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The Effect of Coil Winding Replacement on the Performance of a 200 Kva Transformer (Case Study at PT. Razza Prima Trafo)

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ABSTRACT
The electric power system is a primary need, both for daily life and for industrial life. The provision of stable and continuous electric power is an absolute requirement that must be met in meeting the need for electric power. The distribution system is the distribution of electrical energy from the substation to consumers. There are 2 (two) distribution systems, namely primary distribution and secondary distribution. Primary distribution, the distribution starts from the substation (secondary side of the power transformer) to the distribution substation (primary side of the distribution transformer) or from the substation directly to the 20kV medium voltage consumer. Power transformers are equipped with a grounding transformer that functions to obtain a neutral point from the power transformer. Before replacing the coil winding, measurements were taken using a TTR transformer turn ratio test (megger) measuring instrument. It can be concluded that the location of the damage is in the coil winding section. The results of the voltage measurements on the Primary Winding between phases R-S = 410 V, ST phase = 407 V and TR phase = 375V. and the Secondary voltage between phase and Neutral is RN = 221V, SN = 237V and TN = 222V. and the current in the Secondary winding between phases is R = 7.64A, S phase = 7.64A and T phase = 8.08A.

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INTRODUCTION

The electrical power system is a primary need, both for daily life and for industrial life. This is because electrical energy is easy to transport and convert into other forms of energy (Tanjung, and Atmam, 2016). The development of energy sources to obtain useful work is the key to industrial progress which is important for the continuous improvement of the standard of living for people wherever they are (Badaruddin, 2012).

The reliability of a power transformer is highly dependent on the performance of its insulating oil. The main factor in maintaining the quality of insulating oil is its breakdown voltage, which determines its function as an electrical insulating medium as well as a cooling agent. One of the oil's abilities is to withstand electrical stress before insulation failure occurs. Temperature increases during transformer operation can cause a decrease in the oil breakdown voltage, thereby affecting the overall reliability of the transformer. This study aims to analyze the effect of temperature increases on the breakdown voltage of power transformer oil. Tests were conducted through simulations and laboratory

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measurements at various temperatures to identify the relationship between temperature and oil breakdown voltage. The results showed that increasing temperature significantly reduced the breakdown voltage of the insulating oil, thereby increasing the risk of insulation failure and reducing transformer reliability. The conclusions of this study provide important recommendations for managing the operating temperature of transformers to maintain optimal reliability and service life while avoiding potential failures caused by insulating oil degradation.Haris Gunawan2025)

The electric power system can essentially be divided into two parts, namely the Primary Network System or also known as the Medium Voltage Network (JTM) plays a vital role in distributing electric power to users in a particular area. By utilizing the medium voltage system as the main network, distribution losses can be avoided and voltage quality requirements can be met. PT PLN Persero as the main business entity is obliged to comply with the quality standards stipulated in the Electricity Law Number 30 of 2009. The Secondary Network System or what is known as the Low Voltage Network (JTR) is a downstream component of the electric power system. This network distributes electric power directly to consumers or electricity customers. This network functions to distribute electric power to consumers. (Solly A and Z tharo 2025)

The provision of stable and continuous electricity is an absolute requirement that must be met in meeting electricity needs. (Tanjung, and Atmam, 2016), the distribution system is the distribution of electrical energy from the main substation to consumers. There are 2 (two) distribution systems, namely primary distribution and secondary distribution (Syufrizal and Monantun, 2014).

Primary distribution, the distribution starts from the substation (secondary side of the power transformer) to the distribution substation (primary side of the distribution transformer) or from the substation directly to the 20kV medium voltage consumers. Secondary distribution, the distribution starts from the distribution substation (secondary side of the distribution transformer) to the low voltage consumers (Syufrizal and Monantun, 2014).

In distributing power, the Substation has an electrical tool/component in the form of a power transformer that functions to transform electrical power, by changing the voltage while the frequency remains constant (Za'im, 2014). Power transformers are equipped with grounding transformers that function to obtain a neutral point from the power transformer. This equipment is called the Neutral Current Transformer (NCT), other equipment is the transformer grounding called Neutral Grounding Resistance (NGR) (Za'im, 2014).

In power transmission operations, transformers can be considered the heart of the transmission and distribution system. Under these conditions, a transformer is expected to operate optimally. Given the extensive workload of a transformer, maintenance is also required to be as thorough as possible. Therefore, transformers must be maintained using the correct, proper, and appropriate systems and equipment (Za'im, 2014).

