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PERFORMANCE ANALYSIS OF STEP DOWN TYPE-TRANSFORMATOR OF FACTORIES AT THE COMPANY OF SURYA TOTO INDONESIA CIKUPA

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Abstract: *Transformer is an electrical device used to transform power or electrical energy from high voltage to low voltage or vice versa, through a magnetic coupling and based on the principle of electromagnetic induction. Transformers are widely used, both in the electric and electronic fields. The use of transformers in power systems allows the selection of appropriate and economical voltages for each purpose so that the transformer is a very important component in the distribution of electric power from distribution substations to consumers.*

Keyword: *Performance, Trafo, Step Down, Factory*

INTRODUCTION

At present Indonesia is carrying out development in all fields. Along with the growth rate of development, it is demanded that there are facilities and infrastructure that support it such as the availability of electricity. At present electricity is a major need, both for daily life and for industrial needs. This is because electricity is easy to transport and convert into other forms of power. The supply of stable and continuous electricity is an absolute requirement that must be met in meeting the electricity needs. In meeting the needs of electricity, there is a distribution of loads that were initially evenly distributed but due to the unison time of ignition of these loads then today.

Indonesia is carrying out development in all fields. Along with the growth rate of development, it is demanded that there are facilities and infrastructure that support it such as the availability of electricity. At present electricity is a major need, both for daily life and for industrial needs. This is because electricity is easy to transport and convert into other forms of power. The supply of stable and continuous electricity is an absolute requirement that must be met in meeting the electricity needs. In meeting the needs of electricity, there was a distribution of loads that were initially evenly distributed but due to the uneven timing of the ignition of these loads, it caused an imbalance of loads which impacted on the supply of electricity. This unbalanced load between each phase (phase R, phase S and phase T) is what causes the magnet to flow current in neutral transformer. fickle. As a result, the induction occurs on the primary side. The secondary side receives a magnetic force line from the primary side whose numbers change too. Then on the secondary side also arises induction, consequently between the two ends there is a difference in voltage.

Transformer Theory

A transformer is an electrical device that converts alternating current voltage from one level to another through a magnetic coupling and is based on the principles of electromagnetic induction. The transformer consists of a core, made of layered iron and two coils, namely the primary coil and the secondary coil. The use of simple and reliable transformers allows the selection of suitable and economical voltages for each purpose and is one of the important reasons that alternating current is very widely used for the generation and distribution of electric power. The working principle of the transformer is based on Ampere's law and Faraday's law, namely: an electric current can cause a magnetic field and vice versa a magnetic field can cause an electric current. If one coil on the trans formator is given an alternating current, the number of lines of force.

Distribution Transformer

Distribution transformer is a tool that plays an important role in the distribution system. Distribution transformers convert medium voltage to low voltage. The commonly used distribution transformer is a 20KV / 400V step-down transformer. The phase voltage to phase low voltage network system is 380V (Sya'roni, 2019).

Figure 1. Distribution Transformer

RESULTS AND DISCUSSION

Transformer Analysis Analysis

In determining the load on the transformer may consist of current loads and so forth. To determine the full load current (full load) you can use the following equation:

$$I_{FL} = \frac{S}{\sqrt{3}.V}$$

Where I_{FL} = Full Load Current (A), S = Power Transformer (KVA), and V = Secondary side voltage (kV). Before the current loading of the transformer needs to be known there is a formula of load imbalance on the transformer which then the formula can be derived in the formula of the current loading of the transformer. According to (Suhadi, et al, 2008).

The load imbalance of the transformer at the power of the transformer when viewed in terms of high voltage (primary) can be formulated as follows:

$S = \sqrt{3}.\ V.I$

Where S = Power Transformer (kVA), V = Transformer primary side voltage (kV), and I = Stream current (A).

Symmetric Component System

According to Fortescue an unbalanced system consisting of n phases can be broken down into balanced phasors called symmetrical components. A balanced three-phase system can be broken down into three symmetrical components, namely:

1. The positive sequence components consist of 3 phasors of equal size, separated from each other in phases by 120 ° and have the same phase sequence as the original phasors.

