International Journal of Current Science Research and Review
ISSN: 2581-8341
Volume 07 Issue 11 November 2024
DOI: 10.47191/ijcsrr/V7-i11-38, Impact Factor: 7.943
IJCSRR @ 2024
www.ijcsrr.org

Energize Transformer 400kVA at State Polytechnic of Samarinda with Simulation

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ABSTRACT: The purpose of this study is to analyze the performance and effectiveness of the Energize 400kVA Transformer model which acts as a step-up transformer in the electric power distribution system. The focus of this study is to evaluate the efficiency of the transformer in increasing the voltage from medium to higher levels and the impact of this conversion on power stability, energy losses, and thermal resistance.Testing was carried out by operating the transformer at various load levels and measuring performance parameters such as copper and iron losses, voltage regulation, and cooling capacity. The results showed that the Energize Transformer 400kVA can operate optimally as a step-up transformer with high efficiency in the load range of 70-90% of full capacity and good voltage stability when the load changes. The transformer cooling system also proved effective in maintaining the operating temperature within safe limits, thus contributing to a longer service life and shorter maintenance intervals. Based on these results, the Energize Transformer 400 kVA model is suitable for use as a step-up transformer in medium to large distribution networks, supporting optimal power quality and high operational efficiency.

KEYWORDS: Current, Energize, Distribution, Transformer, Voltage.

1. INTRODUCTION

Distribution transformers are vital components in the electrical network that convert medium voltage from the main utility medium voltage lines to a voltage suitable for use by end consumers. The energizing process, which is connecting the distribution transformer to the power source, is a critical stage in the implementation and operation of the electrical network. Failure in this process can cause power supply disruptions, damage to equipment, and even serious fire risks[1].

At the Electrical Engineering Workshop of the State Polytechnic of Samarinda, distribution transformer 1 is an important part of operational activities related to education, research, and development of electrical infrastructure. However, in this context, it should be noted that the safety, operational efficiency, and maintenance aspects of distribution transformer 1 are the main focus[2].

Although the energizing procedure has been carried out, further research is needed to ensure that this process can be improved in terms of efficiency, safety, and operational reliability. In addition, with the continuous growth in the demand for electric power and technological developments in the electricity industry, there is a need to explore new innovations in energizing distribution transformers to meet future demands[3].

Therefore, this study aims to investigate and analyze the energizing process of distribution transformer 1 at the Electrical Engineering Workshop of the State Polytechnic of Samarinda. The main objective is to improve the understanding of the factors that affect the efficiency, safety, and reliability of energize, and to identify potential improvements or innovations that can be applied in the process. Thus, this research is expected to provide a positive contribution to the practice of energizing distribution transformers not only in the Electrical Engineering Workshop environment of Samarinda State Polytechnic, but can also be adapted and applied on a wider scale in the context of national electricity infrastructure[4]-[6].

2. METHODS

The conceptual framework of the research is a framework or flow of thought for researchers related to the scope, material limitations, and results to be achieved in the research stages as shown in Figure 1.

