Design a three phase step down power suply

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Design a three-phase step-down power supply based on ANSI / IEEE standard

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Abstract. An alternating current three-phase power supply design is a system development process that creates an existing three-phase system whereby the primary side of the Y relationship and the secondary side of the relationship Y. The problems in the design of alternating current power supply are the existence of harmonics, losses and unbalance voltage. Testing the power supply is carried out using no-load and linear load resistance with the value of resistances in range of hundreds ohm. The three-phase systems are tested for resistance number one, resistance number two, resistance number three and resistance number four transformers to obtain a power supply design that meet American National Standards Institute or Institute of Electrical and Electronic Engineering standards. The test results of four transformers in the form of three-phase alternating current found that Resistance number one and resistance number two type transformers have a lowest copper loss percentage, core loss, voltage THD and low unbalance voltage so that, these power supply can be made according to ANSI / IEEE provisions.

1. Introduction

The three-phase step-down alternating current power supply is a power supply with an input voltage between 380V or 400V and an output voltage of the 12V phase. This equipment cannot be found on the market, although it is very much needed in its use. Therefore, an attempt was made to obtain the design using a transformer by selecting as many as 4 types of transformers: resistance number one, resistance number two, resistance number three and resistance number four transformers. A simple and reliable transformer enables the selection of suitable and economical voltages for each purpose and alternating current must be used to supply electricity [1]. Also, power quality problems commonly encountered in operation include transients, sags, swells, surges, outages and impulses that vary in the amount or magnitude of the voltage [2]. This device is expected that practical tools are not just made, there needs to be standards or provisions that can be accounted for. This equipment is sought by the provisions of ANSI (American National Standards Institute) C 84.1 and IEEE (Institute of Electrical and Electronic Engineers). In Alternating Current distribution systems, power quality problems are well studied and handled by the IEEE standard. In the IEEE Standards Association's guide to voltage quality problems in power systems, power quality problems are divided into voltage quality characteristics and steady-state conditions [3]. Problems to get good ANSI C 841 provisions, several indicators must be met, namely unbalance voltage, harmonic voltage distortion, and transformer power losses. Harmonic distortion always arises from alternating current sources with linear and non-linear loads. A harmonic distortion is a form of pollution in power plants that can cause problems if the amount of harmonic currents increases above a certain limit [4]. The published studies are as follows: Analysis of the effect of power quality on transformers and 3 phase induction motors [5] obtained that the harmonics current can produce the copper losses on the transformer while voltage harmonics result can increase the core losses. Power quality problems that consumers require corrective measures to avoid big losses. This is, one important role is the less sensitive equipment. In the end, power quality can be avoided if you use an application that has no problems [6]. The researchers' expectations for the existence of this power supply were fulfilled, unbalance voltage of 2%, harmonic voltage distortion of 5%, copper losses of 2% and core losses of 1%.

2. Materials and Methods

The design and construction of a three-phase step down in this paper consists of transformers that are easy to find on the market. For testing the designed equipment, some measuring equipment were used such as wattmeter, digital multi meter. Harmonics analysis were conducted to measure power, current, voltage, voltage THD and unbalance load. The research material was obtained by assembling three sources of transformer Y on the primary side of 400 volts and the output voltage on the secondary side of 12 volts. Observation or implementation of experiments in a laboratory and supported by literature, journals, and ANSI / IEEE standard guidelines [7]. The research flow is shown in Figure 1, that contains material or components, tools and objects studied, how research works, parameters observed, designs used and analytical techniques.

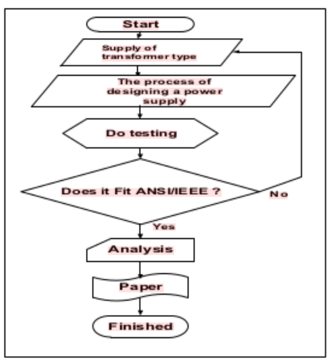

Figure 1. Research flow.