2. Negative sequence components consist of 3 phasors of equal size, separated from each other in a 120 ° phase and having a phase that is opposite to the original phasorphasor.
3. The zero sequence component consists of 3 equal phases and a zero phase shift.

It has become common practice, when solving problems using symmetrical components, that the three system phases are expressed as a, b, and c in such a way that the sequence of the voltage and current phases in the system is abc. Thus, the phase sequence of the positive-sequence component of the unbalanced phasor is abc, while the phase sequence of the negative-component is acb. If the original phasor is stress, then the voltage can be expressed by Va, Vb and PVC. the three sets of symmetrical components are expressed with additional sub-scripts 1 for the positive-sequence component, 2 for negative-sequence components, and 0 for zero-sequence components. The positive-sequence components of Va, Vb, and Vc are:

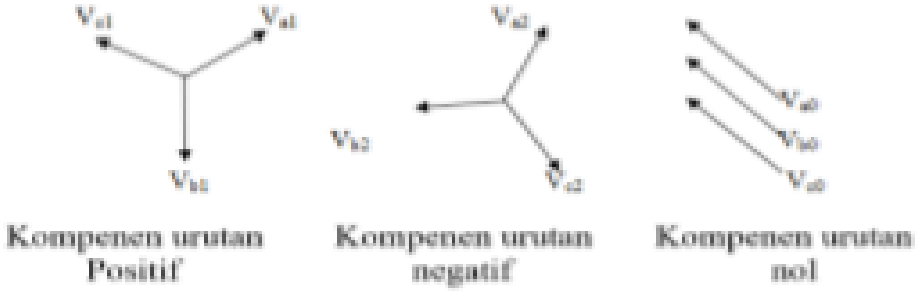

Figure 2. A balanced phasor set which is a symmetrical component of three unbalanced phasors Source: (Jalil et al., 2017)

Discussion and Analysis

According to (Saputro & Yuli, 2018) The efficiency of a transformer can be defined as the ratio between the electrical power output (output) with the electric power input (input) that enters the transformer. Each electrical equipment or machine must have efficiency, efficiency is determined by the losses incurred by the machine in normal operation.

On the transformer power capacity used at factory 1 to factory 8, the average is the same for all, where the stepdown type transformer is with a capacity of 400V-20kV. Where a full current loading analysis can be calculated on the same transformer specifications, as follows:

In the discussion of this report I will discuss about the study of the burden on the factory at PT.Surya Toto Indonesia Tbk. By analyzing, factory 5, and factory 8. Here are the data that I got from PT. Surya Toto Indonesia Tbk.

Load data of Factory 1 PT. STI

Table 1. Load on Factory 1

No/date	Checking hour	Incoming		
		AMP (*A*)	Temperature (℃)	Power (*W*)
25	00.03	347	54	224
	08.25	567	54	377
	16.45	550	58	374
26	00.03	371	54	257
	08.25	533	56	358
	16.45	595	58	400
27	00.03	388	54	251
	08.25	549	56	355

	16.45	757	58	506
	00.03	381	54	257
28	08.25	545	55	368
	16.45	642	58	432
	00.03	349	54	225
29	08.25	130	54	80
	16.45	126	54	78
	00.03	130	54	79
30	08.25	121	54	79
	16.45	132	54	80
∑Fx	Sum	7213	993	4780

From the above data presentation, the writer takes the load data from the transformer with a voltage of 240-400kv under the Trafindo transformer brand by having the data as below:

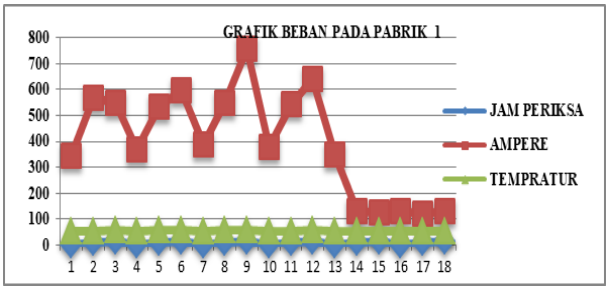

Figure 2. Graph of Load of Factory 1

From the load chart data at the factory above, the writer takes the load data from the current load or amperage, and the temprature load taken from the load data at factory 1 at the end of June 2019 starting from June 25 to June 30 2019. The first load analysis taken from mounting current load at factory 1 at PT. Surya Toto Indonesia Tbk.

