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The Insulating Oils in Electrical Power Transformers

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Abstract

After the composition of the petroleum which prove, the insulated oils are paraffinic or naphthenic, being used as: cooling medium, electrical insulation, arc extinguishing means. The problem of static electricity oil in large power transformers appeared in years 1980 after the breakthrough of a large number of devices, soon after their operation, because of the electrostatic charges created by very rapid movement of oil for cooling windings. To study the behavior of oil-pressboard composite insulation under DC was used the electro-optical method Kerr. This paper presents a stand for checking gas relays.

Key words: *electric field, transformer, insulating oil, sustainable developmen.t*

Introduction

The mineral oil in transformer insulating oil was first patented in the U.S.A. in 1887. First use dates to 1892. At first, they were in the category of paraffinic oils. By 1925 naphthenic mineral oil were equally popular in the commercial market.

Later they were introduced gradually and additives (antioxidants, enhancers flashpoint). Refining processes were also improved in these years. Consequently, current oil not like too much oil used first. Composition provides a wide availability and are used in virtually all types of electrical.devices. Annual consumption is estimated at 1 million tonnes. Around 80% are used in transformers also are used in capacitive insulating crossing, load control switches, splitters, switches and cables.

Until the late 1960s, no poses the problems of toxicity or environmental. The discovery of global pollution with polychlorinated biphenyls (PCB) revealed weaknesses in the overall insulating liquids, which have become subjects for media. The result was a growing suspicion more their security, their use is becoming more restricted and subject to regulations of national authorities, based on the concept of *sustainable development*. This phobia has led researchers to study and find substitutes for „green oil", based on vegetable oils [1].

Static Electricity of the Liquids in Flowing

A particular manifestation of low electrokinetic effects is static electricity of the liquids, particularly oil forced circulation to provide cooling power transformers and also for example to fill the tanks of aircraft or land vehicles. Generating a unipolar space charge by rubbing on fences (lead and insulation), then transported by flow generates a high electric field in the liquid, leading to breakthroughs in transformer (degradation and removal of service), explosions and fires in pumping various liquids.

The problem of static electricity oil in large power transformers occurred in the early 1980s, after the breakthrough of a large number of devices, soon after their operation. Studies have shown that the breakthrough was due to the occurrence of electrostatic charges created by the very rapid movement of oil to cool the windings. Separation of oil and insulating surfaces (wrapping paper) causes the accumulation of ions in different areas (usually positive loads above and below negative charge) and lead to an electrostatic field, which overlaps with the alternating electric field device. Partial discharge or unloading surfaces arc can occur before a breakthrough leading to the transformer [2].

Measurement in space and time distribution of the electric field in liquid. is of great practical importance in problems of isolation. A high reliability optical method allows to achieve this objective by using the electro-otic Kerr's, which offers the advantage of not introducing any disturbance in the studied phenomena (such as method of introducing probes in liquid). . We give below some general information about the Kerr effect and use in practice to measure the electric field [3].

Of course, most anisotropy are bi-refrigerant, them with a secure anisotropy to due their structure. Similar optical phenomena can be observed in more isotropic media is emerging as an asymmetry due to external actions. This is called accidental bi-refrigerant. The vast majority are bi-refrigerant liquids when subjected to an electric field. Kerr effect is called electric bi-refrigerant. Direction electric field E is a prime author of this phenomenon represents a revolution symmetry, optical properties of liquid crystal are those of uniax, so the optical axis direction of the electric field is even. When a light plane parallel electrodes of a capacitor filled with a liquid, the length λ. Experience shows that the radiation wavelength, Kerr's law has the following expression:

$$n_e - n_0 = B\lambda E^2 \tag{1}$$

n_0 - ordinary index corresponding vibration perpendicular field,

n_e - showing great relative to the vibration parallel field,

B - Kerr's constant fluid wavelength.

To sign (n_e-n_0) sign is independent of field, the general properties of a liquid crystal having positive uniax and; B>0. When using a linear polarized light beam, after crossing the condenser, it shows that the phase shift between the two vibrations is:

$$\varphi = 2\pi B\varepsilon E^2 \tag{2}$$

If working between polarizer and analyzer “crossover” and so the axes are arranged at 45 ˚ to the direction of electric field luminous intensity I of vibration analysis is related to the incidence intensity according to the relationship:

$$I = I_0 \sin^2 \frac{\varphi}{2} \tag{3}$$

Radiation wavelength λ is extinguished because $\sin^2 \frac{\varphi}{2} = 0$,

or when:

$$B\varepsilon E^2 = m \tag{4}$$

with m positive.