3. Results and discussion

Before the overall test is first tested the resistance of each type of transformer using the RLC meter. Testing of the alternating current three-phase power supply was carried out with no load and burden. Load-free testing aims to determine the resistance parameters of transformers. The test is loaded to test the value of Total Harmonic Distortion, and unbalance voltage, where load less testing consists of testing open circuits and closed circuits, circuits such as Figure 2 and test results as in Table 1.

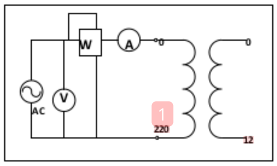

Figure 2. Open circuit set.

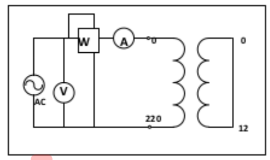

Figure 3. Closed circuit.

Table 1. Test of transformer resistance type without load open circuit (Re).

Transformer type	Re (Ohm)	V (volt)	I_O (Ampere)	P_O (watt)	PF
Re1	41.007	230	0.01	1.29	0.56
Re2	23.303	230	0.018	2.27	0.54
Re3	10.271	230	0.043	5.15	0.52
Re4	19.448	230	0.022	2.72	0.53

Table 2. Test of transformer resistance type without closed circuit load (R close).

Transformer type	R_{close} (Ohm)	V (volt)	I_{close}	P_{Close}	PF	Z_C
R close 1	564	230	0.47	93.7	0.97	489
R close 2	798	230	0.32	66.24	0.97	1000
R close 3	3293	230	0.072	16.06	0.97	3194
R close 4	1129	230	0.17	46.85	0.97	1352

In the transformer, there are three types of losses, including copper loss that is expressed or represented by the value of series resistance in an equivalent circuit, or what is known as Eddy-current loss, therefore a single-phase transformer is needed to determine the parameters of the resistance value, namely the secondary position of the open circuit (Re) and the position resistance value of the closed secondary circuit (Rc). [8].

$$P_{cu} = I_S \text{ x } R_e \text{ and } P_{core} = V_p^2 \text{ x } R_c \quad (1)$$

The increase in nonlinear core losses in the presence of harmonics will be dependent under the effect of the harmonics on the applied voltage and design of the transformer core [9]. Harmonics of currents and the total harmonic voltage so that it becomes:

$$P_{CU} = \sum_{n=2}^{\infty} I_n^2 . R_e \quad \text{and} \quad P_{core} = \frac{\sum_{n=2}^{n} V_n^2}{R_c} \quad (2)$$

Voltage unbalance is regarded as a power quality problem and significantly to be concerned at the electricity distribution level [10]. Over-voltage unbalance is defined as unbalance due to the positive-sequence voltage component being higher than the balanced rated voltage [8].

$$\%V_u = \frac{Avg \max Volta}{Avg\ Volta} \times 100\ \% \quad (3)$$

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$\%V_u$= Unbalance Voltage percent
Avg. max Volta = max deviation average voltage
Avg. Volta = Average voltage.

Equations (1), (2) and (3) are also used to determine the value of three-phase system power loss without load or load and are shown in Table 3 and Table 4.

Table 3. Testing of copper loss and core loss at no-load three-phase system.

Transformer type	Copper losses no load (Watt)			Core losses no load (Watt)		
	P_{O1}	P_{O2}	P_{03}	P_{C1}	P_{C2}	P_{C3}
Resistance 1	93.7	93.7	93.5	1.29	1.29	1.29
Resistance 2	66.24	66.02	66.24	2.27	2.12	1.22
Resistance 3	16.06	16	16.01	5.15	5.15	5.15
Resistance 4	46.85	46.55	46.07	2.7	2.7	2.7

Table 4. Test results of copper loss and core a loss at with load three-phase system.

