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Losses in Power Distribution Transformers

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Abstract

The paper presents the estimation of power losses in distribution transformer of Provincial Electricity Authority (PEA) distribution system at Muang district of Suphanburi province in Thailand. Data of 416 power distribution transformers composed of transformer (kVA), load current, no load loss and full load loss which were used for calculating energy losses. It was found that the total energy loss of all transformers is approximately 1,756,380 kWh/year.

Keywords*: Technical losses, Energy losses, Distribution transformer loss.*

1. INTRODUCTION

All electric power utilities in Thailand aim to provide services to their customers with high efficiency, reliability and safety. Provincial Electricity Authority (PEA) is power distribution utility who serves energy to their customers in almost every provinces of Thailand, excepting Bangkok, Nonthaburi and Samutprakan. There are many electrical equipments in power distribution system such as outdoor and indoor substations equipments, 115 kV sub-transmission, 33kV and 22kV distribution, insulators, lightning arresters, dropout fuses, transformers and so on. A distribution transformer is important equipment for changing voltage levels from 33/22kV to 380/220 V.

The PEA Suphanburi office has responsibility for a distribution system of Suphanburi district, Suphanburi province. The PEA Suphanburi has many distribution transformers. Distribution transformers of PEA can be separated in to two parts of responsibility, namely transformers as belonging to utility and customers. Normally, the loss of transformers consist of a core loss and a copper loss. Therefore, this work is to study losses from distribution transformers in the PEA Suphanburi office area which has 416 utility transformers. Calculation results of losses from distribution transformers can be used for energy loss assessment and management such as reducing losses with transformer tap changing, transformer specification choosing, etc. Beside, It can be combined with conductor losses for considering total losses in service area. Finally, this work also presents a program provided for calculating losses of power distribution transformers as shown in the paper [4].

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2. THEORY

2.1Losses in distribution transformers

There are two parts of transformer losses. Firstly, a core loss is a loss from a iron core as hysteresis and eddy current losses. Secondly, a copper loss is from load current quantity [3].

2.2Load factor

A load factor is a ratio of average load capacity and the maximum load capacity [1].

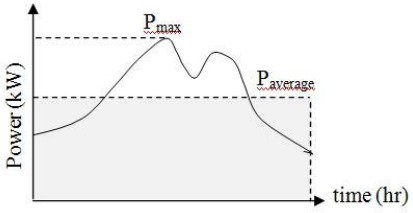

Figure 1. Load profile.

$$Load\ Factor\ (LF) = \frac{Average\ Load\ (P_{\max})}{Maximum\ Load\ (P_{average})} \tag{1}$$

2.3Loss calculation

A total loss is the summation of no load loss or a core loss and a load loss. No load loss and full load loss can be chosen from a table of a transformer manufacturer [2].

$$Load\ Loss = Full\ Load\ Loss \times (0.86LF^2 + 0.14LF) \tag{2}$$

$$Load\ Factor = \frac{kVA_{average}}{kVA_{install}} \tag{3}$$

where Load loss is Average Load Loss (Watt).

3. TRANSFORMER LOSS CALCULATION

3.1 Calculation

Table I. No load Loss and full load Loss of single phase distribution transformer.

Capacity (kVA)	Full Load current (A)	No load Loss		Full load Loss	
		Old (W)	New (W)	Old (W)	New (W)
10	43	75	60	160	145
20	87	120	90	330	300
30	130	160	120	480	430
50	217	200	150	740	670

Old is transformer purchasing before 1997, New is transformer purchasing since 1997.

This section presents an example of total loss calculation of a 30 kVA single phase distribution transformers. No load loss equal 120 Watt and full load loss equal 430 Watt are estimated from Table I. A load factor is calculated from equation (3) and full load loss of transformer is selected from Table 1 and then substitution of LF and full load loss in equation (2) is shown as:

$$LF = \frac{kVA_{Average}}{kVA_{Install}} = \frac{24\ kVA}{30\ kVA} = 0.8$$

where $kVA_{Average}$ is from a total of measured load currents to a full load rated current multiplied by transformer capacity sizing.

$$\text{Load Loss} = \text{FullLoad Loss} \times (0.86 \times LF^2 + 0.14 \times LF)$$
$$= 430\,\text{Watt} \times (0.86 \times 0.64 + 0.14 \times 0.8) = 284.832\,\text{Watt}$$

Therefore, the total loss of 30 kVA single phase distribution transformer is calculated as following:

$$\text{Total Loss} = \text{No Load Loss} + \text{Load Loss} = 120\,\text{Watt} + 284.832\,\text{Watt} = 404.832\,\text{Watt}$$

3.2 Calculation by the transformer loss calculation program provided

This section presents the program for transformer loss calculation which is provided for PEA Suphanburi office by RMUTSB students. The program are created by Visual Basic 6.0 and Access 2007.