Viewed from the graph above the load current and temprature lines in the graph look up and down. Retrieval of data from the last day in June is taken in accordance with the same hour, namely at 03.00 WIB, 08.25 WIB and 16:25 WIB. It can be seen that the current load fluctuates as shown in the Table 1. The value of the current load at the minimum is seen on June 30, 2019 at 08.25 WIB which is 121 Amperes. While the load current at its maximum state is seen on June 27, 2019 at 16:45 which is 757 Amperes.

The up and down current load events in this transformer are first caused by the use of a factory against the current load that occurs to produce an item and in accordance with the amount of factory use of the current load and current load at peak conditions usually occurs when at night or at night. Because at night usually use more current load than during the daytime. Then the second cause of the transformer graph up and down is caused by two factors, namely technical and non-technical factors. Judging from the technical factors, namely the use of current loads on the factory, and the non-technical factors, such as unexpected things happen from outside the factory such as theft of current loads on the factory.

At factory 1, the use of temprature load looks stable from June 25, 2019 until the end of June 30, 2019, with the number 54℃-58℃. The increase and decrease in the temperature at Plant 1 is also due to the use of transformer capacity. When excessive use of transformers, the temperature capacity of the transformer will increase and vice versa. Finally, the analysis of the load at this plant 1 The use of the total current load from this plant is a current load of 7213 Amperes and a temprature load of 993℃.

Load Data of Factory 2

From the load data at the factory 2 the authors take the transformer load data from the load current or amperage and load voltage or voltage. From the data collection we get the results of loading during the last week of June 2019. The following is an exposure to the load data listed in the Table 2 below:

Table 2. Load of Factory 2

No/Date	Checking Hour	Incoming		
		Amp	Temperature	Power
	00.03	531	53	367
25	08.25	490	53	328
	16.45	481	58	330
	00.03	540	53	361
26	08.25	501	54	335
	16.45	360	56	241
	00.03	437	53	287
27	08.25	518	54	334
	16.45	702	56	470
	00.03	338	53	221
28	08.25	540	54	350
	16.45	488	58	329
	00.03	486	53	321
29	08.25	97	52	64
	16.45	119	52	52
	00.03	75	53	48
30	08.25	58	52	37
	16.45	63	52	40
∑FX	Total	6824	969	4515

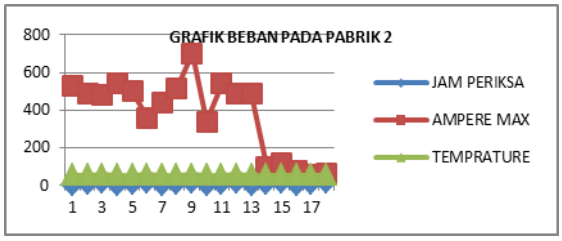

Figure 3. Graph of Load of Factory 1

Viewed from the graph above the load current and temprature lines in the graph look up and down. Retrieval of data from the last day in June is taken in accordance with the same hour, namely at 02.00, 03.00 WIB, 08.25 WIB and 16.03, 16.15 and 16.45 WIB. It can be seen that the current load fluctuates in the Table 2. The value of the current load at the minimum is seen on June 30, 2019 at 00:45 a.m. that is equal to 58 Amperes. Whereas the load current at the maximum state is seen on June 27, 2019 at 16:15 which is 702 Amperes.

The up and down current load events in this transformer are first caused by the use of a factory against the current load that occurs to produce an item and in accordance with the amount of factory use of the current load and current load at peak conditions usually occurs when at night or at night. Because at night usually use more current load than during the daytime. Then the second cause of the transformer graph up and down is caused by two factors, namely technical and non-technical factors. Judging from the technical factors,

namely the use of the current load on the factory, and the non-technical factors, such as unexpected things happen from outside the factory such as theft of current loads on the factory.