Transformer type	Copper losses with load (Watt)			Core losses with load (Watt)		
	P_{O1}	P_{O2}	P_{03}	P_{C1}	P_{C2}	P_{C3}
Resistance 1	8.27	8.14	8.52	1.29	1.29	1.29
Resistance 2	16.9	16.9	15.13	2.27	2.27	2.27
Resistance 3	38.65	46.76	45.99	5.15	5.15	5.15
Resistance 4	16.37	19.58	19.48	2.72	2.72	2.72

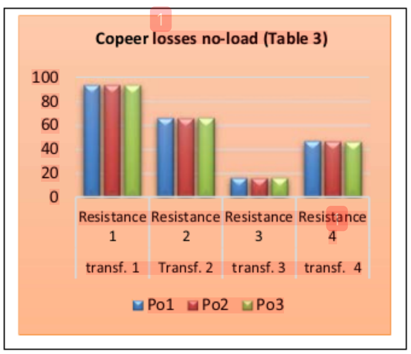

Figure 4. Copper loss no-load.

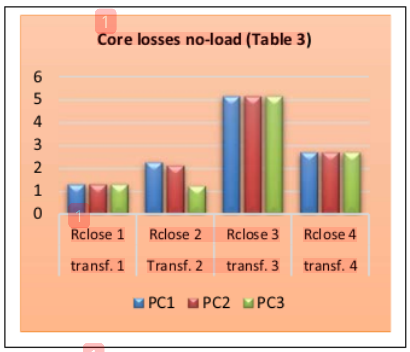

Figure 5. Core loss no-load.

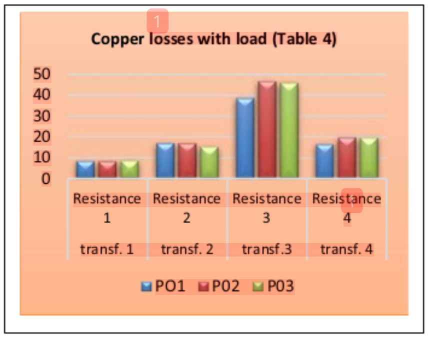

Figure 6. Copper loss with load.

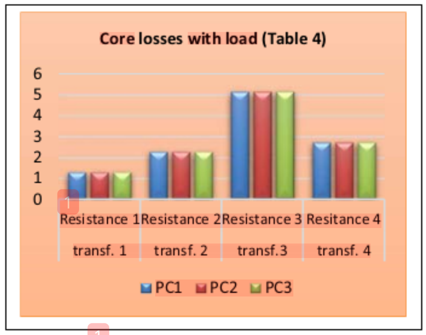

Figure 7. Core loss with load.

From the results of the test for the four types of transformers, it can be explained that the appropriate power supply can be built using the resistance 1 or resistance 2 transformer. The design of the three-phase system power supply as shown in Figure 8 was also tested with linear load.

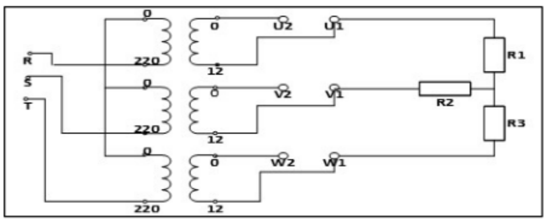

Figure 8. Balanced linear three-phase system circuit.

The results of testing the three-phase system can be determined the value of Total Harmonic Distortion (THD) of the voltage and the unbalance voltage, where the THD test is done by observing the tested equipment with a power quality analyzer while the results of unbalance voltage with Equation 3.

Table 5. Results of secondary side load testing at the resistance 1 transformer.

Transformer type	V (volt)	I_O (Ampere)	THD V	PF	Unbalance voltage (%)
U_1	13.23	0.13	1.1	0.99	1.66
V_1	13.1	0.129	1.3	0.99	1.66
W_1	13.32	0.132	1.2	0.99	1.66

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Table 6. Results of secondary side load testing at the resistance 2 transformers.