Proper distribution of electrical energy requires attention to many aspects, including the reliability of the protection system. To maintain the reliability of electrical equipment,

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especially transformers, a protection system is required. A protection system is a system that functions to prevent or limit damage to equipment due to disturbances. One type of protection used is the Over Current Relay (OCR). The OCR works by detecting excess current exceeding the predetermined setting value, whether caused by a short circuit between phases or an overload.. (Rahmaniar 2020).

Basically, this 3-phase transformer consists of three single-phase transformers with three iron cores mounted on one frame. The three primary coils and the three secondary coils can be connected in a star connection (Y) and a delta connection (Δ) (Za'im, 2014). Based on the above, the author will try to study more deeply about the analysis of the effect of changing coil turns on a 200Kva power transformer on the performance of the transformer at PT. RAZZA PRIMA TRAFO in order to increase students' insight into power transformers.

Literature Review

Distribution Transformer

Distribution Transformer Is one of the components of a PLN distribution system that functions to connect the network to consumers or to distribute electric power to consumers or customers, both medium voltage customers and low voltage customers. The most well-known definition of an Electric Voltage Distribution Transformer is an Electric Transformer building that contains or consists of installations of Medium Voltage Connection Equipment (PHB-TM), Distribution Transformers, and Low Voltage Connection Equipment (PHBTR) to supply electricity needs for customers with both medium voltage (TM 20 KV) and low voltage (TR 220/380 Volt) Distribution Transformers consist of installations of Medium Voltage Connection Equipment (PHB-TM), Distribution Transformers (TD) and Low Voltage Connection Equipment (PHB-TR) to supply electricity needs for customers with both Medium Voltage (TM 20 kV) and Low Voltage (TR 220/380V) (Wahyudianto, 2009).

Transformer Working Principle

A transformer consists of two inductive coils (primary and secondary). These coils are electrically separate but magnetically connected through a path with low reluctance (Badaruddin, 2012). When the primary coil is connected to an alternating voltage source, an alternating flux will appear in the laminated core, because the coils form a closed network, the primary current flows (Prayoga, et al., 2010). For three-phase transformers, referring to SPLN, there are three types of vector groups used by PLN, namely Yzn5, Dyn5 and Ynyn0. The neutral point is directly connected to the ground. For construction, the distribution transformer equipment must fully refer to SPLN D3.002-1: 2007.

Distribution Transformer Specifications

Transformers are used for the purpose of distributing electrical power from power centers to load usage, the function of distribution transformers is to reduce the voltage to a low voltage (step down) according to consumer equipment other than the needs of the power centers (Mertasana, 2015).

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Figure 1.200kVa transformer and 200Kva transformer name plate

For three-phase transformers, referring to SPLN, there are three types of vector groups used by PLN, namely Yzn5, Dyn5 and Ynyn0. The neutral point is directly connected to the ground. For construction, the distribution transformer equipment must fully refer to SPLN D3.002-1: 2007. Main Parts of a Transformer

a. Iron Core
b. Transformer Coil
c. Transformer Oil
d. Bushing
e. Tanks and Conservators

METHODS

This research was conducted at PT RAZZA PRIMA TRAFO, to analyze the effect of changing the windings of a 200kva transformer coil on transformer performance. The research method used for this research is a descriptive research method using a quantitative approach. Quantitative research is a research method whose specifications are systematic, planned, clearly structured and precise. The descriptive approach is an approach method that functions to describe or provide an overview of the object being studied through data or samples that have been collected without engineering. This study used secondary data from PT RAZZA PRIMA TRAFO, as well as references from books and journals. The data collection methods used in this study were observation, interviews, and documentation. Coil or winding damage in transformers can be caused by several factors, including overload, overheating, damaged insulation and also environmental factors, symptoms of this damage are caused by unstable output voltage, increased resistance in the windings. Handling coil damage in transformer windings generally involves repairing or replacing the winding coils, checking the contacts, and carrying out routine maintenance. Rewinding the coil can be done after identifying the transformer if there is damage to the coil, so that it can be concluded that the condition of the coil on the transformer is suitable for rewinding. In coil winding there are several things that must be done, such as:

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1. Identification of damage to the transformer
2. Old coil removal
3. The transformer core is cleaned from the remains of the old coil.
4. Measurements are taken to determine the number of rolls.
5. Installation of insulation to prevent short circuits
6. A re-inspection is carried out after re-winding to ensure the quality and suitability of the transformer.