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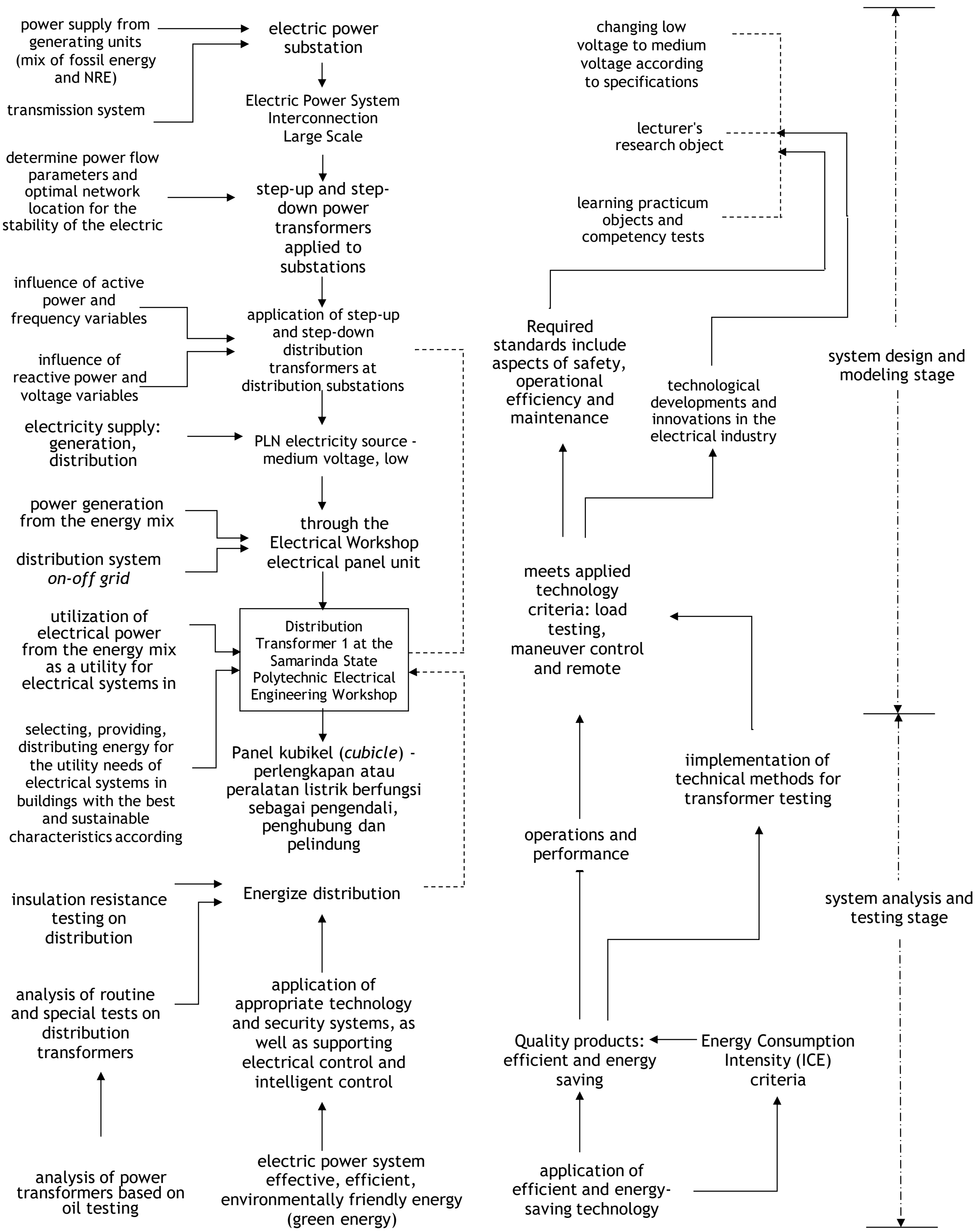

Figure 1. Research Concept Framework

Figure 3.1 shows that there is the use of electric power from the energy mix as an electrical system utility in medium-scale buildings that require electrical system utilities according to the required standards, so that technology is needed using a new approach in providing solutions to the problem of energizing distribution transformers in the form of distribution transformer operations based on

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the results of insulation resistance and grounding resistance tests on distribution transformers, as well as routine and special test analysis on distribution transformers.

Energizing distribution transformers in the form of distribution transformer operations based on the results of insulation resistance tests on distribution transformers, as well as routine and special test analysis on distribution transformers, one of which can be applied to distribution transformer 1 at the Samarinda State Polytechnic Electrical Engineering Workshop. The energizing of distribution transformers in the form of distribution transformer operations through active power and frequency control methods, and implementation of technical methods for testing transformers. In addition, also through the application of appropriate technology and security systems, as well as supporting electrical control and intelligent control automation in order to achieve an effective, efficient, environmentally friendly energy (green energy) electric power system.