Transformer type	V (volt)	I_O (Ampere)	THD V	PF	Unbalance voltage (%)
U_1	13.2	0.13	1.5	0.99	2.35
V_1	13.28	0.13	1.4	0.99	2.35
W_1	12.97	0.28	1.2	0.99	2.35

Table 7. Test results for secondary side loads on the resistance 3 transformer.

Transformer type	V (volt)	I_O (Ampere)	THD V	PF	Unbalance voltage (%)
U_1	11.52	0.11	2.1	0.99	7.9
V_1	12.47	0.121	1.9	0.99	7.9
W_1	12.08	0.12	2.2	0.99	7.9

Table 8. Test results for secondary side loads on the resistance 4 transformer.

Transformer type	V (volt)	I_O (Ampere)	THD V	PF	Unbalance voltage (%)
U_1	11.98	0.11	3.7	0.99	3.7
V_1	12.43	0.121	2.1	0.99	3.7
W_1	12.01	0.12	2.6	0.99	3.7

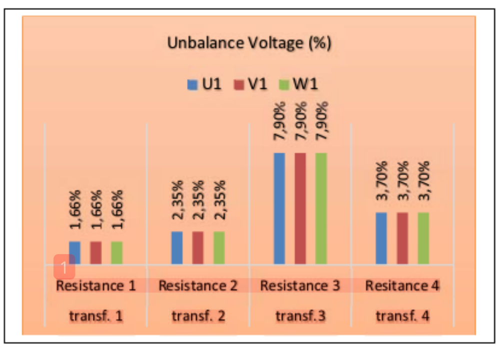

Figure 9. Voltage percentage unbalanced.

Table 5 to 8 show the results of the three-phase power supply measurements where the THD and unbalance voltage of resistance 1 transformer has the lowest percentage, and make it meets with ANSI / IEEE provisions. The design that is suitable for making alternating current three-phase power supply is the resistance 1 and resistance 2 transformer, the results of which can be shown as shown in Figure 9.

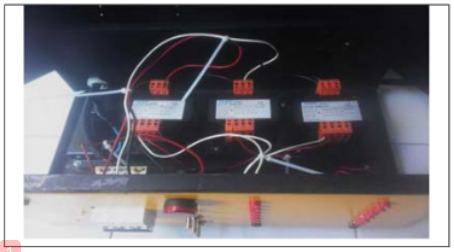

Figure 9. Step-down three phase alternating current power supply.

4. Conclusions

The design of a three-phase system from all four transformers has been tested and found that the resistance 1 and the resistance 2 transformers have the lowest copper losses, core losses, voltage Total Harmonic Distortion and unbalance voltage to make them meet ANSI / IEEE standards.

5. References

[1] Whaite S, Grainger B and Kwasinski A 2015 *Energies* **8** 4378-4399
[2] Rizky F and Eddy W 2014 *Singuda Ensikom* **8** 13-18
[3] Deswall S S, Dahiya R and Jain D K 2013 *International Journal of Electronics Communications and Electrical Engineering* **3** 36-54
[4] Ridwan A, Vivaldi R, Setiawidayat S and Mukhsin M 2016 *Prosiding Sentia* **8** *B70-B76*
[5] Ko A, Swe W and Zeya A 2011 *The Internet and Management* **19** 66.1-66.6
[6] Mehmet TUR R 2018 *Journal of Engineering and Technology* **2** 1-9
[7] Yusuf Y M, Firdaus and Feranita 2016 *Jurnal Online Mahasiswa Fakultas Teknik* **3** 1-12
[8] Kenechi V, Abanihi, Daniel O, Aigbodion, Edet D, Kokoette and Samuel D R 2014 *International Journal of Science, Environment and Technology* **3** 1657 – 1667
[9] Alamgir S M and Dev S 2015 *International Journal of Advanced and Technology* **75** 21
[10] Youb L 2014 *International Journal of Electrical Energy* **2** 34-38

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