If the field is uniform in the liquid is evenly lit spatula between the electrodes or stopped. Contrary to a heterogeneous field will correspond to a variable light. We also see clear areas of shadow fringes corresponding to a well-defined field, which draws a clear map of the field to assess the spatial tasks. If uniformity of field is very large, liquid filled cells, having large Kerr's constant (unionized, for example nitrobenzene) have enabled the rapid shutters and light modulators.

Note that Kerr's constant is very high for polar liquids ($B = 4{,}44x10^{-12}$ m·V^{-2} for nitrobenzene) and much lower for non-polar liquids ($B = 4{,}44x10^{-15}$ m·V^{-2} for benzene comparable with transformer oil). whether you have intense fields or weak fields should use sophisticated devices.

Kerr electro-optical method was used to study the behavior of oil-pressboard composite insulation under voltage, Fig. 1.a.

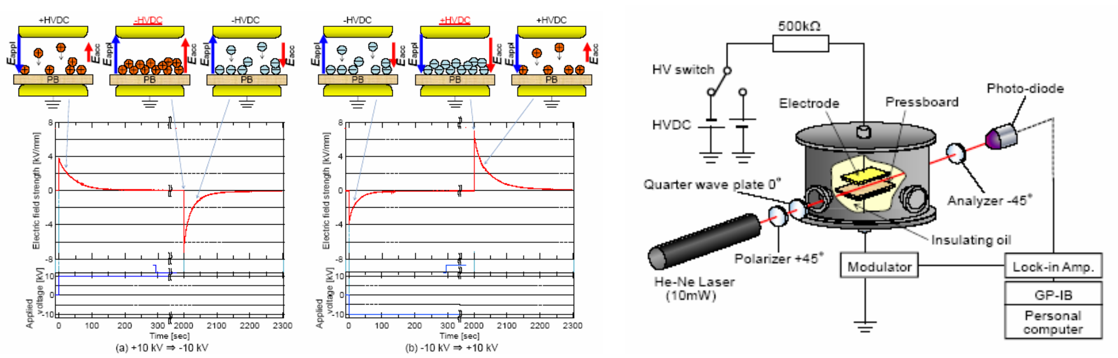

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Fig. 1 Kerr electro -optical Method : a) the electric field distribution in composite oil-pressboard insulation; b) schematic diagram of the device to measure electric field strength Kerr method

The oil-pressboard insulation composite was measured electric field strength of mineral oil by electro-optical method, Figure 1 b. Density of electric charge accumulation on the pressboard was estimated. Considering the intensity of the electric field generated by electric charge accumulation on the pressboard was derived critical value of electric field intensity which initiates discharge in oil. The following results were obtained:

1. Electric field strength in oil immediately after blood increases with a capacitive distribution and gradually decline over time because the electrical charges accumulate on the pressboard;
2. Immediately after changing polarity electric field strength in oil is the sum of the electric field strength generated by the accumulation of electrostatic charges on the pressboard and applied electric field strength. This value is approximately two times the voltage applied to the top, where the voltage level is equal before and after polarity reversal;
3. Downloading the reverse polarity is initiated when the amount of electric field strength generated by the accumulation of tasks cardboard applied electric field strength exceeds the breakdown electric field strength in oil.

At the first time, elecromagnetic properties of the light were studied by Michael Faraday, in 1845 with the device of Fig. 3. On an insulating base 1 is placed an electromagnet 2. Radius light of the natural world is directed by lens 3 to massive piece of glass 4, the area is deflected through the electromacnetic field. This change is seen through the lens 5 and demonstrates connection between light and electromagnetism [4].

