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Analysis of The Effect of Loading on Parallel Generator Work at PT. Mitrabara Adiperdana Tbk

Analisa Pengaruh Pembebanan Terhadap Kerja Paralel Generator Pada PT. Mitrabara Adiperdana Tbk

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Abstract _ *Genset is a combination of two different devices: the engine as a rotating device and the generator as a generating device. Genset at PT. Mitrabara Adiperdana. Tbk is used as a backup when the electricity source from PLN goes out. Due to fluctuating loads, an ample power supply is needed when the conveyor is operating, so more than one generator is needed to supply electricity according to load demand. To meet the power needs at PT. Mitrabara Adiperdana. Tbk, 2 gensets with a capacity of 500 kVA and 3 gensets with a capacity of 800 kVA were synchronize. Generator synchronization aims to obtain optimal power, good efficiency and efficient specific fuel consumtion (SFC). When 5 generator units were paralleled, the lowest efficiency was 19.2% with an SFC of 0.48 liters/kWh in September with a capacity of 800 kVA, while the highest efficiency was 62.98% with an SFC of 0.15 liters/kWh in July with a capacity of 800 kVA. The calculation result, when given the same loading, obtained the lowest efficiency of 1% with an SFC of 9.3 liters/kWh in August with a capacity of 500 kVA and the highest efficiency of 51.45% with an SFC of 0.18 liters/kWh in August with a capacity og 800 kVA. The calculation result show that the efficiency is affected by the amount of output power, the difference in the initial year of operation, anf the difference in several parameters of the nmaplate. Meanwhile, the generator's Specific Fuel Consumtion (SFC) is influenced by the output and hours meter.*

Keywords: *Parallel Generator; Load; Genset Efficiency; Specific Fuel Consumtion.*

Abstrak_ Genset adalah suatu peralatan gabungan dari dua perangkat berbeda yaitu engine sebagai perangkat pemutar dan generator sebagai perangkat pembangkit. Genset di PT. Mitrabara Adiperdana. Tbk digunakan sebagai backup saat sumber listrik dari PLN padam. Karena beban yang fluktuatif, maka saat conveyor beroperasi dibutuhkan suplai daya yang besar, sehingga diperlukan lebih dari satu genset untuk dapat mensuplai listrik sesuai permintaan beban. Untuk memenuhi kebutuhan daya di PT. Mitrabara Adiperdana. Tbk, maka dilakukan sinkronisasi 2 unit genset kapasitas 500 kVA dan 3 unit genset kapasitas 800 kVA. Sinkronisasi genset bertujuan untuk memperoleh daya yang optimal, efisiensi yang baik dan konsumsi bahan bakar spesifik yang efisien. Pada saat 5 unit genset diparalel diperoleh efisiensi terendah yaitu 19,2% dengan SFC 0,48 liter/kWh dibulan September dengan kapasitas 800 kVA, sedangkan efisiensi tertinggi yaitu 62,98% dengan SFC 0,15 liter/kWh dibulan Juli dengan kapasitas 800 kVA. Hasil perhitungan saat diberikan pembebanan yang sama diperoleh efisiensi terendah yaitu 1% dengan SFC 9,3 liter/kWh dibulan Agustus dengan kapasitas 500 kVA dan efisiensi tertinggi yaitu 51,45% dengan SFC 0,18 liter/kWh dibulan Agustus dengan kapasitas 800 kVA. Dari hasil perhitungan diketahui bahwa efisiensi dipengaruhi oleh besarnya daya output, perbedaan tahun awal pengoperasian dan perbedaan beberapa parameter dari name plate. Sedangkan Specific Fuel Consumption (SFC) pada genset dipengaruhi oleh daya output dan juga hours meter.

Kata kunci: Paralel Genset; Beban; Efisiensi Generator; *Specific Fuel Consumption.*

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I. INTRODUCTION

Genset is a power plant that uses a diesel engine. Generators are an alternative source of backup electricity when the PLN power source goes out and are widely used in offices, hospitals, malls, industry and others. Because of its function as a back-up , the power generated must also be equivalent to the electricity supply from PLN.