In this second plant, the use of temprature load seems to be stable from June 25, 2019 until the end of June 30, 2019, which is 50℃ and above. The increase and decrease in the temperature in plant 2 is also due to the use of transformer capacity. When excessive use of transformers, the temperature capacity of the transformer will increase and vice versa. But the temperature temprature in factory room 2 remains stable at 50℃ or higher. At factory 2, the use of the temprature load looks stable from June 25, 2019 until the end of June 30, 2019, with 50℃ and above. The increase and decrease in the temperature in plant 2 is also due to the use of transformer capacity. When excessive use of transformers, the temperature capacity of the transformer will increase and vice versa. But the temperature temprature in plant 2 remains stable at a rate of 50atasC and above, with a minimum temperature of 52℃ and a maximum temperature of 58 analisisC. with a minimum temperature of 52 ° C and a maximum temperature of 58 ° C. Finally, analysis of the load on this plant 2 The use of the total current load from this factory 1 is the current load of 6824 Amperes and the temprature load of 969 ° C.

Load Data of Factory 3

Table 3. Load Data of Factory 3

No/Date	Checking Hour	Incoming		
		Volt	Amp Max	Power
	00.03	399	329	255
25	08.25	403	231	159
	16.45	405	154	88
	00.03	400	162	100
26	08.25	398	175	118
	16.45	398	160	96
	00.03	397	119	78
27	08.25	391	460	307
	16.45	397	839	372
	00.03	398	455	310
28	08.25	393	612	444
	16.45	400	774	532
	00.03	396	346	232
29	08.25	391	660	447
	16.45	401	653	450
	00.03	397	180	114
30	08.25	396	224	150
	16.45	377	123	81
∑FX	TOTAL	7137	6656	4333

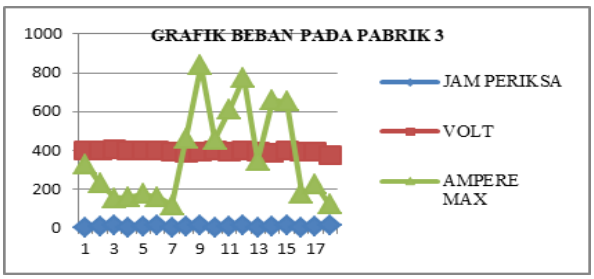

Figure 4. Load Chart at Factory 3

From the load chart data at the factory above the authors take the load data from the load current or amperage, as well as the load voltage or voltage taken from the load data at factory 3 at the end of June 2019 starting from June 25 to June 30 2019. Analysis the first load is taken from the mounting current load at factory 3 at PT. Surya Toto Indonesia Tbk. Viewed from the graph above the line load current and the load voltage on the graph looks up and down. Retrieval of data from the last day in June is taken in accordance with the same hour, namely at 00.00 WIB, 08.02 WIB, 08.03 WIB, 08.04 WIB, 08.05 WIB and 16.05 WIB, 16.15 WIB. It can be seen that the current load fluctuates in the Table 3. The value of the current load at the minimum is seen on June 30, 2019 at 16:15 WIB which is 123 Amperes. While the load current at the maximum state is seen on June 27, 2019 at 16:00 hours, that is equal to 839 Ampere.

The up and down current load events in this transformer are first caused by the use of a factory against the current load that occurs to produce an item and in accordance with the amount of factory use of the current load and current load at peak conditions usually occurs when at night or at night. Because at night usually use more current load than during the daytime. Then the second cause of the transformer graph up and down is caused by two factors, namely technical and non-technical factors. Judging from the technical factors, namely how to use the current load on the factory, and the non-technical factors, such as unexpected things that happen from outside the factory such as theft of current loads on the factory.

At factory 3, the use of voltage load seems to fluctuate from June 25, 2019 to the end of June 30, 2019, which is 300-410V. The increase and decrease in voltage at factory 3 is also due to the use of transformer capacity. When excessive use of the transformer, the voltage capacity of the transformer will increase and vice versa. Finally, the analysis of the load at this factory 3 The total current load from factory 1 is the current load of 6656 Amperes and a voltage load of 7137 Volts.

