

Transformers

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86 TRANSFORMER ASSESSMENT USING HEALTH INDEX: SENSITIVITY ANALYSIS AND CRITICAL DISCUSSION

Bhaba DAS, Luiz CHEIM

Transformer health indexing has become a popular tool for performing transformer health assessments on a larger fleet of transformers. Sensitivity analysis of the “scoring” and “weighting” health indexing approach is presented in this article. The need for a more “sensitive” model is discussed.



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94 21 ADVANTAGES OF USING MICAFLUID TECHNOLOGY IN 2021

One of the world's leaders in delivering the highest quality oil purification systems, MICAFLUID from Switzerland is on a mission to give a longer and better life to transformers. The article brings 21 advantages of using MICAFLUID technology to address challenges for 2021.



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104 USING COMPUTER-AIDED ENGINEERING TO ENABLE THE DIGITALISATION OF TRANSFORMERS

John WANJIKU, Mike GRUETZMACHER

The main challenges in applying virtual twin models and prototypes is the long simulation times that make it difficult to explore designs in development and to forecast scenarios during operation. However, by applying some unique techniques described in the article, the simulation turn-around time needed to yield actionable information can be reduced significantly without foregoing accuracy.



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112 COST EFFECTIVE ON-SITE LEAK REPAIR OF POWER TRANSFORMERS

The proper functioning of oil and SF₆ insulated equipment, which are essential components of electrical grids around the world, is critical. The quick and cost-effective repair of power transformer leaks ensures reliable and high-quality electrical services to homes, businesses, and industries. The PowerPatch family of leak repair sealants allows for the safe and economical repair of oil and gas leaks in a variety of transformer and switchgear equipment.



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116 PRELIMINARY ASSESSMENT OF THE TECHNICAL CONDITION OF THE POWER TRANSFORMER BASED ON REGULAR OIL TESTING

Marek SZROT, Janusz PŁOWUCHA, Jan SUBOCZ, Patryk BOHATYREWICZ

As the acquisition of operation data concerning the technical state of the transformer is limited during its lifetime, it is crucial to use all available samples. The article presents an expert system based on the most common procedures performed during periodical maintenance - the oil tests.



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124 MORE RELIABLE TRANSFORMER THANKS TO PHENOLIC-GLUED PRESSBOARD

Röchling is a manufacturer of insulation material made of high-quality laminated pressboard designed to address the highest demands on electrical, mechanical, and thermal properties. Trafoboard® is such an insulation material made of high-quality laminated pressboard. Röchling has had several decades of experience with the phenolic resin for use in oil-filled transformers.



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128 BENEFITS OF SMART BREATHERS

Emilio MORALES CRUZ

The life of the transformer depends on the quality of insulation which depends on temperature and moisture level. Breathers are moisture safety barriers for transformers. Traditional breathers are a low-cost solution, but they require maintenance and often use toxic materials. Smart breathers require no maintenance and associated costs and offer features like data logging and self-analysis.



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134 TRANSFORMER SAFETY IS PARAMOUNT, BUT ARE WE ACTING ON IT?

Barry MENZIES

From the inconvenient to the catastrophic, a transformer failure can mean anything from a slight glitch to months of business disruption. The article discusses which transformers are particularly at risk and how to mitigate those risks. The safety of the transformer will ensure workers' safety as well as the reliable continuation of the business.



21 advantages of using MICAFLUID technology in 2021

Headquartered in Switzerland and with operation centres in the EU, MICAFLUID is the sole beneficiary of a century-old heritage of extensive knowledge and experience in the power industry, making it a world leader in the engineering and development of insulating oil treatment, regeneration, and integrated systems.

Electricity is one of the most crucial discoveries in human history, providing comfort, encouraging inventions, and having huge importance fuelling our everyday life.

The most important enabler of all these possibilities are transformers, located on all branches of the power-line. Yet, a great number of transformers in use are already at, or close to, the end of their lifecycle. The ongoing integration of renewable energy-systems is causing fluctuations to occur more strongly and more frequently, endangering the stability of the system [1].

