THOMSON REUTERS ENDNOTE

[Wahdaniyah* *et al.*, 5(7): July, 2016] ISSN: 2277-9655
IC™ Value: 3.00 Impact Factor: 4.116

IJESRT

INTERNATIONAL JOURNAL OF ENGINEERING SCIENCES & RESEARCH TECHNOLOGY

PURIFICATION OF TRANSFORMER OIL in PT. PJB UP PAITON

Gusti Wahdaniyah*, Purnomo Tri Prasetyo, Arif Setiabudi, Totok R. Biyanto
PT. PJB UP Paiton, Probolinggo, Indonesia
Department of Engineering Physics, Institut Teknologi Sepuluh Nopember (ITS) Surabaya, Indonesia

DOI: 10.5281/zenodo.56908

ABSTRACT

The purpose of this paper is to describe the filtration or purification of transformer oil. One of the main equipment in coal-fired power generation unit is transformer. When the transformer fail to operate properly, the continuity of distribution system become interrupted. As a part of transformer, transformer oil contribute the failure of transformer due to the aging. To solve this problem, several methods is applied starting from dehydration process, degasification process, oxidation removal and filtration or purification. After the purification process is performed, the transformer oil then analyzed. The result shows that the purified transformer oil is better than before purified.

KEYWORDS: Transformer oil, purification, failure.

INTRODUCTION

Transformer is the main equipment in coal-fired power generation unit (PLTU) aside from the turbine equipment, cold handling and boiler. In the condition of normal load plant capacity, age of the transformer depends on the used insulation where the insulation has a mechanical, electrical resistance and protected oil isolation that will make the transformer has the ability to work accepting load or high electrical pressure (electric stress) [1]. Transformer oil as liquid insulation operates to separate the parts that have difference voltage between parts so that do not occur leap electrical (flash-over) or spark (spark-over). The failure of the insulation on the high-voltage equipment that occurs when equipment is operating, it could cause damage to the tool so that the continuity of distribution system becomes interrupted. From the few cases show that isolation failure related to the existence of a partial discharge. Partial discharges can occur in solid insulating materials, liquid insulating materials and gas insulating materials. The failure mechanism on solid insulating material covers intrinsic failures, electro mechanical, thermal and erosion. On gas material is mainly caused by the mechanism of town send and the mechanism of steamer. While in the liquid material is caused by bubbles (cavitation), and mixed liquid insulation material (contamination). Liquid insulation is used because it has 1000 times more density than gas insulation and has high dielectric strength, liquid insulation will fill a gap or space that will be isolated, and it can absorb the heating that arises and insulates the liquid that tend to be able to repair itself if there is a release of charge (discharge). But the main drawback of liquid insulation is easily contaminated [2]. The Damage of the oil insulation in transformer is more caused by age, where naturally insulating paper that used will damage continuously and naturally transformer oil also oxidize continuously, because there is oxygen in the oil or there is air in the transformer. Reclamation, inhibitor giving and its product bond such as acid or sludge and return the oil to the new conditions. The speed of this oxidizing product strongly affected the conditions of temperature, moisture, electric stress, quality of paper insulation transformer. Nowadays, advanced measurement and forecasting of these variables [3-4]. There are also several research already available in assessing the health of transformer oil [5-7]. Meanwhile, in this paper purification process is conducted to assess and restore the transformer oil health.

REVIEW

Water in Tranformer Oil

Water in transformer oil is obtained from the atmosphere or the product of a chemical reaction. In oil insulation, water can occur in some of the following conditions:

- In dissolved condition
- In emulsion condition
- In the bottom container transformer

Even very little amount of water can have significant effects to transformer characteristics. In this case, the presence of water emulsion is more dangerous than dissolved condition. Figure 1 shows the curve relationship between the dielectric strength and quantity of water emulsion in mineral insulator oil.

The water quantity that can dissolve in the oil is directly proportional to the increase in the oil temperature as described in the curve of Figure 2. Then the oil temperature should be considered for separation of water from oil, because the purification oil in high temperature can decrease the dielectric strength, when water transformation is dissolved to be emulsion.