Load Data of Factory 5

Table 4. Load Data of Factory 5

No/Date	Checking Hour	Incoming		
		Voltage (V)	Amp Max (V)	Power (kW)
25	00.03	399	434	102
	08.25	403	281	109
	16.45	403	171	115
26	00.03	399	281	52
	08.25	397	103	37
	16.45	400	70	21
27	00.03	396	71	38
	08.25	391	571	280
	16.45	401	462	275
28	00.03	398	433	124
	08.25	394	564	310
	16.45	402	435	270
29	00.03	395	459	107
	08.25	391	512	311
	16.45	404	332	224
30	00.03	396	385	120
	08.25	396	71	74

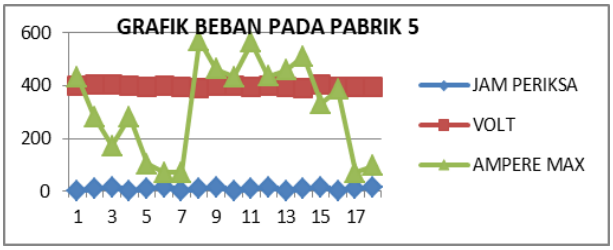

Figure 6. Graph of Load at Factory 5

Viewed from the graph above the line load current and the load voltage on the graph looks up and down. Retrieval of data from the last day in June is taken in accordance with the same hour, namely at 00.00 WIB, 08.02 WIB, 08.03 WIB, 08.04 WIB, 08.05 WIB and 16.05 WIB, 16.15 WIB. It can be seen that the current load fluctuates as shown in the Table 4. The value of the current load at the minimum is seen on June 26, 2019 at 16.00 WIB, which is 70 Amperes. While the load current at the maximum state is seen on June 27, 2019 at 08.03 hours which is equal to 571 Amperes.

The up and down current load events in this transformer are first caused by the use of a factory against the current load that occurs to produce an item and in accordance with the amount of factory use of the current load and current load at peak conditions usually occurs when at night or at night. Because at night usually use more current load than during the daytime. Then the second cause of the transformer graph up and down is caused by two factors, namely technical and non-technical factors. Judging from the technical factors, namely the use of the current load on the factory, and the non-technical factors, such as unexpected things happen from outside the factory such as theft of current loads on the factory.

At this factory 5 the use of voltage load seems to fluctuate from June 25, 2019 to the end of June 30, 2019 with the numbers 300-410V. The increase and decrease in voltage at plant 5 is also due to the use of transformer capacity. When excessive use of the transformer, the voltage capacity of the transformer will increase and vice versa. Lastly, the analysis of the load at this plant 5 The total current load from this plant 5 is the current load of 5732 Amperes and the voltage load of 7162V.

Factory Load Data 6

Table 5. Load Data of Factory 6

No/Date	Checking Hour	INCOMING		
		Ampere (A)	Temperature (℃)	Power (W)
25	00.03	427	50	291
	08.25	172	52	118
	16.45	95	57	52
26	00.03	190	50	120
	08.25	145	52	92
	16.45	150	57	99
27	00.03	188	50	128
	08.25	595	52	390
	16.45	358	56	239

28	00.03	430	50	291
	08.25	595	52	450
	16.45	478	56	329
29	00.03	440	50	286
	08.25	506	50	333
	16.45	359	50	146
30	00.03	364	50	247
	08.25	91	50	49
	16.45	70	50	39
∑FX	TOTAL	5653	934	

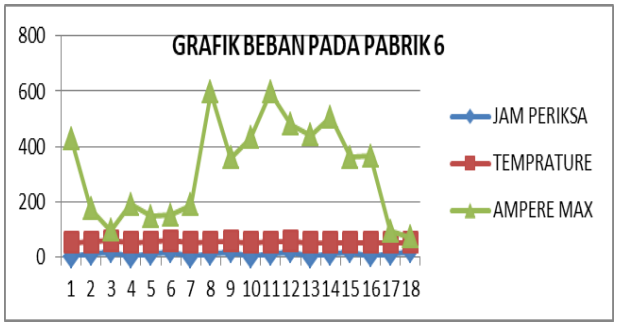

Figure 7. Load Graph of Factory 6

Viewed from the graph above the load current and temprature lines in the graph look up and down. Retrieval of data from the last 7 days in June is taken in accordance with the same hour, namely at 00.00 WIB, 08.02 WIB, 08.03 WIB, 08.04 WIB, 08.05 WIB and 16.05 WIB, 16.15 WIB. It can be seen that the current load fluctuates as shown in the Table 5. The value of the current load at the minimum is seen on June 30, 2019 at 08.02 WIB which is 91 Amperes. While the load current at the maximum state is seen on 27 and 28 June 2019 at 08.03 and 08.04 which is 595 Amperes.