Gensets used in industrial companies certainly require a large power supply, so more than one generator is needed with a power capacity according to industrial needs. The use of more than one generator must be done by paralleling the generators. Parallelizing a generator is the process of combining two or more electricity sources to get a larger electricity source . This synchronization process must pay attention to phase sequence, voltage, frequency and phase angle. The use of one generator with a larger power capacity can be replaced with several generators using a parallel process. This is because if the load used is small, not all generators need to be operated, so this can save fuel.

To regulate the distribution of generator power automatically, the deapsea module is used . So when the load is less than the specified nominal value, only one generator is needed, then when the load increases, another generator is needed. This process is carried out automatically [1] . To meet increasing electricity needs, the solution is to synchronize generators. If a generator is loaded beyond its capacity, the generator cannot work or may even be damaged. One effort to overcome increasing electricity needs or loads is by running another generator, then operating it in parallel with the generator that was working previously [2].

In research related to power management between PLN and generators, the generator's parallel working system aims to obtain greater power. Generator efficiencyis good when the generator is loaded up to its maximum load. The rate of fuel consumed by a diesel engine is greatly influenced by the power absorbed by the load during operation, wheater parallel or not [3].

The next research related to the synchronization of 3 phase generators with a capacity of 511 kVA and 820 kVA with the load is PT. Ungaran Sari Germents. In this research, before the synchronization process between 2 generators, it is necessary to pay attention to the generator capacity. So the loading of a generator must pay attention tpo the maximum power capacity by load sharing by turning them on one by one according to the generator power capacity for the load, then synchronization will run smoothly and the load will be applied to all PT. Ungaran Sari Germents areas can be fulfilled [4].

This research was conducted at PT. Mitrabara Adiperdana Tbk, generator used at PT. Mitrabara Adiperana Tbk is used as a backup electricity source when PLN electricity goes out so that the coal production process and other work that requires electricity supply can continue to be carried out. The greater the need for electrical power, the greater the need for more than one generator that is capable of serving the load , especially during peak loads. The biggest expense at PT. Mitrabara Adiperdana Tbk is a conveyor, so when conditions are not under loading, electricity is only used in the workshop/all estuary areas, including maintenance equipment , lighting and others. The use of a 500 kVA generator at peak load, which occurs during the in loading and out loading processes , causes an imbalance between the power generated and the load demand. Therefore, it is necessary to parallel 500 kVA and 800 kVA generators with the aim of optimizing the output power to match with load demand.

Based on this description, it is necessary to carry out studies or research to overcome this problem. Thus, this research aims to determine the effect of loading on efficiency and fuel consumption in parallel generators . By conducting this research, hopefully it can become a reference for industry players.

II. METHODS

This research is a quantitative research . This research emphasizes on the power obtained when the generator is synchronized , what level of efficiency is obtained and fuel consumption. Starting from identifying problems to compiling, processing and analyzing data, it is aimed at testing hypotheses.

2.1 Data collection

Generators with capacities of 500 kVA and 800 kVA are 2 x 500 kVA and 3 x 800 kVA. This generator with a power capacity of 500 kVA was initially used to serve the BLC (Barge Loading Conveyor), all estuary areas (office) and crushers with alternating day and night operating times. Meanwhile, a generator with a power capacity of 800 kVA is operated to serve the Coal Handling Facility (CHF). However, currently the generator is used as a backup when the PLN power supply goes out.

[Figure 1 about here]

[Figure 2 about here.]

2.2 Energy Production

Energy production obtained from the field was for ten months in 2018 and for three months in 2019 with data as in Table 1 and Table 2 below. From the 2018 data, there are two data points, G5, which were not operational in January and February, as well as G4 which was not operational in October. This is because there is damage that requires the generator to stop operating temporarily.

[Table 1 about here]

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[Table 2 about here]

2.3 Fuel Consumption (Liters/kWh)

This fuel consumption data (liters/hour) was obtained in accordance with energy production data, namely for ten months in 2018 and three months in 2019.

[Table 3 about here]

[Table 4 about here]

2.4 Research Flowchart

[Figure 3 about here.]

