A Quality Distribution Networks with Unbalanced Load Management Distribution Transformator

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Abstract: *Load imbalance is a sure thing for power distribution. Especially on the low voltage network side. The higher the load imbalance will be the higher the current arising in the neutral carrier. The current flowing in the neutral conductor will be the loss of electrical power on the network. Therefore, in the distribution of electric power load imbalance must be minimized in order to achieve optimal channeling efficiency. This research was conducted at work area of PT. PLN (Persero) Area Sibolga, by taking sample 3 substation distribution. Data retrieval is done at two time ie at peak load time and beyond peak load time. From the calculation data obtained shows the magnitude of power losses due to unbalance of the load on the three substations ranging from 0.05% ~ 4.38%.*

Key Words: *Load Unbalance, Neutral Flow, Power Loss, Secondary Distribution Network.*

1. INTRODUCTION:

Power distribution channels are one of the components that distribute electrical energy from substations to load centers or consumers. In the distribution of electric power should be cultivated as well and as efficiently as possible. To achieve this then all things that can cause losses must be minimized, both in the form of technical and non-technical [1].

One of the non technical losses is the uneven loading of the Distribution Transformer phase. Load imbalance between each phase (phase R, phase S, and phase T) is what causes loss of power [2].

The purpose of this distribution transformer load management is to improve the efficiency of electric power so as to reduce the loss of electrical power due to unbalanced load on Distribution Transformator [3]

In this case is done by using 3 pieces of substation samples in the workplace at PT. PLN (Persero) Area Sibolga.

2. WORKING PRINCIPLE AND METHOD:

2.1 TRANSFORMATOR

The transformer is an electrical device that converts the alternating current from one level to another by a magnetic coupling and based on the principles of electromagnetic induction. The transformer consists of a core, made of plated iron and two coils, the primary and secondary coils [4]. The use of simple and reliable transformers allows the selection of suitable and economical voltages for each purpose and is an important cause that alternating current is widely used for power generation and distribution [5].

The working principle of the transformer is based on Ampere's law and Faraday's law, namely: electric current can generate magnetic field and vice versa magnetic field can generate electric current. If on one of the coils on the transformer is given alternating current, the number of magnetic force lines varies. Consequently on the primary side there is induction [4]. The secondary side receives a magnetic force line from the primary side whose numbers are also changing. So on the secondary side also arise induction, the result between the two ends there is a voltage difference [3].

2.2 LOAD IMBALANCE

What is meant by a balanced state is a situation where:

a) The three vectors / voltages are equal
b) The three vectors form a 120̊ angle to each other.

Meanwhile, what is meant by the unbalanced state is the condition where one or both conditions of unbalanced state are not met. Possible unbalanced state there are 3 kinds, namely:

a) The three vectors are equal but do not form 120̊ angles to each other The three vectors are not as large but form 120̊ angles to each other
b) The three vectors are not as large and do not form 120̊ angles to each other.

2.3 CURRENT NETRAL

The neutral current in the electric power distribution system is known as the current flowing in the neutral wire in the low-phase three-phase low-voltage distribution system [5]. This neutral current appears if:

a) Load conditions are not balanced
b) Due to the presence of harmonic currents due to non-linear loads.

The current flowing in the neutral wire which is the alternating current for the three-phase three-wire distribution system is the sum of the vectors of the three phase currents in the symmetrical component [6].

As a result of loading in each phase is not balanced, it will flow the current on the neutral carrier. If in the ground of neutral grounding there are indigo values and flowing current, then the neutral wire will be voltage which causes the voltage on the transformer is not balanced. The current flowing along the neutral wire, will cause power loss along the neutral wire for:

PN = IN x RN

Where :

PN = Losses arising in neutral carriers (watt)
IN = The current flowing through the neutral wire (Ampere)
RN = Prisoner on neutral wire (Ohm)

3. RESULT OF MEASUREMENT 3 TRAFFO DISTRIBUTION

According to IEC standard the allowable load imbalance is 5% with the high load imbalance affecting the magnitude of neutral currents, where large neutral currents lead to increased losses and lower power quality so as to affect the quality of power delivery systems. Based on the above, it is necessary to calculate the percentage of the imbalance in each substation being sampled.

Table 1. Measurement Result of Rayon Card SB 46

PHASE	CURRENT (A)	
	LWBP	WBP
R	138	160
S	152	230
T	130	283
N	36	95

Tables 2. Measurement Result of Rayon Card MR 17

PHASE	CURRENT (A)	
	LWBP	WBP
R	155	360
S	90	264
T	167	340
N	45	111

Tables 3. Measurement Result of Rayon Card SB 129

PHASE	CURRENT (A)	
	LWBP	WBP
R	170	423
S	147	360
T	135	450
N	58	121

From the calculation results can be the value as follows :

Tables 4. Precentage Of Implementation

Rayon Card	SB 46	MR 17	SB 129
LWBP	4.42 %	19.40 %	5.09 %
WBP	17.04 %	12.95 %	11.96 %

3.1 LOSSES

After calculating the neutral current on each transformer, it can be determined the amount of power loss due to load imbalance. The magnitude of power loss arises because of the current on the neutral carrier on the secondary distribution network side.

From the calculation results obtained as in the table below:

Tables 5. Result calculation Result

RESULT	SB 46		MR 17		SB 129	
	LWBP (W)	WBP (W)	LWBP (W)	WBP (W)	LWBP (W)	WBP (W)
CALCULATION	109,26	4.291,12	2.625,09	6.933,87	620,74	14.887,22
MEASUREMENT	517,67	4.041,48	2.295,98	8.689,79	3.209,1	14.622,56

4. ANALYSIS:

From the calculation that the imbalance seen from the 3 sample of substation obtained the average imbalance in LWBP of 9,6% and WBP of 13,98%. Where this value has exceeded the limit value of imbalance established by IEC that is equal to 5%.

From the magnitude of the imbalance it causes the occurrence of current flowing in the neutral conductor. From the calculations made from the three phase currents obtained results that the magnitude of neutral currents in each substation near the measurement results made. Where from 6 sample measurement, there are 4 measurement approaching result of calculation, while 2 calculation have big enough difference, that is at measurement moment LWBP LWBP di gardu SB.46 and MR.17 . This can be due to the presence of harmonics due to non linear loads. Where if there is a harmonic then the harmonic current of the zero order in each phases adds up in neutral transformer.

The amount of power loss in each substation. From the three substations that are sampled, the interval of power loss due to load imbalance that is 0,05% ~ 4,38% and average power loss of 1,85% for the calculation (the neutral current of the vector sum of each phase) and 2,09% for measurement (neutral current from direct measurement).

This means that the magnitude of the neutral current is directly proportional to the increasing loss of power due to load imbalance. However, it does not mean that substations that have a high percentage of imbalances produce higher power losses than other substations that have a lower imbalance, this is due to the different capacity of the transformer and the amount of load borne.

5. CONCLUSION:

Based on the results of the analysis of several substations taken as sample can be taken conclusion:

1. The percentage of load imbalance that occurs in the three distribution substations ranges between 4,42% -19,4%.
2. The magnitude of the neutral currents from the calculation results on the three distribution substations ranges 15,62 –112,46 A. In some substations there is a considerable difference between the value of calculation and neutral current measurement, this may be due to other factors that influence the emergence of neutral currents other than due to unequal load.
3. Average loss of power arising from unbalance loads on the three distribution substations of 5,24 Kw.

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