Essential to the life expectancy of any transformer is the state of its insulating oil. Not only is it an integral part

of the oil and paper insulation system, but it also serves to provide cooling and health indicators through oil analysis.

However, over time, the ageing rate of transformer oils, besides temperature, is accelerated by water, oxygen and gas content as well as acids derived from oil degradation. These, along with other contaminants adversely affect the dielectric strength of the oil resulting in a lower Breakdown Voltage (BDV), propagating into a series of operational issues which shorten the service life of the asset.



Insulation oil types and how to treat them?

It is well known that the main oil types in use today for insulations fall within the following categories:

- Naphthenic-based mineral oil
- Paraffinic-based mineral oil
- Synthetic ester oil
- Natural ester oil
- Silicone oil

Each fluid has a different set of characteristics which make them better suited to certain applications, conditions, and cost.

Mineral oil is the most widely used insulation oil despite having some disadvantages due to its limited biodegradability and low fire point. It is important to avoid light fractions in a vacuum and thermal cracking during treatment.

Synthetic ester is chemically derived and

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Driven by Swiss technology since 1913, MICAFLUID is on a mission to give a longer and better life to transformers

optimized to have a higher fire point as well as better water solubility and higher viscosity in comparison to mineral oil. Treatment, therefore, requires a higher process temperature, increased vacuum capacity and specific process cycles to avoid poor treatment results.

Natural esters are vegetable-based fluids which appear to satisfy the growing trend towards greener, more biodegradable fluids while presenting high flash and fire points. Its higher viscosity also calls for a higher vacuum capacity and more specific treatment parameters.

Silicone is a synthetic fluid which has self-extinguishing characteristics with good thermal stability. It also requires increased heat and vacuum for treatment due to its extremely high viscosity. Furthermore, due to its non-compatibility with other fluids, treatment systems have to be dedicated to silicone oil treatment only, to avoid contamination of other oils.

MICAFLUID VOP treatment systems are prepared to treat **all types of oils**, and we are committed to delivering high-quality oil purification systems which keep up with the latest developments in the world of insulation oils.

Furthermore, due to an array of technical features which guarantee effective vacuum-tight treatment without the risk of microbubbles or contamination, MICAFLUID systems ensure process integrity without any compromises to



CRP regeneration plant inlet and outlet oil colour change

the asset whether in a production line or substation.

21 advantages of using MICAFLUID technology in 2021

1. Efficient degassing with the single-stage vacuum

MICAFLUID plants require only the smallest suction capacity from the vacuum pumps as the operating pressure for effective degassing is between 1 - 9 mbar.

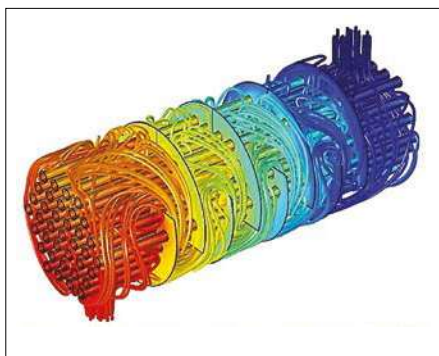
2. Optimized electric heating system with horizontal configuration

The oil is indirectly heated and automatically regulated to within 1 °C of the

Essential to the life expectancy of any transformer is the state of the oil which is an integral part of the transformer's insulation system, serves as a coolant and is used as a health indicator through oil analysis

MICAFLUID VOP treatment systems are prepared to treat all types of oils, and we are committed to delivering high-quality oil purification systems which keep up with the latest developments in the world of insulation oils

setpoint while ensuring a thermal flux of $< 1 \text{ W / cm}^2$ which prevents hot spot cracking of the oil and guarantees its integrity.



CFD VOP baffle heating system [2]

3. The complete system is vacuum tight

The entire system is vacuum leak tested with a guaranteed leakage rate of $< 0.025 \text{ mbar} \cdot \text{l / s}$, thus eliminating any entry of air into the process. No inlet feeding pump is therefore required for normal oil treatment.

4. Variable flow-through

Due to an oil level control system, especially developed by MICAFLUID, the oil flow is automatically adjusted to the flow-throughput setpoint without the risk of flooding. MICAFLUID systems are designed to ensure laminar flow on the outlet, which prevents the creation of microbubbles usually caused by turbulence.