2.5 Generator Efficiency

Generator efficiency is the comparison between the effective power of the generator and the amount of fuel consumption multiplied by the calorific value of the fuel (9,240 Kcal/liter). Then from the following equation it is known that the constant 1 Watt is equal to 1 Joule/second and 1 Kcal/hour is equal to 1.16 Joule/second [5].

$$\eta = \frac{N_e}{G_f \cdot Q_c} \times 100\% \quad (1)$$

Where η is the efficiency in units of %, N_e is the effective power in units of Watts, G_f is the hourly fuel consumption in units of liters/hour, and Q_c is the calorific value of the fuel in units of kJ/kg.

2.6 Specific Fuel Consumption

Specific fuel consumption is the fuel used in the engine every hour for every energy produced [5]. Equation for to find out how much fuel consumption is used is as follows:

$$SFC = \frac{G_f}{N_e} \times 100\% \quad (2)$$

Where SFC is the specific fuel consumption in units of kg/kWh, N_e is the effective power in units of Watts, and G_f is the hourly fuel consumption in units of liters/hour.

III. RESULTS AND DISCUSSIONS

3.1 Efficiency of 500 kVA and 800 kVA Gensets with Parallel Connection and Single Operation in 2018

The data used in the following calculations was obtained from energy production and fuel consumption data contained in the table below, with a fuel calorific value of 9,240 Kcal/liter. Then it is known that the constant 1 Watt is equal to 1 joule/second and 1 kcal/hour is equal to 1.16 joule/second. Where, the calorific value of the fuel and the equivalent value of 1 kcal/hour equals 1.16 joules/second will be used to calculate efficiency for the following month.

[Table 5 about here]

Two generator units with a capacity of 500 kVA work in single operation, 500 KVA Generator (G1):

$$(\%\eta) = \frac{87440\,W}{(36{,}27\ \text{liter/hour}\ .\ 9.240\ \text{kkal/hour})} \times 100\%$$

$$= \frac{87.440\ \text{joule/detik}}{335.134{,}8\ \text{kkal/hour} \times 1{,}16\ \text{joules/second}} \times 100\%$$

$$= \frac{87.440\ \text{joules/second}}{388.756{,}4\ \text{joules/second}} \times 100\%$$

$$= 22{,}5\%$$

The next calculation uses the same formula, so that the following efficiency calculation results are obtained:

[Table 6 about here]

3.2 Efficiency of 500 kVA and 800 kVA Gensets in Parallel Connection in 2019

[Table 7 about here]

500 KVA Generator (G1):

$$(\%\eta) = \frac{111.700\ \text{W}}{(36{,}94\ \text{liter/jam}\ .\ 9.240\ \text{kkal/liter})} \times 100\%$$

$$= \frac{111.700\ \text{joule/detik}}{341.325{,}6\ \text{kkal/jam} \times 1{,}16\ \text{joule/detik}} \times 100\%$$

$$= \frac{111.700\ \text{joule/detik}}{395.937{,}7\ \text{joule/detik}} \times 100\%$$

$$= 28{,}2\%$$

The next calculation uses the same formula, so that the following efficiency calculation results are obtained:

[Table 8 about here]

[Table 9 about here]

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3.3 Specific Fuel Consumption (SFC) Genset 500 kVA and 800 kVA Parallel Connection and Single Operation 2018

[Table 10 about here]

Two generator units with a capacity of 500 kVA work in single operation.

500 KVA Genset (G1) 26.6% load:

$$SFC = \frac{36,27}{87,44} = 0,4\ \text{liter/kWh}$$

500 KVA Genset (G2) 2.2% load:

$$SFC = \frac{25,85}{7,2} = 3,6\ \text{liter/kWh}$$

The next calculation uses the same formula, so that the following SFC calculation results are obtained:

[Table 11 about here]

3.4 Specific Fuel Consumption (SFC) Genset 500 kVA and 800 kVA Parallel Connection in 2019

[Table 12 about here]

Two generator units with a capacity of 500 kVA work in parallel.

500 KVA Genset (GS01042) 30.4% load:

$$SFC = \frac{36,94}{111,7} = 0,33\ \text{liter/kWh}$$

500 KVA Genset (GS01049) 35.4% load:

$$SFC = \frac{31,77}{130,310} = 0,24\ \text{liter/kWh}$$

The next calculation uses the same formula, so that the following SFC calculation results are obtained:

[Table 13 about here]

[Table 14 about here]

3.5 Graph of Efficiency Calculation Results

[Figure 4 about here.]

