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ANALYSIS OF TRANSFORMER OIL TESTING EQUIPMENT

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ABSTRACT

Transformer oil is subject to various factors such as electrical, thermal, and chemical contamination, which can lead to improper operation of transformers. Transformer oil plays a crucial role, particularly in cooling transformers. Transformer oils must undergo testing and analysis for several reasons:

- To determine key electrical properties
- To assess the oil's suitability for continued use
- To extend component service life
- To identify transformer aging conditions
- To detect electrical or thermal faults
- To evaluate oil quality

Transformer oil is vital for ensuring the reliability and long-term performance of electrical equipment. Special testing devices are used to timely determine the oil's quality and condition. This article analyzes the types of transformer oil testing equipment, their working principles, and their significance.

KEYWORDS

Transformer oil, Dielectric strength, KF analyzer, DGA device.

Introduction

Transformer oil plays a crucial role in our daily lives, particularly in **power supply, transmission, and distribution systems**, as well as in industrial plants where numerous transformers are installed. The larger the transformer, the higher its operating temperature becomes. If heat dissipation is inadequate, it can significantly **shorten the transformer's operational lifespan**. Transformer oil possesses cooling properties that help **delay aging and extend the transformer's service life** by efficiently dissipating heat.

Transformer oil is a mineral-based oil derived from the distillation and refining of crude petroleum. It is a pure and stable liquid consisting of a mixture of natural hydrocarbons obtained from the lubricating oil fraction of petroleum, processed to remove acids and hydroxides to achieve low viscosity, excellent insulation, and optimal cooling properties.

During the operation of transformer oil, the quality of the oil deteriorates due to aging and degradation of the oil itself as well as contamination from the external environment. This affects the transformer's insulation, heat dissipation, and arc suppression capabilities. During transformer operation, partial discharge heating of the insulation leads to the formation of chemical gases in the transformer oil.

1. Importance of Transformer Oil

Transformer oil performs the following key functions: **electrical insulation, cooling, and corrosion prevention**.

- **Electrical Insulation** – Provides insulation between high-voltage components inside the transformer.
- **Cooling** – Dissipates heat generated during transformer operation.
- **Corrosion Prevention** – Protects metal parts from oxidation and rusting.

Deterioration in oil quality can lead to **transformer failure**, making regular testing and monitoring essential.

2. Types of Transformer Oil Testing Equipment

2.1. Dielectric Strength Testers

These devices measure the insulating properties of transformer oil by applying high voltage (typically 0-80 kV or 0-100 kV). The breakdown voltage indicates the oil's dielectric strength.

- **Standards:** IEC 60156, ASTM D1816.
- **Example device:** MOM-100 (measures dielectric breakdown voltage).

2.2. Moisture Content Analyzers (KF Coulometers)

These instruments determine water content in transformer oil using the **Karl Fischer (KF) titration method**. Excess moisture reduces the oil's insulating properties.

- **Example device:** Metrohm 831 KF Coulometer.

2.3. Dissolved Gas Analyzers (DGA)

DGA devices detect and quantify dissolved gases (H_2, CH_4, C_2H_2, CO) in transformer oil. Gas concentrations help identify internal faults (e.g., arcing, overheating).

- **Example device:** LumaSense Technologies TD-500.

2.4. pH and Acidity Testers

These measure the **pH level** and **Total Acid Number (TAN)** of the oil. High acidity accelerates corrosion of transformer components.

- **Example device:** Hach Sension+ pH meter.

3. Operating Principle of Testing Devices

1. **A sample of transformer oil is collected.**
2. **The device measures various parameters** of the oil (dielectric strength, moisture content, gas composition).
3. **The obtained data is compared with standards** to determine the oil's condition.

4. Comparison of Testing Devices

Parameter	Dielectric Strength Tester	KF Analyzer (Karl Fischer)	DGA Device (Dissolved Gas Analyzer)
Measured Parameter	Insulation strength	Water content (ppm)	Dissolved gases (H_2, CH_4, C_2H_2, etc.)
Testing Speed	5-10 minutes	10-15 minutes	30-60 minutes
ost Range	Affordable ($500-$2,000)	Mid-range ($3,000-$8,000)	Expensive ($10,000+)

CONCLUSION

Transformer oil testing devices play a crucial role in ensuring the reliability of electrical networks. Each device is designed to determine specific parameters, and their proper selection and application ensure the long-term operation of transformers.

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