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Electrical Strength of Transformer Oil Research on the Dependence to Water and Mechanical Mixture Quantity

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ABSTRACT: This article studies the effect of the amount of water and mechanical mixture in the oil, which has long died in operation, on the electrical strength of the oil. The combined effects of the amount of water in the oil and the amount of mechanical mixing have been researched. The main reason for premature failure of power transformers is a violation of liquid and solid insulation. Therefore, it is an urgent matter to study the technical condition of liquid insulation and monitor the factors that negatively affect its electrical properties.

KEY WORDS: power transformer, oil, mechanical mixture, water, humidity, breakdown voltage, electrical strength.

I. INTRODUCTION

Considering that high-voltage oil power transformers operate continuously 24 hours a day overnight, 365 days a year. It is known to everyone that Transformers work both in hot summer conditions, in rainy days with high humidity and in cold winter climates [1-2]. Therefore, in the summer season, water and mechanical impurities from the slit have been observed to enter the transformer tank with an increase in moisture due to rubber stretching, burns and abrasions under the cover due to overheating of Transformers. This in turn affects the breakdown of the oil composition, which is the liquid insulation of the transformer, and the electrical properties of the oil in particular the electrical strength of the oil [2]. The puncture voltage is very sensitive to the presence of impurities. With the slightest change in the moisture content of the transformer oil and the presence of impurities in it, the dielectric strength drops sharply. It is relevant to study the dependence of the amount of water and mechanical mixture in the oil on the puncture voltage.

II. SIGNIFICANCE OF THE SYSTEM

The purpose of the study is to study the dependence of the amount of water and mechanical mixture on the electrical strength of transformer oils in long-term operating conditions [4-5]. The materials and methods of the study used the regression analysis method and methods of systematic analysis of the results in the research process, and mathematical models were developed. Its advantages, which in the research process used the device HZJQ-X1 Figure 1, which measures the electrical strength of modern transformer oil: small size, having its own internal printer, high measurement speed and accuracy [2,3].

III. LITERATURE SURVEY

Oil degradation processes The factors affecting oil degradation are inextricably linked with each other, and are largely influenced by increased temperature. With oil heating, the following processes are observed:

1. Increase in the amount of emulsified water in the oil: as the oil heats up, free water that does not interfere with the oil gradually decomposes and adds to the oil content, causing deterioration of parameters such as the dielectric strength of the oil, dielectric Ruby, flash temperature viscosity and acid number.
2. Increased gas concentration: water molecules in the oil increase the concentration of different gases (hydrogen, methane, ethane, ethylene, acetylene, carbon monoxide and carbon dioxide) due to the chemical reaction these gases cause malfunctions in different internal parts of the transformer (detailed harg method).
3. Degradation of solid insulation: the increase in the concentration of water and gases does not erode the vacuum insulation of the transformer and dramatically reduces the insulating properties of the insulation. Through the Furan diagnostic method, the state of paper insulation and possible disorders of origin are predicted.
4. Partial discharge States: an increase in the concentration of water and gas causes partial discharge States, which leads to the appearance of mechanical impurities.

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5. Increased viscosity: processes in the oil result in increased viscosity, which limits the free movement of oil in transformer radiator tubes and causes resin to form in the chull and magnetic core parts. As a result, the cooling function of the oil decreases.

Dependence of oil temperature with increased transformer temperature

The temperature of the transformer increases due to external and internal factors.

1. External temperature: as a result of continuous operation of Transformers, days with a temperature of 40ºC are observed in the summer season for 30-40 days. The iron body of the transformer absorbs the temperature and increases the internal temperature.

2. Internal temperature: in the process of energy transformation in the lungs and magnetic cores, the temperature rises.

With an increase in the external and internal temperature, the temperature of the transformer housing and oil increases sharply. The increase in temperature accelerates the degradation process of the oil and negatively affects its physicochemical properties.

IV. METHODOLOGY

As a result of the breakdown of the paper insulation of the insulation medium of power transformers, a short circuit process occurs in copper pipes, which, as a result, causes the transformer to be obtained from premature operation. A major influencing agent for paper insulation degradation is liquid insulation. Because liquid insulation is impregnated with permanent paper insulation, it has been found that the physicochemical parameters of these two insulation agents are related to each other in bevosti. Therefore, the assessment of the technical condition of the transformer by diagnosing the physicochemical indicators of liquid insulation is an urgent issue. A number of factors negatively affect the physicochemical indicators of oil.

V. EXPERIMENTAL RESULTS

Fig 1. HZJQ-X1 device measuring transformer oil electrical strength

In preparation for the study, we collect the necessary equipment these: plastic containers, oil, measuring containers, liquid for washing the container, water and measuring instrument; We conduct the study as follows: first of all, we determine the electrical strength of the purified oil sample.