Figure 4 shows the efficiency values with quite a large difference between generators with unit numbers G1 and G2. Where, G2 has a very low efficiency value (1.60%) in August. The use of G2 operates beyond the working hours of the G1 generator with the smallest load, namely 1,694 kWh in August and the highest load, namely 8,923 kWh in May. Meanwhile, G1 serves a larger load, namely the smallest load of 15,788 kWh in September and the highest load of 30,568 kWh in August.

[Figure 5 about here.]

The graph in Figure 5 shows the efficiency value with an average value of 30% and above with the highest efficiency value being in August for the G3 and G4 generators, this is because coal production increases in August so the output power increases . These three generators operated in parallel in 2018 to serve CHF (Coal Handling Facility) loads when there was production and inloading and outloading processes. This can be seen from the amount of electricity load/production (kWh) each month with the largest load being 69,552 kWh in June.

[Figure 6 about here.]

[Figure 7 about here.]

[Figure 8 about here.]

From the calculation results in Figure 8, the G2 generator has greater efficiency than before parallel, namely from an efficiency of 1% to 3.50% in 2018 increasing to 28.3% to 37.65 and above in 2019. Then 3 generators with a capacity of 800 kVA has greater output power in 2019, but has lower efficiency. This is because the loading pattern applied places three generator units with a capacity of 800 kVA as a priority when serving large loads such as serving all estuary areas, inloading and outloading , so that the load (kWh) of the 800 kVA generator is much greater, up to 90,428 kWh (G4) in the month August with hour meters above 200. The 500 kVA generator set operates to serve all estuary areas and also the inloading process . Then the hours meter for the 500 kVA capacity generator was reduced because the 800 kVA capacity generator was used as a priority.

After making a comparison using energy production in 2018 to calculate efficiency in 2019 (Figure 7 and Figure 8), a lower efficiency was obtained, namely the lowest efficiency before parallel, namely 1.60% (G2) while the lowest efficiency after parallel was 1% (G2). This is because the 2018 energy production data used in the calculations is smaller (1,694 kWh smallest load) compared to 2019 data, then using fuel

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consumption data (liters/hour) in 2019 which is much higher (up to 93.7 liters). /O'clock).

3.6 Specific Fuel Consumption (SFC) Calculation Results

[Figure 9 about here.]

The graph in Figure 9 shows that the SFC G1 value for 10 months has a value with a small difference, namely 0.3 liters/kWh in February as the lowest value and 0.6 liters/kWh in September as the highest value. Meanwhile, the SFC G2 value has the lowest value, namely 1.1 liters/kWh in May and 5.75 liters/kWh as the highest value. The high SFC value is caused by the long time it has been in operation.

[Figure 10 about here.]

The SFC calculation results of the three 800 kVA generators in Figure 9, it shows a very small value, namely 0.14 liters/kWh in August. This happens because the hours meter is small, namely 112 hours with an output power of 413.75 kWh in August.

[Figure 11 about here.]

[Figure 12 about here.]

[Figure 13 about here.]

When a comparison is made by equalizing the load, the SFC value is actually greater than before parallel. This happens because the calculation uses fuel consumption per hour and then divides it by electricity production (kWh). Fuel consumption when 5 generator units are paralleled is very large, reaching 93.7 liters/hour compared to before paralleling with the highest value of 89.1 liters/hour. By equalizing the load, the resulting SFC value becomes smaller. Then the large fuel consumption per hour after five parallel generators is caused by the greater the output power so that the greater the load that must be handled by the diesel engine to produce electricity. The greater the power required, the more fuel the engine needs to maintain the combustion process and produce sufficient thermal energy.

V. CONCLUSION

After 5 generator units are paralleled, the operating pattern for each generator is applied, namely priority and secondary. Where each generator will operate according to the shift and load demand that has been set in the loading pattern. From the calculation results, the lowest efficiency was obtained, namely 21.5% (G4) in July 2019 with the highest SFC value, namely 0.53 liters/kWh, while the highest efficiency value was 62.98% (G5) in July 2019 with the lowest SFC value, namely 0.15 liters/kWh.