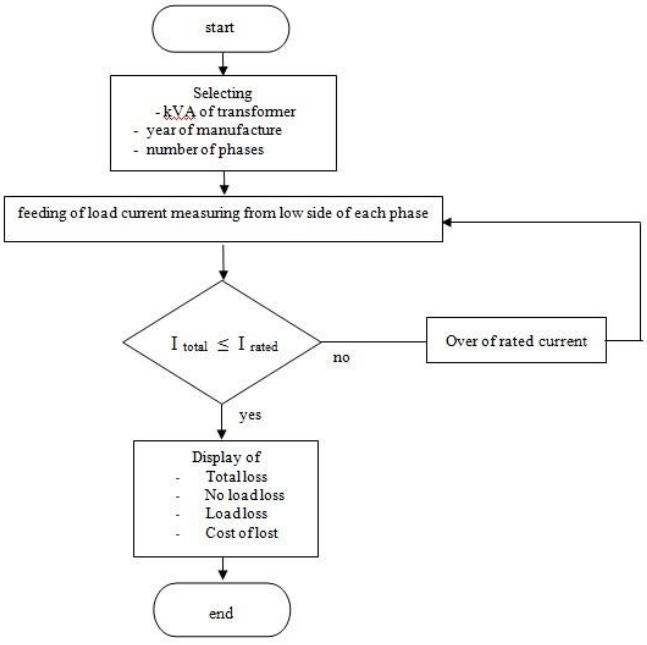

Figure 2. A diagram of the transformer loss calculation program.

Figure 3. A Display of input data and results of the transformer loss calculation program

4. RESULTS

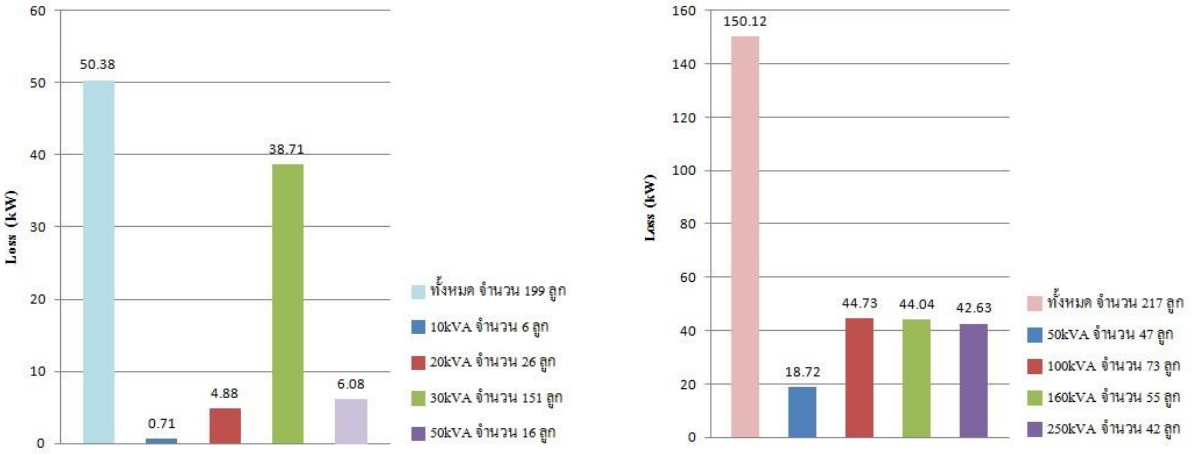

Figure 4. Transformer loss calculation

Table 1. Number of Power Distribution Transformers of the PEA Suphanburi office

Single Phase				Three Phases			
Total of 199 Distribution Transformers				Total of 217 Distribution Transformers			
Capacity (kVA)	Number of Total	Number of New	Number of Old	Capacity (kVA)	Number of Total	Number of New	Number of Old
10	6	-	6	50	47	20	27
20	26	-	26	100	73	38	35
30	151	85	66	160	55	34	21
50	16	1	15	250	42	13	29
Total = 416 Distribution Transformers							

In Table 1 shows number of power distribution transformers of the PEA Suphanburi office. Data are separated into a number of single phase transformers, three phases transformers and transformer capacity sizing. Fig 4 shows results of transformer loss calculation. Graphs of transformer power loss are plotted and separated by transformer phase and capacity sizing.

5. CONCLUSION

Power losses of 416 distribution transformers in the PEA Suphanburi office can be calculated by the provided program for transformer loss calculation. There are 199 single-phase and 217 three-phases transformers and the energy losses of distribution transformers of the PEA Suphanburi office are 441,329 kWh/year for single phase transformers, 1,315,051 kWh/year for three-phases transformers and 1,756,380 kWh/year for the total energy losses. Cost of transformer losses is about 5,269,140 Baht/year. For the Program provided for helping transformer loss calculation can calculate power losses of distribution transformers, add transformer a database, find a transformer PEA code and evaluate cost of energy losses.

REFERENCES

[1] Hokierti, J. 2006. Electrical Power System, Faculty of Engineering, Kasetsart University. (in Thai)

[2] Provincial Electricity Authority, 2012. Standard manual of Power Distribution Transformer Installation. (in Thai)

[3] Olivares, J. C., Liu,Y., Canedo,J. M., Escarela-Pérez, R., Driesen, J., and Moreno, P. 2003. Reducing Losses in Distribution Transformers. IEEE Trans. on Power Delivery Vo.13 No.3 July. pp. 821-826

[4] Philphud, M., Sungthong, T. and Rachawong, W. 2013. Study of Loss in Power Distribution Transformer. Engineering Student Project. Rajmangala University of Technology Suvarnabhumi, Suphanburi Campus. (in Thai)