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Fig. 2. Medium electrical strength of transformer oil

Fig. 3. Results from a sample with the addition of water and a mechanical mixture

In the study of the effect of 1ml of water on transformer oil and the amount of mechanical mixture, we carry out the following research: in the study, we separate the purified transformer oil into 5 pieces 250ml containers and mix the mechanical mixture with 1ml of water and increasing the amount in each container Figure 2 and Figure 3.

We will determine the puncture voltage using a device that determines the electrical strength of the oil in the finished Research ammunition. Using the results obtained, we determine the plot of the dependence of the amount of 1ml of water and mechanical mixture in the oil on the puncture voltage, as well as the law of change.

A dependence graph Figure 4 as well as a mathematical model (1) of the amount of 1ml of water and mechanical mixture can be seen in the transformer oil. We first measure the perforation voltage of the purified oil (31 kV). In the next step, we check in order our mixtures prepared above. We enter the results in Table 1. The graph shown in Figure 4 shows that the electrical strength of the oil decreases sharply with an increase in the amount of 1ml of water and mechanical mixture in the oil. Using Table 1, we find the 1ml of water in the oil as well as the amount of mechanical mixture with the functions of dependence on the electrical strength of the oil. The functions corresponding to the resulting function are determined using a computer program. We get the connection with the polynomial function, exponential function and linear functions, and the function closest to the graph as the law of change.

Table 1. Test results that increase the amount of mechanical mixture when the oil contains 1 ml of water

№	Mechanical mixture quantity, ml	Breakdown voltage, kV	Oil quantity, gr
1	-	31	250
2	1	24	250
3	2	22	250
4	3	19	250
5	4	16	250
6	5	15	250

$$y = 0{,}4643x^2 - 5{,}3786x + 30{,}357$$
$$R^2 = 0{,}9815 \quad (1)$$

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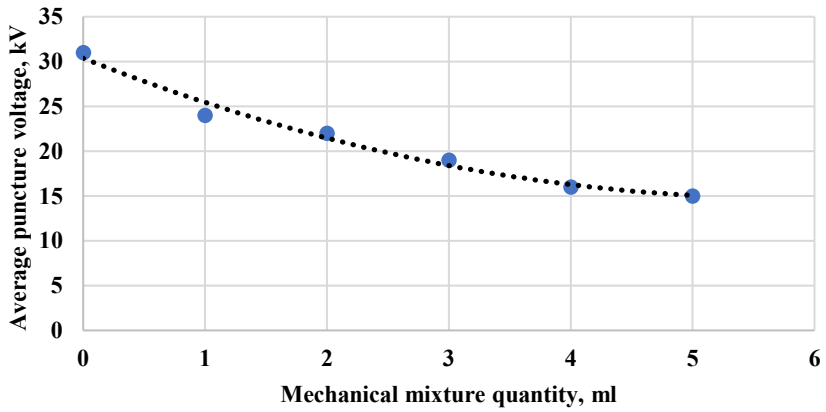

Fig. 4. Graph of the dependence of the amount of 1ml of water and mechanical mixture in the oil on the electrical strength of the oil (polynomial function)

Table 2. Derived regression dependencies

№	Function type	Function	R^2
1	Polynomial	$y = 0{,}4643x^2 - 5{,}3786x + 30{,}357$	0,9815
2	Exponential	$y = 29{,}312e^{-0{,}143x}$	0,9695
3	Linear	$y = -3{,}0571x + 28{,}81$	0,9355

Since the results obtained using a polynomial function from the square functions in Table 2 above are more accurate than the rest of the results, we choose a polynomial function [1].

The above function meant that 1ml of water and 1gr of mechanical mixture in the oil were found to reduce the oil's puncture voltage by 29.4%. With an increase in the oil content of 1ml of water and a mechanical mixture, it has been found that the oil's puncture voltage [1,2] varies by law. In place of the conclusion, it can be said that using the above graph as well as the function, it is possible to determine the reliability of transformer oils, as well as the amount of water in the oil.

VI. CONCLUSION AND FUTURE WORK

A model of the joint action of moisture and mechanical mixture on the power transformer oil has been identified. It was found that the moisture content of transformer oil (1 ml) to the state of transformer insulation worsened by 24%, and the amount of mechanical impurities in its composition (1 gr) worsened by 5% [2,3]. Focusing on the results of the study, the amount of moisture in transformer oil is slightly less than the amount of mechanical mixture, as long as it leads to a deterioration in electrical strength by five times. It turned out that the combined effect of the effects on the different type on the state of the isolation of the transformer worsened by 29%. The combined effect of water and mechanical impurities on the electrical strength of the oil was found to be stronger than the individual effects of these factors.

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