By using 2019 data with 2018 loads, the lowest efficiency was obtained, namely 1% (G2) in August 2019 with the highest SFC value, namely 9.3 liters/hour, and the highest efficiency value, namely 82.3% (G3) in August 2019 with The smallest SFC value is 0.1 liter/kWh. From the results of comparing SFC by equalizing the load, it is obtained that the SFC value actually increases (Figure 4.14). This is because when the generators work in parallel, the power produced increases as does the fuel consumption (liters/hour), by equalizing the load and using a fixed fuel consumption (liters/hour), the SFC value (liters/kWh) actually increases accordingly . Equation 2.2 is used.

The efficiency value is influenced by the amount of output power , differences in the initial year of operation and differences in several parameters of the name plate . Meanwhile, SFC (Specific Fuel Consumption) in liters/kWh is influenced by the output power and operating time of each generator. The greater the output power with an operating time of 12 hours or less for each generator, the greater the generator efficiency will be. Increased efficiency will be followed by a decrease in the Specific Fuel Consumption value (liters/kWh). Where, the smaller the Specific Fuel Consumption value (liters/kWh), the less fuel is needed to produce the same energy

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DAFTAR TABLE

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Table 1. Electricity Production (kWh) for 2018

	G1 500 kVA	G2 500 kVA	G3 800 kVA	G4 800 kVA	G5 800 kVA
Jan	87.44	7.2	251.12	269,614	-
Feb	112,633	20.6	398.81	405,555	-
Mar	57.9	18,613	172,255	205.82	308.44
Apr	86.75	10.94	274.8	256.3	130.03
May	69,641	23.8	305.04	271.62	250,323
June	80.1	12.7	304.45	298.51	269.54
July	96.02	11.8	304.82	301.6	310.74
Aug	100,553	4.52	174.1	480.3	249.7
Sept	50,441	11.5	171.93	413,750	316.4
Oct	75,981	6,305	255.94	-	229.83

Table 2. Electricity Production (kWh) in 2019

	G1 500 kVA	G2 500 kVA	G3 800 kVA	G4 800 kVA	G5 800 kVA
July	111.7	130,31	200,705	162.3	556,211
Aug	162,843	169,914	340,811	334.3	-
Sept	147,995	170,823	183.4	395.6	430.1

Table 3. Fuel Consumption (Liters/Hour) in 2018

	G1 500 kVA	G2 500 kVA	G3 800 kVA	G4 800 kVA	G5 800 kVA
Jan	36,27	25.85	74.46	76.49	-
Feb	34.79	22.68	89.1	70.65	-
Marc	26,16	26,21	74.28	74.15	74.32
Apr	27.81	27,81	71,1	71,1	70,41
May	27,02	27,02	76,1	76,64	76,26
June	28,52	27,72	75,6	75,6	75,6
July	30,2	30,24	78,83	78,82	78,48
Aug	25,99	25,99	69,9	69,7	69,2
Sept	28.84	28.83	68.98	69.12	68.87
Oct	26.03	26.02	75.1	-	75.1

Table 4. Fuel Consumption (Liters/Hour) in 2019

	G1 500 kVA	G2 500 kVA	G3 800 kVA	G4 800 kVA	G5 800 kVA
July	36,94	31,77	84,45	86,9	82,4
Aug	44,4	42,1	81,54	87,1	-
Sept	43,5	44,4	89,12	90,42	93,7

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Table 5. Performance for 5 Genset Units for March 2018

Generator set	Energy production (kWh)	O'clock	kW	Fuel consumption (liter/hour)
G1 500 KVA	16.610	287	57,9	26,16
G2 500 KVA	6.887	370	18,613	26,21
G3 800 KVA	24.997	145	72,255	74,28
G4 800 KVA	43,01	209	205,82	74,15
G5 800 KVA	18,2	59	308,44	74,32

Table 6. 2018 Efficiency Calculation Results

	G1 500 kVA	G2 500 kVA	G3 800 kVA	G4 800 kVA	G5 800 kVA
Jan	22,5%	2,6%	31,5%	32,9%	-
Feb	30,2%	8,5%	41,8%	53,6%	-
Marc	20,65%	6,6%	21,6%	25,9%	38,7%
Apr	29,1%	3,7%	36,1%	33,63%	17,2%
May	24,05%	8,2%	37,4%	33,1%	31,03%
June	26,2%	4,3%	37,6%	36,8%	33,3%
July	29,7%	3,6%	36,1%	35,7%	36,9%
Aug	36,1%	1,6%	23,2%	64,3%	33,7%
Sept	16,3%	3,7%	23,2%	55,8%	42,9%
Okt	27,2%	2,3%	31,8%	-	28,5%