Paper isolation on transformer is very porous and it can absorb water in great abundance. The increasing amount of dissolved water and emulsion in oil insulating, then the amount of absorbed water on the paper insulation is getting bigger as well. As a result is greatly able to decrease the dielectric strength. After being absorbed, the water is very difficult to be eliminated. Therefore, to prevent the absorption, it is necessary to keep the water content in oil insulation at certain level as low as possible [2].

Basic Test for Determining of Tranformer Oil State

Sub-subheading should be 10pt Times new roman, Italic, Justified.

The degradation process of the oil insulation can be monitored and measured by a series of tests, the most important and widely applied is as following:

1. Water content – test ASTM D 1533

Water is one of the factors that affect the oil quality and transformer characteristic in the transformer. Water content should be at a level that is as low as possible (no more than 30 ppm) [2].

2. Dielectric strength – test ASTM D 877, D 1816

Characteristic from dielectric strength on transformer oil is very important and usually it will be investigated first. Physically, dielectric strength is the voltage at which the transformer oil that starts to work. The value should be at the highest level. The decrease of this value indicates the increase of water content in transformer oil [2].

3. Neutral number - acidity number – test ASTM D 974

The unit of acidity number is mgKOH/mg that represents caustic potassium milligram that added to the gram of oil to neutralize the acidity. The oil transformer in new condition almost no acid level if the storage procedure and transformer charging is done correctly. The value of new oil acidity is below 0.05. Acidity level increases in line with the oxidation process in the oil and proportional to the amount of oxygen content in the oil. Acidity limit in the transformer oil is 0,2, because in the value of acidity to reach 0,4 resinoid layer will form drastically that affects characteristic transformer [2].

4. Inter surface stress – IFT test – test ASTM D 971

Inter surface stress is a characteristic that allows the formation of resinoid layer, although it does not mean that this layer is formed. Physically, inter surface stress is the force that required to break down the oil layer, which is on the boundary between oil and water. Unit is N/m (or mN/m). The value for the new oil is around 40 mN/m. The value of inter surface good stress is more than 22 mN/m. Transformer Oil which has inter surface stress with a value of between 15 and 22 mN/m should be purified, while under 15 mN/m it almost certainly shows a resinoid layer [2].

In addition to the fourth above tests also contain several tests for oil isolator such as specific gravity, colour, total dissolved combustable gas, visual/sediment, total furan, liquid power factor, inhibitor content, and corrosive sulfur

METHOD

Because of the importance of the use of the transformer on a regular basis, reviewing the complexity degradation and the aging to the problem of the isolation transformer, at this point some methods have been developed, especially concerning the improvement of condition of isolation transformer passes through some of the following procedures:

1. Dehydration (Removing water content)
2. Degasification (Removing oxygen content and another gases)
3. Removing several oxidation process.
4. Filtration.

Filtration that the most commonly used is in the following:

- Natural sedimentation

Natural sediment is based separation of water at the bottom of the transformer container naturally, while the transformer does not operate for at least 24 hours. After that, the oil is pumped out while the water content removed from the bottom, cleaning is performed repeatedly until the natural sediment is removed. This method is rather slow and requires more energy, and the efficiency is less satisfactory to meet the standard set [2]

- Filter presses

Filter presses can consist of several types of construction but the most used type is based on the principle of circulation of oil through a series of filtering and absorbing (e.g. filter paper). This method cannot be used to oil degasification. To remove water content, filtering element must be replaced and dried periodically [2].

- Portable devices with filter elements

Portable devices for filtering elements are frequently used because of their small size, easy handling and several advantages that are compared to use another larger filter. In these devices, there are several ready-used elements such as cartridge that is used to filter the oil from 1 µm to 25 µm. This device can separate the water and the oil very well[2].

- Coalescer filtration

Filtration coalescer is a comparatively new developed method, based on filtering methods for aircraft fuel. The filtering element is made of fiberglass where water can be separated because of the increase of differential pressure on its operational. This method has the advantage over the other methods, but the main drawback is the sensitivity of the filtering elements to the solid particles in the oil.