The basic principles of technical methods for testing transformers in the operation of electric power distribution transformers are applied to medium-scale electric power systems. The design and system modeling stages meet the criteria of applied technology, such as load testing, maneuver control, and remote control. While the system analysis and testing stages are through insulation resistance testing on distribution transformers, routine and special test analysis on distribution transformers, and power transformer analysis based on transformer oil testing.

Based on the research concept framework as shown in Figure 3.1, where the research process consists of the system design and modeling stage, and the system analysis and testing stage, the targets to be achieved in the applied research process stages carried out at the Electrical Engineering Workshop of the Samarinda State Polytechnic are as follows:

1. System design and modeling stage, which is the stage to obtain a system model for a step-up distribution transformer that functions as a step-up distribution transformer based on applied technology criteria, such as load testing, maneuver control, and remote control
2. System analysis and testing stage, which is the stage to obtain a step-up distribution transformer energize model based on insulation resistance testing criteria, routine and special testing, and transformer oil testing.

3. RESULT

3.1 PERFORMANCE RESULTS OF ENERGIZE STEP-DOWN DISTRIBUTION TRANSFORMER TO STEP-UP

The energized model of the step-up distribution transformer located in the Electrical Engineering Workshop of the State Polytechnic of Samarinda was selected based on the results of analysis and testing which included specification testing, insulation resistance testing, and transformer oil testing.

As previously described, the distribution transformer model-1 functions as a step-up distribution transformer with specifications of 25 kVA 3 Phase 50 Hz 400 V / 20 kV. While the distribution transformer model-2 with specifications of 400 kVA 3 Phase 50 Hz 20 kV / 400 V with several technical considerations only functions as a means of testing.

The energized model of the step-up distribution transformer with specifications of a power capacity of 400 kVA 3 Phase 50 Hz 400 V / 20 kV located in the Electrical Engineering Workshop of the State Polytechnic of Samarinda has been successfully energized and operated with the procedures and mechanisms as required as shown in Figure 2 to figure 4.

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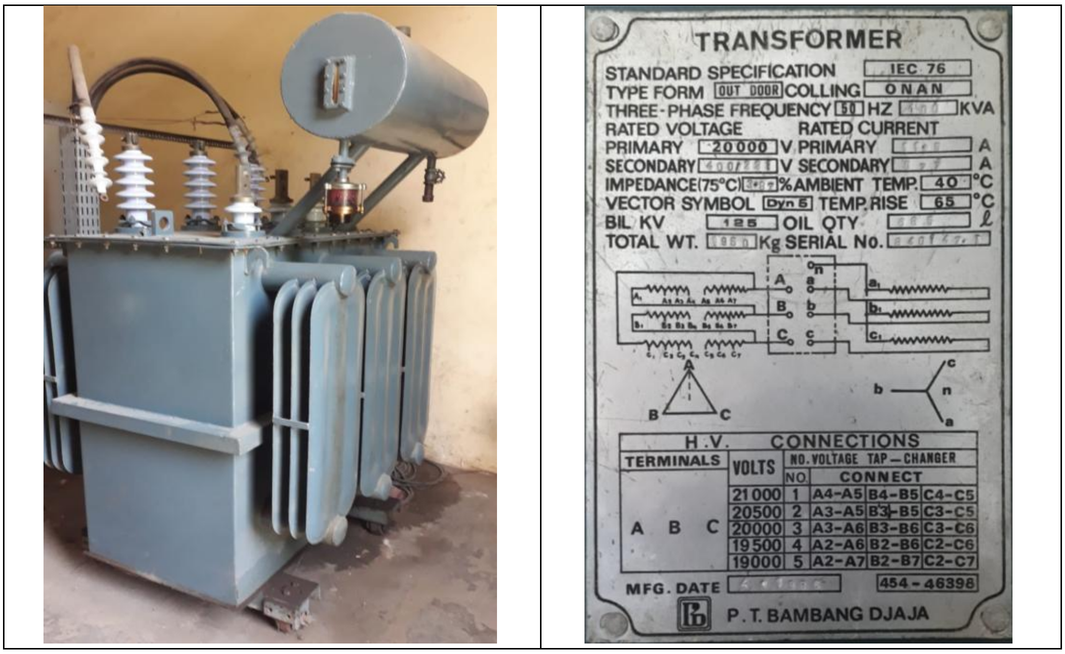