The up and down current load events in this transformer are first caused by the use of a factory against the current load that occurs to produce an item and in accordance with the amount of factory use of the current load and current load at peak conditions usually occurs when at night or at night. Because at night usually use more current load than during the daytime. Then the second cause of the transformer graph up and down is caused by two factors, namely technical and non-technical factors. Judging from the technical factors, namely the use of the current load on the factory, and the non-technical factors, such as unexpected things happen from outside the factory such as theft of current loads on the factory.

At factory 6, the use of temprature load seems to be stable from June 25, 2019 until the end of June 30, 2019 with the number 540℃-587℃. The increase and decrease in the temperature at plant 6 is also due to the use of transformer capacity. When excessive use of transformers, the temperature capacity of the transformer will increase and vice versa. The last analysis of the load at this plant 6 The total current load from this plant 6 is the current load of 5653 Amperes and the temprature load of 934℃.

Load Data of Factory 7

Table 5. Load Data of Factory 7

No/Date	Checking Hour	INCOMING	
		AMP MAX(*A*)	TEMPRATUR(℃)
	00.03	265	50
25	08.25	463	52
	16.45	266	54
	00.03	260	50
26	08.25	127	52
	16.45	80	54
	00.03	122	50
27	08.25	782	52
	16.45	528	55
	00.03	267	50
28	08.25	790	52
	16.45	640	54
	00.03	266	50
29	08.25	765	52
	16.45	440	50
	00.03	253	50
30	08.25	189	50
	16.45	57	50
∑FX	TOTAL	6560	927

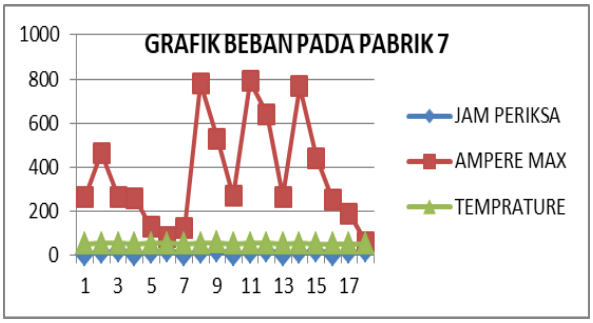

Table 6. Load Charts at Factory 7

From the load chart data at the factory above, the writer takes the load data from the current or amperage load, and the temprature load which is taken from the load data at factory 7 at the end of June 2019 starting from June 25 to June 30, 2019.

The second load analysis is taken from increasing the current load at plant 7 at PT. Surya Toto Indonesia Tbk. Viewed from the graph above the load current and temprature lines in the graph look up and down. Retrieval of data from the last day in June is taken in accordance with the same hour, namely at 00.00, 01.00 WIB, 08.02 WIB, 08.04 WIB, 08.05 WIB, and 16.00 WIB, 16.03 WIB, and 16.15 WIB. It can be seen that the current load fluctuates as shown in the Table 5. The value of the current load at the minimum is seen on June 30, 2019 at 16:15 WIB which is 57 Amperes. While the load current at the maximum state is seen on June 28, 2019 at 08.04 hours which is equal to 790 Amperes.

The up and down current load events in this transformer are first caused by the use of a factory against the current load that occurs to produce an item and in accordance with the amount of factory use of the current load and current load at peak conditions usually occurs

when at night or at night. Because at night usually use more current load than during the daytime. Then the second cause of the transformer graph up and down is caused by two factors, namely technical and non-technical factors. Judging from the technical factors, namely the use of the current load on the factory, and the non-technical factors, such as unexpected things happen from outside the factory such as theft of current loads on the factory.

At factory 7, the use of temprature load looks stable from June 25, 2019 until the end of June 30, 2019, with a number of 50° C-52° C and above. The increase and decrease in the temperature at factory 7 is also due to the use of transformer capacity. When excessive use of transformers, the temperature capacity of the transformer will increase and vice versa. But the temperature temprature in factory 7 remains stable at 50° C-52°C, with a minimum temperature of 520°C and a maximum temperature of 52° C. Lastly, the analysis of the load on this factory 7 The total current load from factory 7 is the current load of 6560 Amperes and the temprature load of 927° C.