- Vacuum dehydration

Vacuum dehydration method is widely used and highly efficient which oil purification was done by warming the oil isolator and drying it in a vacuum. In this condition boiling point of water is significantly low and the separation of the water content of the oil can be applied. This method is very efficient to use degasification. The main drawback of the method is the energy needs for heating oil during the process of purification. An increase in temperature of the insulating oil is above 65°C, then drying it in a vacuum has caused the loss of an important oil fraction required for good insulation quality of oil [2]. While at a lower temperature, drying efficiency will decrease rapidly. Transformer oil purification in PT PJB Paiton also uses this vacuum dehydration method.

RESULTS AND DISCUSSION

After Purification, transformer oil becomes in good condition again as shown in Table 1.

Table 1. The Results of Laboratory Test of Transformer Oil

Variable	Unit	Reference	The Value		
		Standard	Standard	Before	After
Neutralisir Number (ACID)	MgKOH/mg	ASTM D974	<0.06	0.014	0.014
Interfacial Strenght (IFT)	mN/m	ASTM D971	>32	34.9	37.2
Dielectric Strenght (DIEL)	kV	ASTM D877	>=30	90	91
Specific Gravity (SP. GR)		ASTM D1298	0.84-0.91	0.8718	0.8784
Colour		ASTM D1524	<=3.5	1.5	1.5
Total Dissolved Combustable Gas		ASTM D3612	720	53	1
Visual/Seiment		ASTM D1524	Clear	Clear	Clear
Total Furan		ASTM D5837	<100	ND	ND
Liquid Power Factor	20oC 100oC	ASTM D924	<0.1 <2.99	0.060 2.140	0.010 2.990
Inhibitor Content		ASTM D2688	>0.20	ND	0.34
Water Content (Moisture)	ppm	ASTM D1533	<30	7	6
Corrosive Sulfur		ASTM D1275B	1	1B	1B

From the table above shows that the water content in oil transformer declined from 7 ppm to 6 ppm and acquiesce on standard range that are used i.e. < 30 ppm. For dielectric strength and interfacial strength increases gradually with the value of 91 kV and 23.1 mN/m. Then for neutralizer number does not changed significantly after purification i.e. 0.014 MgKOH/mg, but it is still on standard range that is used.

CONCLUSION
From the results of testing on the lab showed oil transformer parameters before and after reclaimed according the standard range that is given. Acid level increased from the standard condition 0.008 mmKOH/mg to 0.014 mmKOH/mg. Interfacial tension, specific gravity, and inhibitor content increase after purification. Interfacial tension increased from 34.9 mN/m to 37.2 mN/m, specific gravity increased from 0.8781 into 0.8784 and inhibitor content of ND is 0.34. For the value of moisture and dissolved gases decreases after purification is 7 ppm to 6 ppm for moisture and 53 ppm to 1 ppm for dissolved gas.

ACKNOWLEDGEMENTS
The authors gratefully thank to PT. PJB UP Paiton Indonesia for providing the facilities in conducting this research.

REFERENCES
[1] J. Filippini, R. Tobazéon, P. Guuinic, and O. Moreau, "The spontaneous ionic purification phenomenon of transformer oil: Presentation and consequences," *Journal of Electrostatics,* vol. 67, pp. 737-740, 2009.
[2] I. Mačužić and B. Jeremić, "Modern Approach to Problems of Transformer Oil Purification," *Tribology in industry, Kragujevac*, vol. 24, 2002.
[3] Bin, Song, and Li En-Wen. "Study on state of health for power transformer oil with multiple parameters." *Power System Technology (POWERCON), 2014 International Conference on*. IEEE, 2014.
[4] Malik, Hasmat, et al. "UV/VIS response based fuzzy logic for health assessment of transformer oil." *Procedia Engineering* 30 (2012): 905-912.
[5] NEGARA, Yulistya, et al. Investigation of intrinsic breakdown of transformer oil insulation: An experimental approach. In: *Power Engineering and Renewable Energy (ICPERE), 2014 International Conference on*. IEEE, 2014. p. 66-69.
[6] DU, Y., et al. Measurements of moisture solubility for differently conditioned transformer oils. In: *Dielectric Liquids, 1999.(ICDL'99) Proceedings of the 1999 IEEE 13th International Conference on*. IEEE, 1999. p. 357-360.
[7] FEI, Sheng-wei, et al. Particle swarm optimization-based support vector machine for forecasting dissolved gases content in power transformer oil.*Energy Conversion and Management*, 2009, 50.6: 1604-1609.