Figure 2. Transformer 400 kVA

Figure 3. Model cubicle 20 kV

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Figure 4. work process energize transformator 400 kVA

To help the analysis, a simulation is also carried out that resembles the energize model, in the display below. This simulation provides a source of inter-phase voltage of 380 volts, then goes to a transformer with a capacity of 25 kVA. In the model after the transformer output goes to the cubicle, but in the simulation the cubicle becomes only a circuit breaker and separator. The results of the simulation show the same output voltage, therefore this simulation uses an ideal transformer so that there is no loss from the transformer and no current flows as shown in figure 5 and figure 6.

LOAD FLOW REPORT

	Bus		Voltage		Generation		Load		Load Flow					XFMR
	ID	kV	% Mag.	Ang.	MW	Mvar	MW	Mvar	ID	MW	Mvar	Amp	%PF	%Tap
	Bus1	20.000	99.968	0.0	0	0	0	0	Bus3	-0.003	-0.002	0.1	83.4	
									Bus7	0.003	0.002	0.1	83.4	
*	Bus3	0.400	95.000	0.0	0.003	0.002	0	0	Bus1	0.003	0.002	5.3	83.4	
	Bus7	20.000	99.968	0.0	0	0	0.003	0.002	Bus1	-0.003	-0.002	0.1	83.4	

* Indicates a voltage regulated bus (voltage controlled or swing type machine connected to it)

# Indicates a bus with a load mismatch of more than 0.1 MVA

Figure 5. Load flow report for simulation

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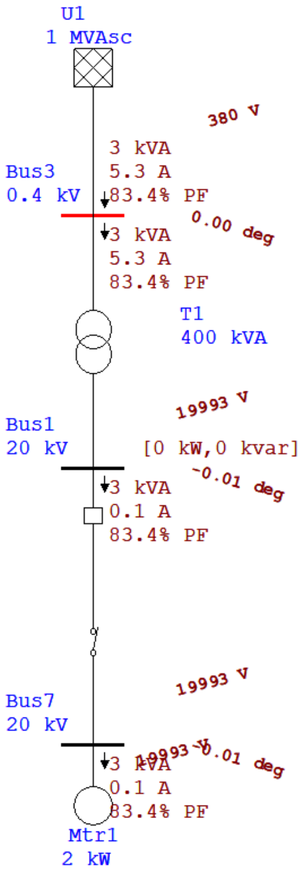

Figure 6 Simulation circuit

3.2 PERFORMANCE ANALYSIS OF ENERGIZE DISTRIBUTION TRANSFORMER FROM STEP-DOWN TO STEP-UP

Furthermore, related to the optimal system performance on the step-up distribution transformer energize model as previously described, namely conducting analysis and discussion related to performance that shows the level of performance of the step-up distribution transformer equipment system at the Samarinda State Polytechnic Electrical Engineering Workshop which has been energized through energy supply from the PLN Low Voltage Distribution Network as a low voltage (LV) input to the primary side of the distribution transformer, while the secondary side as a medium voltage (MV) output to the cubicle panel equipment, where the magnitude of the variables indicated in the equipment system meets the required standards including power capacity, no-load and loaded power, voltage, current, frequency, resistance, reactance, primary - secondary coil relationship with certain limits using the Qualitative - Descriptive Analysis method, and Quantitative - Descriptive Analysis. Distribution transformers must be measured periodically to determine their performance. The efficiency of transformer usage is when the transformer has a load of 60% - 80%. Distribution transformers that experience loads exceeding 80% of the transformer capacity can affect the life of the distribution transformer, the level and quality of service to consumers, and have the potential for disruption.

