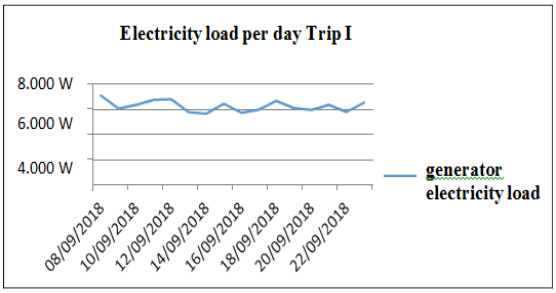

Fig. 4. Electric load on trip I

On the voyage of trip II for 16 days data collection was also carried out with an average load of electricity on the ship is 6,082.7 Watt, while trip III which was made after the ship underwent repairs known that the average electricity load of 5,710.9 Watt. Comparison of the average magnitude of the electricity load of the generator with the installed power on the generator that is 17.6 kW for 45 days the screen period can be seen in Fig 4. The efficiency of the generator on each trip is 35.11%, 34.56% and 32.45%.

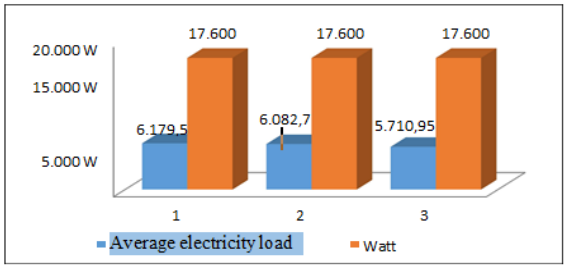

Fig.4. Graph of generator power efficiency one time trip

Working conditions factor of the electric generator

Fig. 5. Check the generator output voltage with neutral

Fig. 6. Voltage check on AVR

From the results of checks made on the measurement of these generator components as a whole there are some differences from the data contained in the AVO meter measuring instrument showing the voltage generated for the three phases is in the range of numbers namely 360 - 392 Volts and for one phase in the numbers 210 - 230 Volts and for measurements after entering the electric panel also in numbers 360 - 392 Volts and 210-230 Volts, for the PMG system the stator entering into the AVR also shows normal numbers with voltages ranging from 150 Volts AC - 180 Volts AC and for the figures produced for engine speed when normal idle at 1500 RPM but when given a reduced load to 1300 - 1350 RPM to overcome so that the resulting voltage remains at 220 Volts the idle RPM is raised to 1600 RPM so that when given a load will drop to 1500 RPM, but this results in a voltage surge at the beginning of the engine is operated or also when the load is used to change such as the use of air conditioning while the compressor is working and not working there will be changes in engine speed so that the voltage also generated up and down, generator engine RPM often up and down or hunting causing unstable voltage. Changes in load conditions as the dynamic behavior of the system will cause changes in the current flowing in the generator system which causes changes in the voltage of the armature and the generator terminal.

CONCLUSION

1. The amount of generator electricity load based on the calculation of the electricity load does not exceed the capacity of the generator so that the AVR damage is not due to an overload.

exciter stator windings at 13 Volt DC - 60 Volt DC. Other checks in the form of checking the condition of the cable to ensure no cable is peeled or leaking, checking the connection between cables and terminals to ensure no connection is loose, broken or loose, as well as checking the generator mounting bolts to ensure the condition of strength and stability in holding vibration from work generator and motor drive. Based on the above activities, it was observed that the work of the generator was in normal condition, so it was concluded that the AVR damage had not been due to the generator condition.

Generator driving force factor

From observations of the generator driving motor factors as a whole before and after operation there are some problems that occur, namely lubricating oil which is often reduced in the oil reservoir so that each will be operated must add lubricating oil, the cylinder head breathe hose also emits black smoke, smoke coming out at recognize a thick black generator and leave an oily crust in seawater,

2. The working condition of the generator is based on electric current data collection under normal circumstances.
3. The performance of the driving machine has decreased causing AVR damage which is indicated by a decrease in engine speed when the engine is loading. A decrease in engine performance results in fluctuations in the voltage generated by the generator which will damage the AVR.

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