5. Thin-film degassing

The patented oil distribution system for **maintenance-free** thin-film degassing over the Raschig rings packed columns is known to be the most efficient method of dehydrating and degassing insulating oil. This had been proven in a study performed at the ETH Zurich.

6. Automatic froth control

All VOP plants are equipped with an anti-froth control system. In case of unexpected foaming, the system detects and automatically reduces suction and flow through in the degasser **without breaking vacuum**. This helps the treatment of **high viscosity oils**.

7. Filtration with clog detection and automatic control

Three options for fine filters are used in MICAFLUID systems, namely nylon, polypropylene and fibreglass with varying characteristics depending on the final application:

- Beta X from $\beta 1000$ to $\beta 5000$
- Nominal fineness from $0,35 \mu\text{m}$ to $5 \mu\text{m}$
- Temperature range up to 120°C .

Furthermore, clog detection allows for early warning of a required filter change which can then be performed safely during treatment without stoppages or the introduction of air into the system and process.

8. In-line gas and water content measurement



VZ212A applied on a VOP plant to measure water and total gas content

9. In-line Tan Delta measurement



VZ220A applied on a VOP plant to measure Tan Delta

10. In-line breakdown voltage measurement with MicaSonic™



MicaSonic™ applied on a VOP plant to measure:
- Breakdown voltage [kV]
- Moisture content [ppm]
(at 20°C and actual temp. as per IEC)

11. Process supervision

All MICAFLUID plants are controlled by PLC, which automatically control and supervise each operating step and provide process trend data and alarm history.

12. Alarming

Essential to process supervision is the diagnosis and alarming. MICAFLUID systems generate information alarm dialogues both on the HMI and via SMS for immediate operator notification and action.

13. Safety functions

Adhering to safety standards such as ISO / DIS 13849 - 1, MICAFLUID takes the safety of the operators, process and system very seriously and therefore have standard features such as overpressure and temperature protection for the entire installation. Further features such as a leak or flood detection, dry run protection and phase sequence control ensure continuous fail-safe operation.

14. Operator friendly

With an intuitive touch screen interface, operation of any MICAFLUID system is child's play, reducing the time needed for operator training.

15. Industry 4.0

With the use of smart communication protocols and sensors, MICAFLUID systems are prepared for full client-side integration embracing the Fourth Industrial Revolution.

16. Online treatment process on the energized transformer

MICAFLUID plants are prepared to perform on onload treatment of transformers using the adaptable onload kit which ensures a completely vacuum-tight process from start to end.

17. IEC compliant & energy efficient

All units are IEC compliant, thereby achieving the required performance with efficient energy consumption.

18. Low maintenance

The robust plant design requires minimum intervention, limited to vacuum pump oil and filter change. Furthermore, since MICAFLUID units are vacuum-tight long-term storage even in high humidity corrosive environments.

19. Spare parts guarantee

MICAFLUID offers outstanding spare parts and after-sales service during the lifecycle of the plants.

20. Retrofittable accessories

Retrofit of all supplements or optional accessories, offered by MICAFLUID, can

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MICAFLUID is committed to delivering the highest quality oil purification systems, our team is fully dedicated and constantly innovating a wide range of products and services focusing on the customer's requirements

be installed by the customer without additional mechanical works on the plants.

21. Cost and travel reduction with MVA support platform



By subscribing to Micafluid's machine virtual assistance (MVA) support platform, users have instant access to remotely control and supervise their machine as well as direct Micafluid technical support and online diagnosis via secure sockets layer (SSL).

MVA quickly enables companies to remotely view and act on the oil treatment operation, reducing downtime, as well as travel and operator costs.

Furthermore, having the possibility to perform site or factory acceptance tests and as well as training remotely, MICAFLUID is able to drastically reduce its carbon footprint.



MVA support platform

Our range includes:

VOP - Variable Oil Purification
CRP - Conventional Regeneration
VPU - Vacuum Systems
OFP - Oil Filtration
HOS - Hot Oil Spray
ODS - Oil Distribution Systems



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