The performance characteristics of distribution transformers can indicate several things, including transformer load, voltage drop percentage, and load imbalance factor percentage. The following are some things to consider regarding distribution transformer performance, namely:

- Full load or transformer loading does not exceed 80%
- Voltage drop percentage does not exceed 10%
- Load imbalance factor percentage does not exceed 20%.

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System performance is measured and displayed according to the same variable magnitude including phase sequence polarity, voltage, and frequency controlled through power system control and the use of Smart Grid technology in meeting small signal stability (steady state stability) optimally which is a function of operating conditions to increase or decrease frequency and voltage with certain limits, namely by using the Linear Model approach and the Statistical Analysis method - Descriptive, Qualitative Analysis - Descriptive, and Descriptive Quantitative Analysis which are processed based on reference data.

Power System Performance Analysis in this distribution transformer energize model changes the initial condition of a transformer with a capacity of 25 kVA. The initial condition of the transformer is installed as a step-down position. This condition changes the voltage from 20 kV to 220/380 V. So that a 220/380 V source is given from the secondary side (which makes this the primary side) and comes out to 20 kV. However, there are losses along the transformer even though it is operated without load. The following are the measurement results from the simulation which show that the transformer whose initial condition is step-down can be changed to step-up with results according to estimates.

Bus Loading Summary Report

Bus			Directly Connected Load								Total Bus Load			
			Constant kVA		Constant Z		Constant I		Generic					Percent
ID	kV	Rated Amp	MW	Mvar	MW	Mvar	MW	Mvar	MW	Mvar	MVA	% PF	Amp	Loading
Bus1	20.000		0	0	0	0	0	0	0	0	0.003	83.4	0.1	
Bus3	0.400		0	0	0	0	0	0	0	0	0.003	83.4	5.3	
Bus7	20.000		0.003	0.002	0	0	0	0	0	0	0.003	83.4	0.1	

* Indicates operating load of a bus exceeds the bus critical limit (100.0% of the Continuous Ampere rating).
# Indicates operating load of a bus exceeds the bus marginal limit (95.0% of the Continuous Ampere rating).

Figure 7. power measured at the branch point

Seen in the figure 7, the voltage on bus 1 is the output voltage of the transformer. Bus 3 is the transformer input, the value next to the bus identity is the voltage value measured from the simulation. The value on bus 1 is 20 kV, this value is in accordance with the initial estimate that the step-down transformer can be made step-up. Then for bus 3 the voltage value is 0.400 kV or equivalent to 400 volts. The image also shows the right end for a load of 0 watts or no load. Furthermore, related to losses in the energize model through simulation, as follows.

Branch Losses Summary Report

CKT / Branch	From-To Bus Flow		To-From Bus Flow		Losses		% Bus Voltage		Vd	
ID	MW	Mvar	MW	Mvar	kW	kvar	From	To	% Drop in Vmag	
T1		-0.003		-0.002		0.003		0.002		0.0
					0.0		0.0			

Figure 8. Measurable loss at the branch point

The figure 8 shows no loss in the simulation because the simulation assumes the transformer used is very ideal and there is no gap for loss. This is different from what is measured that there is a current on the primary side or input of the transformer. This current

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has been discussed previously as a closed circuit from the primary side of the transformer and becomes a loss of power for induction. Furthermore, the transformer performance parameters in figure 9.