A transformer consists of two winding coils, namely the first coil which is called the primary coil and the second coil which is called the secondary coil. The materials needed to wind the transformer winding coils include:

a. Kern, This is a soft iron coil containing silicon that is shaped like the letters E and I.

Figure 2.KERN (Current) or iron core

b. Koker**,** House or place for winding primary and secondary coils

Figure 3.KOKER (Coil winding sleeve)

c. Email Wire, Wire made of copper coated with heat-resistant insulating material.

Figure 4. Enamel wire (copper wire coated with insulating material)

d. The type of cable used in this study in winding a 200Kva transformer is a cable

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called EMAIL DRAT, which is copper coated with insulation (CU), and has a diameter of 1.6mm. For the number of coils on the 200 KVA transformer winding coil, it is according to the type of each transformer, for research on this transformer, winding was carried out with the number of primary coils totaling 2244 turns and secondary coils totaling 24 turns, with the formula:

$$Np / Ns = Vp / Vs$$

Where :
Np = Number of primary turns
Ns = Number of secondary turns
Vp = Primary voltage
Vs = Secondary voltage

After determining the cable diameter, number of coils, and cable material used in winding the 200Kva transformer coil, the process of winding the coil can be carried out.

RESULTS AND DISCUSSION

From the results of the research method carried out before replacing the coil windings on a 200kVA transformer, namely by identifying damage to the transformer, then finding the source of damage to the transformer using a tool called a transformer turns ratio (TTR) tester and a high clamp tester (ampere clamp). If damage has been found that causes damage to the transformer winding side, then the transformer coil winding can be replaced. The results after rewinding the transformer coil windings are tested first to obtain good transformer performance results and in accordance with the transformer capacity resistance.

Before replacing the winding coil, measurements were taken using a TTR transformer turn ratio test (megger) measuring tool. It can be concluded that the location of the damage is in the winding coil section. And in this study, the damage occurred in the primary coil as shown in the following image.

Figure 5. Measurements to find damage to the transformer

After the measurements are carried out, the results of the damage to the primary

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winding of the transformer will be obtained, and can be shown in the following image.

Figure 6. Damaged primary coil of transformer

Then, after finding out the damage to the primary coil, you can rewind the problematic winding coil, which can be seen in the following picture.

Figure 7. The process of rewinding transformer winding coils

Figure 8. The results after rewinding the transformer coil windings

After carrying out the steps to replace the windings on the primary side of the transformer, the next step is to measure and test the primary winding that has been

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replaced, so that when the measurements and tests are carried out, the voltage and current in each phase can be known. This is shown in the following image, where the image shows the measurement and testing process as follows:

Figure 9. Measurement after replacing the winding coil

Figure 10. Testing after replacing the coil winding

Figure 11. Testing after replacing the coil winding

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From the results of measurements and tests carried out for approximately 3 days, the results of voltage measurements on each winding of the 200kVa transformer were obtained, which are explained in Table 1 and Table 2 below:

Table 1. Measurement results from transformer testing after changing the windings

PRIMARY VOLTAGE		SECONDARY VOLTAGE	
INTER-PHASE	VOLT	PHASE - NEUTRAL	VOLT
R - S	401	R - N	221
S - T	407	S - N	237
T - R	375	T - N	222

Table 2. Results of Secondary Current Measurements on a Transformer After Winding Replacement

SECONDARY WINDING CURRENT	
PHASE	AMPERE
R	7.64
S	7.64
T	8.08

From the test data above, it can be concluded that the effect of coil replacement on a 200KVA transformer tends to have less significant resistance compared to a factory-built transformer that hasn't had its coils replaced. Therefore, regular maintenance is required to maximize the transformer's performance.

CONCLUSION

Conclusion of this paper are: After testing the transformer, it can be concluded that the effect of changing the windings on the 200Kva transformer is that the results of the voltage measurements on the Primary Winding between phases R-S = 410 V, phase ST = 407 V and phase TR = 375V. and the Secondary voltage between phases and Neutral is RN = 221V, SN = 237V and TN = 222V. and the current in the Secondary winding between phases is R = 7.64A, phase S = 7.64A and phase T = 8.08A. After testing the transformer, it can be concluded that the effect of changing the windings on the 200Kva transformer has a resistance of approximately 85% of the factory transformer, due to the replacement of several components which are carried out manually, resulting in reduced performance resistance on the transformer. To prevent the same problem from occurring, routine maintenance should be carried out to maximize the durability performance of transformers that have been reconditioned or rewound.

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