Table 7. Performance for 5 Genset Units for July 2019

Generator set	Energy production (kWh)	O'clock	kW	Fuel consumption (liters/hour)
G1 500 KVA	18.572	166,3	111,7	36,94
G2 500 KVA	22.687	174,1	30,31	31,77
G3 800 KVA	33.879	168,8	200,7	84,45
G4 800 KVA	32.149	198,1	162,3	86,9
G5 800 KVA	32.149	57,8	56,21	82,24

Table 8. 2018 Efficiency Calculation Results

	G1 500 kVA	G2 500 kVA	G3 800 kVA	G4 800 kVA	G5 800 kVA
July	28,2%	28,3%	22,2%	21,5%	62,98%
Aug	34,2%	37,65%	38,99%	35,8%	-
Sept	31,7%	35,9%	19,2%	40,8%	42,8%

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Table 9. Efficiency Calculation Results Using Load

	G1 500 kVA	**G2 500 kVA**	**G3 800 kVA**	**G4 800 kVA**	**G5 800 kVA**
July	24,25%	3,5%	33,7%	32,4%	35,2%
Aug	21,13%	1%	19,9%	51,45%	-
Sept	10,8%	2,4%	17,99%	42,7%	31,5%

Table 10. Load and Fuel Consumption for January 2018

Generator set	Electricity production (kWh)	Fuel consumption (liters/hour)
G1 500 KVA	87.44	36.27
G2 500 KVA	7.2	25.85
G3 800 KVA	251.12	74.46
G4 800 KVA	269,614	76.49
G5 800 KVA	-	-

Table 11. 2018 SFC Calculation Results

	G1 500 kVA	**G2 500 kVA**	**G3 800 kVA**	**G4 800 kVA**	**G5 800 kVA**
Jan	0,4	3,6	0,29	0,28	-
Feb	0,31	1,1	0,2	0,17	-
Marc	0,45	1,4	0,43	0,36	0,24
Apr	0,32	2,54	0,26	0,28	0,54
May	0,39	1,13	0,25	0,28	0,3
June	0,36	2,2	0,25	0,25	0,28
July	0,31	2,5	0,26	0,26	0,25
Aug	0,3	5,75	0,4	0,14	0,28
Sept	0,6	2,51	0,4	0,17	0,22
Okt	0,34	4,13	0,29	-	0,33

Table 12. Load and Fuel Consumption for July 2019

Generator set	Electricity production (kWh)	Fuel consumption (liters/hour)
G1 500 KVA	111,7	36,94
G2 500 KVA	130,310	31,77
G3 800 KVA	200,705	84,45
G4 800 KVA	162,3	86,9
G5 800 KVA	556,211	82,24

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Table 13. 2019 SFC Calculation Results

	G1 500 kVA	**G2 500 kVA**	**G3 800 kVA**	**G4 800 kVA**	**G5 800 kVA**
July	0,33	0,24	0,42	0,53	0,15
Aug	0,27	0,25	0,24	0,26	-
Sep	0,29	0,26	0,48	0,23	0,22

Table 14. SFC Calculation Results Using Load (kWh) in 2018

	G1 500 kVA	**G2 500 kVA**	**G3 800 kVA**	**G4 800 kVA**	**G5 800 kVA**
July	0,38	2,7	0,28	0,28	0,26
Aug	0,44	9,3	0,46	0,18	-
Sept	0,9	3,86	0,52	0,22	0,29

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Figure 1. Generator Capacity 500 kVA