2-Winding Transformer Input Data

Transformer		Rating					Z Variation			% Tap Setting		Adjusted Phase Shift		
ID	Phase	MVA	Prim. kV	Sec. kV	% Z1	X1/R1	+ 5%	- 5%	% Tol.	Prim.	Sec.	% Z	Type	Angle
T1	3-Phase	0.400	0.380	20.000	4.00	1.50	0	0	0	0	0	4.0000	YNd	0.000

Figure 9. Input data on transformer

The performance of the transformer in the simulation performed is seen to show the voltage according to that given. On the primary side, a 3-phase source is given with a voltage of 380 volts. This voltage value is indeed different from the voltage value on the input bus. On bus 1 or the input bus, the voltage value is 400 volts, it should be noted that this value is rounded from 380 volts. The simulation display setting shows a rounded value so that it shows 400 volts. Then for the transformer power, it is also seen as 0.400 MVA or 400 kVA

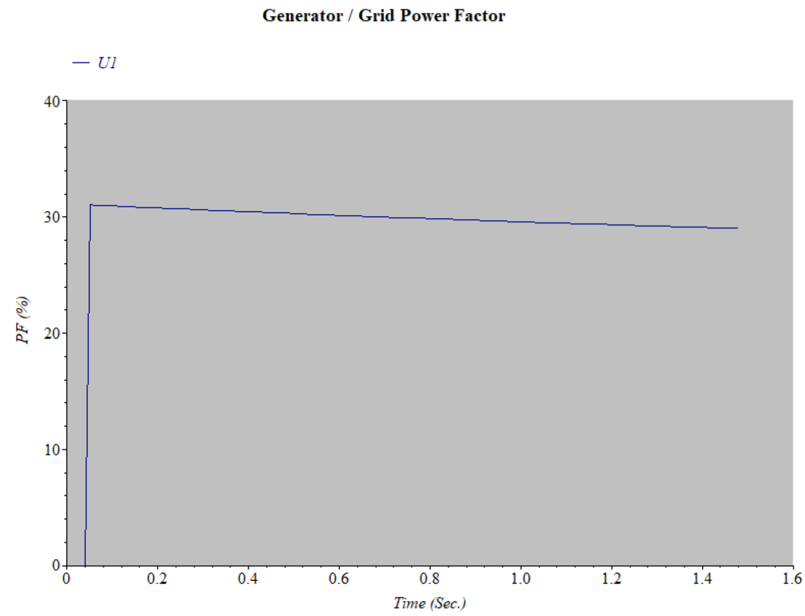

Figure 10. Curve power factor incoming transformer

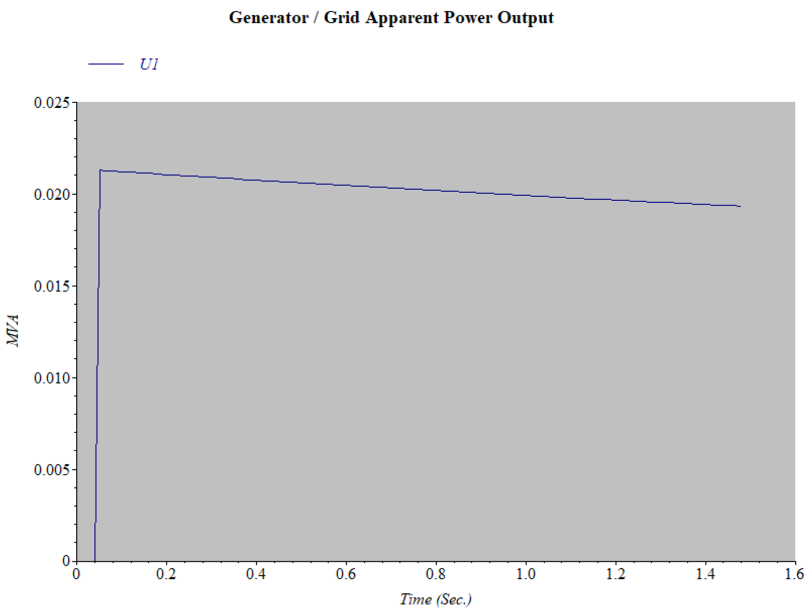

Figure 11. Curve Apparent Power incoming transformer

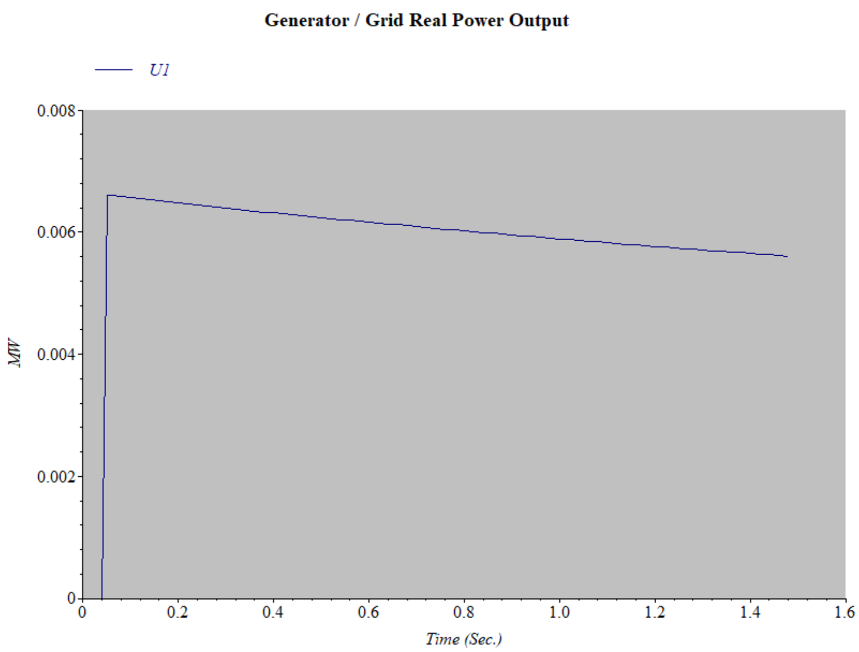

Figure 12. Curve real power incoming transformer

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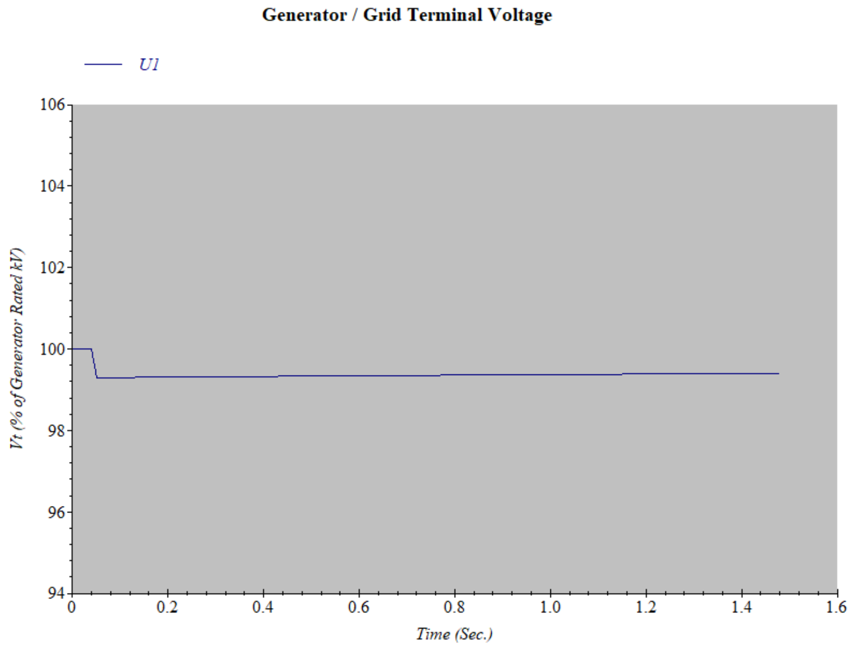