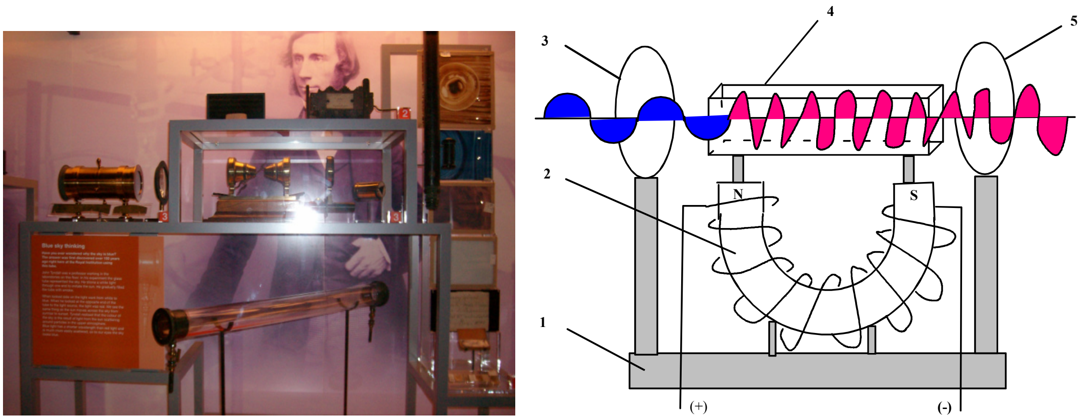

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Fig. 2 Device for the study of electromagnetic properties of light: a) Piece of the Michael Faraday Museum, 1845; b) Scheme of the experiment: 1- insulating base; 2- electromagnet; 3 - lens through which beam natural light,; 4 - thick glass; 5 - lens observed that the beam deformed.

Stand for Checking Gas Relays

We present below a stand for checking gas relays [5], which are mounted on electrical conduction of the power transformer tank and the conservative oil to protect internal processor faults.

In order to check the gas relay is known a solution [6], for checking gas relays, consisting primarily of a device for measuring the response time in case of contact with mercury tilt, which are equipped with most relays mounted gas power transformers in operation in power system. The disadvantage of this solution is that it requires a large number of attempts to carry out verification, namely to establish the threshold for operating the relay, leading to a higher cost price, while decreasing reliability.

Stand, according to the invention removes the disadvantages mentioned in that, is composed primarily of a supporting frame which is fixed an oil tank, tank shaping power transformer and two mounting flanges for gas relay, as those from the transformer, electric insulating oil which is circulated by a pump, thus realizing the condition of pressure necessary for the relay to operate.

The invention has the following advantages: low cost price, high reliability and better modeling of actual operating conditions of gas relays. It further gives an example in connection with Fig. 3 b, which is schematic diagram of the stand for check gas relays.

Stand for checking gas relays, according to the invention, consisting of a supporting frame 1, which is mounted a tank 2, which is a quantity of oil that is pushed by a pump 3, through a pipeline 4, passing through the flanges 5 and 5 ', under which is fixed verification gas relay. A dial gauge pressure measured 6 to oil gas passing through the relay to determine the threshold of operation of the relay, after which the oil returns through the pipe 4' in tank 2. For the best possible conditions simulation of power transformers in operation, oil is heated by a resistor 7, the temperature was measured with a thermometer with electrical contacts 8, bringing the temperature being monitored by a power unit and control 9.

Is a simulation as perfectly real conditions of temperature and pressure of oil flow to working in case of failure, gas relays mounted on electric power transformers in operation in power system.