Figure 2. Generator Capacity 800 kVA

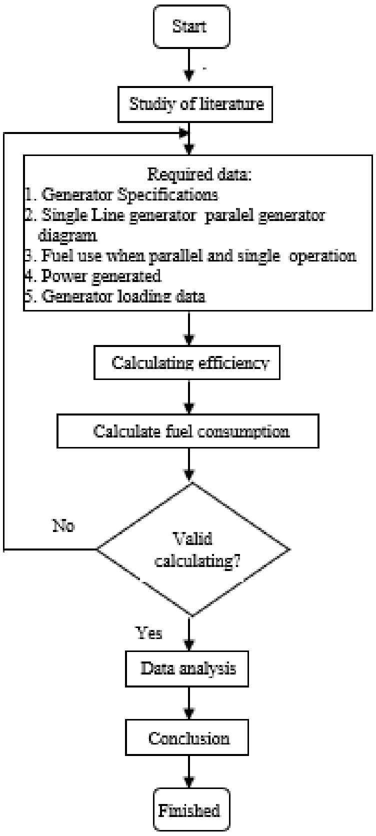

Figure 3. Research Flowchart

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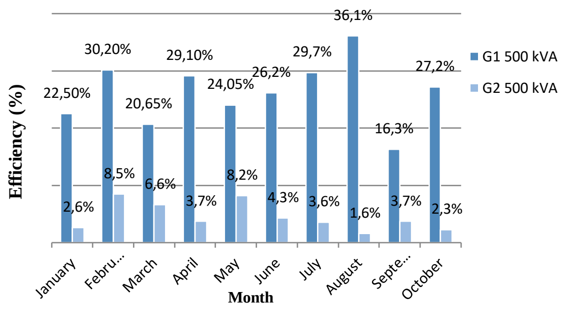

Figure 4. Efficiency Graph Of Two 500 Kva Generator Units Working In Single Operation

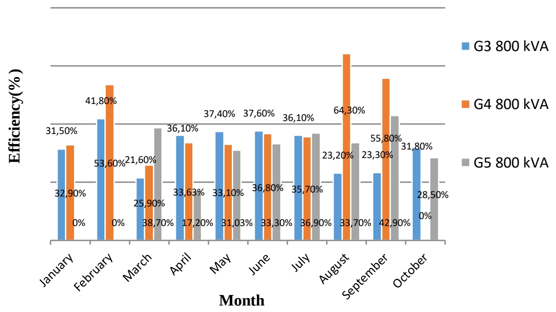

Figure 5. Efficiency Graph Of Three 800 Kva Generator Units Working In Parallel

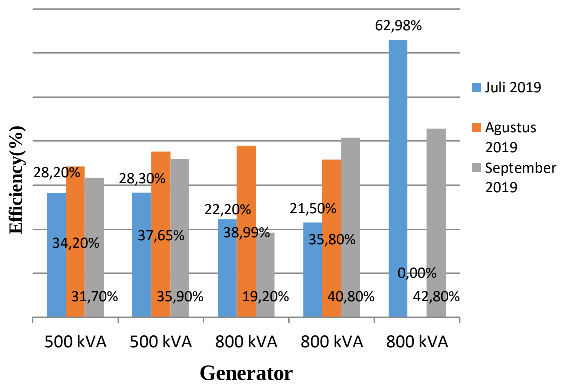

Figure 6. Efficiency Graph Of Five Generator Units Working In Parallel

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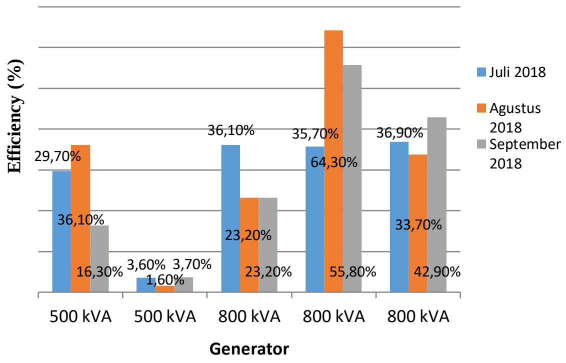