Figure 13. Curve voltage incoming transformer

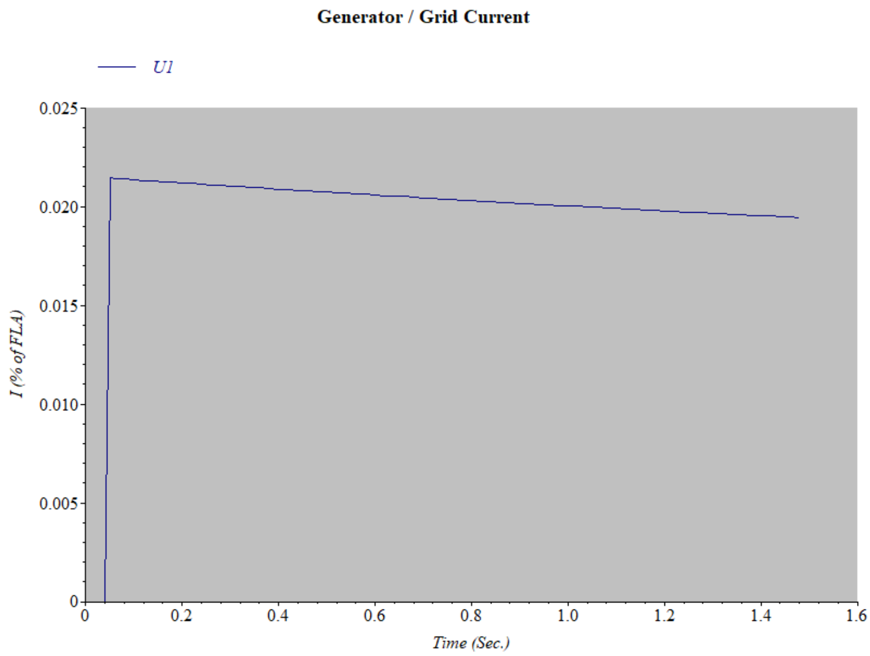

Figure 14. Curve current incoming transformer

Figure 10 to Figure 14 shows some of the first parameter results related to the measured nominal power factor showing a value of 30 or in PF units of 0.3. In the apparent power, it can be seen that the power recorded on the input side is 0.02 MVA or 2 kVA. The active power recorded through the curve above shows a value of 0.006 MW or 0.6 kW. The voltage recorded on the input side is 99 pu or 390 volts with an initial setting of 400 volts. Furthermore, on the input current side, a value of 0.02 pu or 5.3 A appears. Based on the results of the curve above, it shows the input results from the source as the input side of the transformer. The results shown show the performance results that successfully energized the 400 kVA transformer successfully.

4. CONCLUSION

This study concludes that the Energize Transformer 400kVA model can function effectively as a step-up transformer in a power distribution system. Based on the test results, this transformer shows optimal performance in the load range of 70-90% of its rated capacity and shows high efficiency in stepping up the voltage from medium to high levels. Copper and iron power losses are within acceptable limits, indicating that the core design and conductor materials support the overall efficiency of the transformer. In addition, this transformer has excellent voltage stability and can maintain power quality even when there is a load fluctuation. This is important for a reliable power supply. The cooling system used has proven to be effective in maintaining thermal stability, keeping the operating temperature within safe limits even at high loads, extending the service life and reducing maintenance contributions. Overall, the Energize Transformer 400kVA is considered suitable for use as a step-up transformer in medium to large distribution networks. High efficiency, voltage stability, and good thermal resistance make this model a reliable choice to support energy savings and improve the quality of power distribution.

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Cite this Article: Susilo R.A., Ipniansyah (2024). Energize Transformer 400kVA at State Polytechnic of Samarinda with Simulation. International Journal of Current Science Research and Review, 7(11), 8512-8522, DOI: https://doi.org/10.47191/ijcsrr/V7-i11-38

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