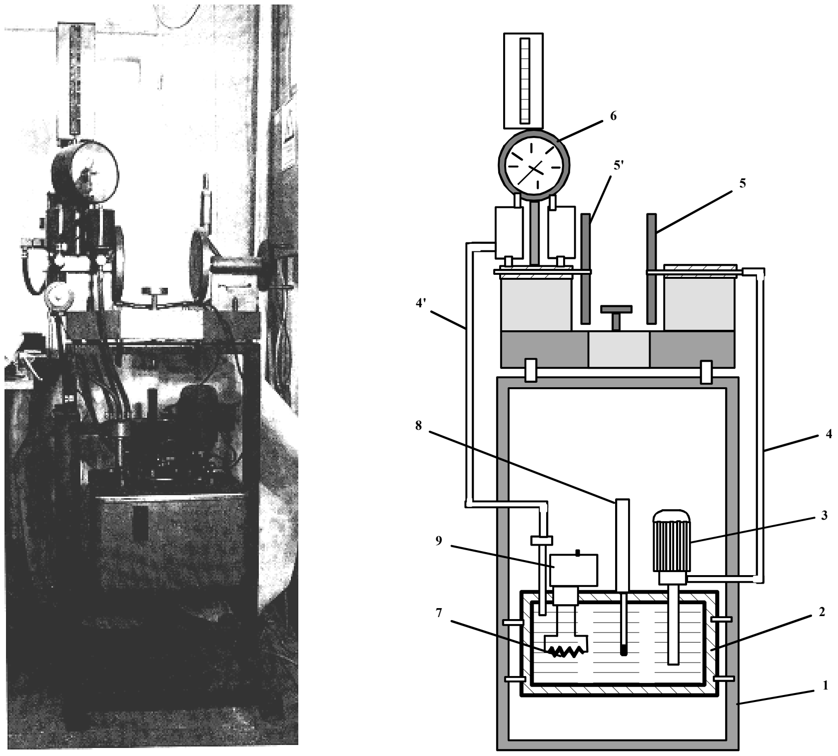

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Fig. 3 Stand for check gas relays: a) Overview; b) The principle scheme: 1 - supporting frame; 2 - oil tank; 3 - oil circulation pump; 4 and 4' - pipelines; 5 and 5' - pipe flanges for gas relay connection; 6 - dial gauge; 7 - resistance heating; 8 - electric contact thermometer; 9 - power and thermostatic

Conclusions

1. In the vicinity of a solid insulating shield, there is excess ion density whose importance was long unsuspected laws governing its formation are still imperfectly known, but their influence on the conduction and dielectric loss is undoubtedly very important, and its role in the breakthrough impregnated insulation.

2. Basic protection of power transformers insulation for liquid gas accumulations is equipped with special gas called relays (relays Buchholz) [7]. Currently, in the gas relays field, studies were developed in the following way [8]:

- improve the operation conditions of vibration contact with mercury tilt;
- new solutions for safer switching systems for vibration and seismic conditions;
- increased sensitivity to gas relays for use in case of small power transformers and special purpose;
- carrying three relays distinct functions: sign to the slow accumulation of gas, trigger violence if accompanied by the formation of defects where oil from a tank to conservative, trigger for lower oil levels as a result of leaks.

References

1. Cujbă, T. O. *Contribuţii teoretice şi experimentale preliminarii în domeniul creşterii siguranţei în exploatare a transformatoarelor electrice de putere,* Referat II în cadrul stagiului de pregătire pentru doctoat (coordonat de prof.dr.ing. D. Cernomazu), Universitatea “Ştefan cel Mare” Suceava, 2010.

2. Nara, T.; Kato, K; Endo, F and Okubo,H. *Study on Dielectric Breakdown at DC Polarity in Oil/ pressboard-composite Insulation System* Conference on Electric Insulation and Dielectric Phenomena, Virginia Beach, SUA, 2009.
3. Lesaint, G.; Gournaz, P.; Tobazêon, R. *Investigations on Transient Currents Associated with Strimer propagation in Dielectric Liquids* (Investigations sur les courants streamers dans les liquides diélectriques), IEEE Trans. On Electr. Insul, EI 26, Nr. 4, 1991, pag.699-707.
4. Cernomazu, D., Cujba, T. O. *Michael Faraday - Three Famous Experiments,* 3th Inernational Symposium o the History of Elecrical Engineering and of Tertiary-Level Engineering Education IEEI, Iasi,, October, 27-29, 2010.
5. Cujbă, T. O., Cernomazu, D. *Stand pentru verificarea releelor de gaze,* Cerere de brevet de invenție, A/00693 din 03.08.2010, OSIM, Bucureşti.
6. Cernomazu, D., *Instalație pentru măsurarea timpului de răspuns în aer la sistemele de comutație aferente releelor de gaze* Brevet RO Nr. 93601, Bucureşti: OSIM, 1986
7. *** www.scando.ro
8. Cernomazu, D.; Ciobanu, C.; Rață, M., *Studii pentru perfecționarea releelor de gaze*. Volumul Conferinței Internaționale de Transformatoare Electrice, 9-10 mai 1986, ICPE-ME S.A. Bucureşti, pag. TT46-T50.

Uleiurile electroizolante din transformatoarele electrice

Rezumat

După compoziția petrolului din care provin uleiurile.electroizolante sunt parafinice sau naftenice, fiind utilizate ca: mediu de răcire, izolator electric, mijloc de stingere a arcului. Problema electrizării uleiului în marile transformatoare de putere a apărut în anii1980, după străpungerea unui mare număr de aparate, la scurt timp după punerea lor în funcțiune, din cauza.sarcinilor electrostatice create de circulația foarte rapidă a uleiului pentru răcirea bobinajelor. Pentru a studia comportamentul izolației compozite ulei-carton presat sub tensiune continuă a fost utilizată metoda electro-optică Kerr. Lucrarea prezintă şi un stand pentru verificarea releeelor de gaze.