Figure 7. Efficiency Graph For 5 Single Operation Generator Units

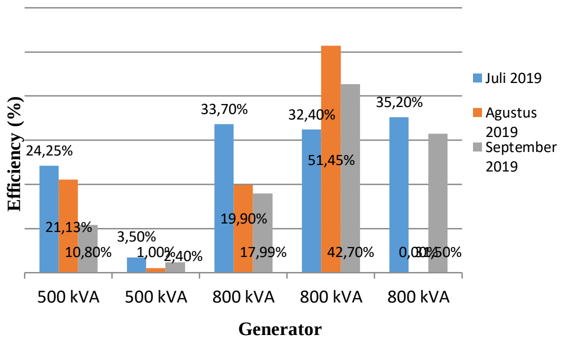

Figure 8. Graph Of Efficiency Results Using 2018 Loads

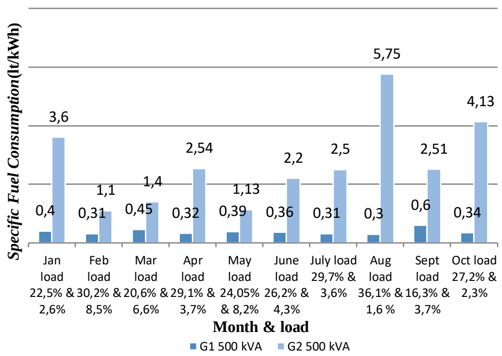

Figure 9. Specific Fuel Consumption Graph For 2 500 Kva Generator Units Working In Single Operation

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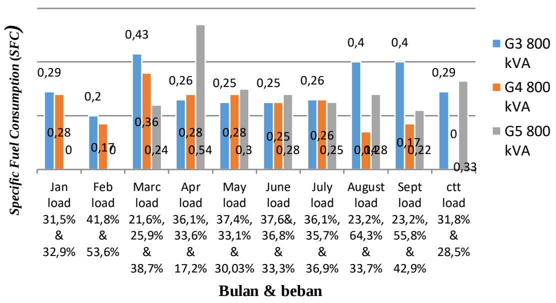

Figure 10. Specific Fuel Consumption Graph For Three 800 Kva Generator Units Working In Parallel

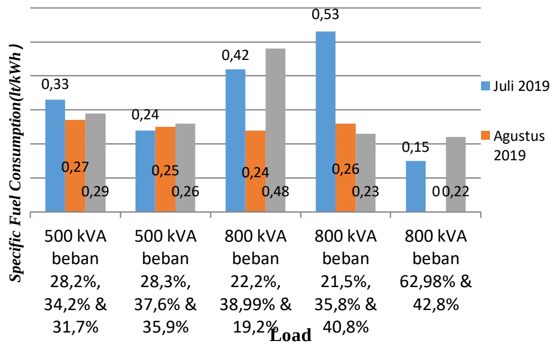

Figure 11. Specific Fuel Consumption Graph For Five Generator Units Working In Parallel

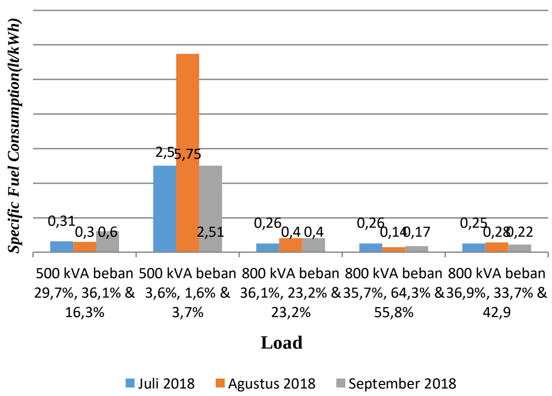

Figure 12. Specific Fuel Consumption Graph For 5 Single Operation Generator Units

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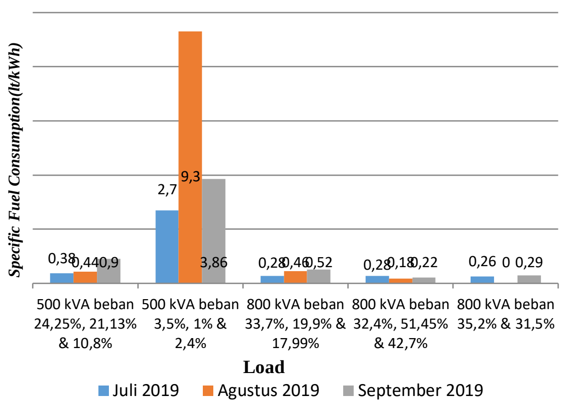

Figure 13. Graph Of Specific Fuel Consumption Results Using Load In 2018