7. Factory Load Data 8

Table 7. Factory Load Data 8

No/Date	Checking Hour	Incoming	
		VOLT(*V*)	AMP MAX(*A*)
25	00.03	398	282
	08.25	402	320
	16.45	403	221
26	00.03	399	235
	08.25	400	105
	16.45	398	129
27	00.03	399	120
	08.25	391	425
	16.45	402	290
28	00.03	397	477
	08.25	393	340
	16.45	399	327
29	00.03	394	521
	08.25	391	435
	16.45	400	209
30	00.03	395	349
	08.25	398	135
	16.45	400	60
∑FX	TOTAL	7159	4980

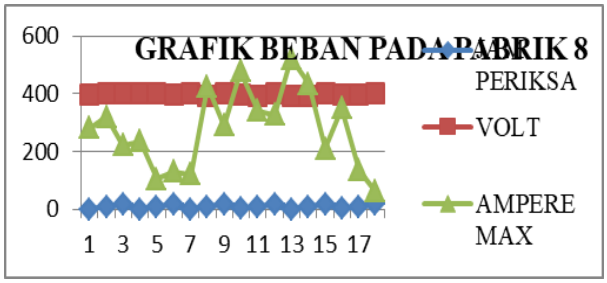

Figure 8. Graphic Load at Factory 8

From the load chart data at the factory above, the writer takes the load data from the load current or amperage, as well as the voltage load taken from the load data at the factory 8 on the end of June 2019 starting from June 25 to June 30 2019. The first load analysis taken from mounting current load at factory 8 at PT. Surya Toto Indonesia Tbk. Viewed from the graph above the load current and voltage lines on the graph look up and down. Retrieval of data from the last day in June is taken in accordance with the same hour, namely at 00.00 WIB, 03.00 WIB, 08.02 WIB, 08.03 WIB, 08.04 WIB, 08.15 WIB and 16.05 WIB, 16.15 WIB. It can be seen that the current load fluctuates as shown in the Table 7. The value of the current load at the minimum is seen on June 30, 2019 at 16:15 WIB which is 60 Amperes. Whereas the load current at the maximum state is seen on June 28, 2019 at 03.00 WIB which is 477 Amperes.

The up and down current load events in this transformer are first caused by the use of a factory against the current load that occurs to produce an item and in accordance with the amount of factory use of the current load and current load at peak conditions usually occurs when at night or at night. Because at night usually use more current load than during the daytime. Then the second cause of the transformer graph up and down is caused by two factors, namely technical and non-technical factors. Judging from the technical factors, namely the use of the current load on the factory, and the non-technical factors, such as unexpected things happen from outside the factory such as theft of current loads on the factory.

At factory 7, the use of voltage load seems to be stable from June 25, 2019 until the end of June 30, 2019, which is 300 V - 405 V. The increase and decrease in voltage at factory 7 is also due to the use of transformer capacity. When excessive use of the transformer, the voltage capacity of the transformer will increase and vice versa. Finally, the analysis of the load on this factory 7 The total current load from factory 1 is the current load of 7159 Amperes and a voltage load of 4980V.

CONCLUSION

The conclusions obtained from the Industry Practice Report this time are as follows: 1) Performance comparison of data load from factory 1 to 8 can be concluded with the results of the maximum current load occurs at factory factory 1 with a load of 7213 Amperes, the maximum temperature load at factory 1 with the number 993℃ and the maximum voltage load with the number 7162 Volts at the factory 5. While The minimum current load occurs at factory 5 with a number of 5732 Amperes, the minimum voltage load with the number 7137 Volts at factory 3 and the minimum temperature load at factory 7 with a temperature load of 927℃, 2) The occurrence of the current load up and down on this transformer is first caused by the use of a factory against the current load that occurs to produce an item, and according to the amount of factory use of the load current. And the load current at peak conditions, usually occurs when at night, or before night. The greater or higher the current value at the load, the greater the reactive power generated at the transformer in both the transformer brand and other brands, and vice versa.

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