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Welcome Letter

Dear Colleagues,

We would like to personally encourage each of you to join us at IEEE Second International Scientific Conference Data Stream Mining and Processing (DSMP’2020), which is held in Lviv, UKRAINE, 21-25 August, 2020. Our main goal is not only to provide an opportunity for networking and learning recent scientific achievements but also a chance to be involved in real time panel discussions with IT representatives to review and discuss their practical outcomes on real projects.

The DSMP is organized by IEEE Ukraine Section, IEEE Ukraine Section (Kharkiv) SP/AP/C/EMC/COM Societies Joint Chapter, IEEE Ukraine Section (West) AP/ED/MTT/CPMT/SSC Societies Joint Chapter, IEEE Ukraine Section IM/CIS Societies Joint Chapter, Ukrainian Catholic University, Manhattan College and Kharkiv National University of Radio Electronics.

Agenda of the DSMP’2020 is very rich. This year we have nominated a 88 number of accepted papers coming from about 12 countries which makes DSMP a truly international high impact conference. Major highlights of DSMP’2020 are its keynotes speakers. This conference proved to be extremely important given the fruitful dialog and a chance to exchange ideas and sharing valuable hands-on experience.

This year program is based on the following topics: Hybrid Systems of Computational Intelligence, Machine Vision and Pattern Recognition, Dynamic Data Mining & Data Stream Mining, Big Data & Data Science Using Intelligent Approaches and also panel with participation of IT Companies.

We are proud of the fact that DSMP proceedings have been included into the IEEE Xplore Digital Library as well as other Abstracting and Indexing (A&I) databases (Scopus, Web of Science and etc.). High quality of the DSMP program would not be possible without the contribution of authors, keynote speakers, organizers, students, 53 reviewers who devoted a lot of enthusiasm and hard work to prepare papers, presentations, organization infrastructure and carefully review all submissions. We are very grateful for their efforts.

We would like to thank each of your for attending our conference and bringing your expertise to our gathering.

We would like to express our gratitude to our partners and sponsors for being so generous and sponsoring our conference.

We wish all participants an excellent conference, fruitful discussions and pleasant stay in Lviv and Conference venue.

Sincerely

Yuriy Rashkevych Yevgeniy Bodyanskiy Igor Aizenberg

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Topic #4

Big Data & Data Science Using Intelligent Approaches

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Information Processing System for Detection Impurity in Technical Oil Based on Laser

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Abstract **– The article describes the method for constructing a laser control system for the impurities level of technical oil (using the example of transformer oil pollution analysis). In the system under consideration, technical oil acts as a transformer cooling medium, and therefore requires impurities control (to ensure the quality of its cooling properties). Determination of indicators of oil impurities is based on the effect of scattering of the laser beam. Literary sources and authors' research were used to construct the structure of the laser measuring system. The effectiveness of the laser meter is verified by a series of experiments. The experiments took place in two stages. The first stage included the calibration of the photometer (to determine the refractive index of the glass of the photometer). The second stage included a series of experiments in which the values of the reference oil were compared with the value of the experimental contaminated samples.**

Keywords – Measurement, Transformer oil, Laser photometry, Expansion of a resonance laser beam.

I. Introduction

In the process of power plants operation it is important to observe safe operating modes of all its components. Excessive heating of some elements during operation (eg, power transformers) can cause emergency situations (shutdown of individual units, fires). In systems of cooling of transformers are used special technical (transformer) oils (which act as a cooling environment).

Stability of parameters in the operation of power supply systems is one of the main operational tasks. The stable operation of the system depends on the technical state of all its components (which are part of it). An important components of the stable power plant operation are powerful electro-transformers. To ensure the stable operation of transformers, monitoring of its cooling system (to avoid overheating) is required.

II. Problem Task Review

Nowadays, optical and physical research is very common. This is due to the ability to perform laser research quickly, locally and without direct contact with the object. It is also possible to allocate a high level of the received information when carrying out laser sounding of the environment. This method of research (optical-physical) is a physical experiment. In such an experiment, all the information is transmitted and received by the laser beam [1-7].

There are two components in the process of processing information during laser scanning [4, 5, 7]:

- receiving and processing the image of laser signal and signal structure recognition (as the basis for the formation of informative features) [5];
- obtaining a laser signal, evaluating its characteristics (energy). Discrimination of the laser signal power center is the basis for detecting the structure of the object (energy and geometric). [4, 5].

Radiation sources (optical) that currently exist cannot provide a clear directional diagram. That is why laser sensing of an object (and processing of a scattered signal to reveal additional information about it) is an effective method for obtaining data about the studied environment (its state). [1, 8-12].

In [1-11] only the basic concepts of methods of analysis based on photometry are considered. Such methods can solve a wide range of problems (control in technical systems, chemical and biophysical reactors). In [5, 7, 19] methods of construction of measuring information systems on the basis of laser are considered. Such systems are designed to manage (and control) processes with high operating temperatures. The effectiveness of laser monitoring systems for a number of technologies (eg chemical processes) is also shown.

I In [5, 12, 19] the parameters of chemical solute (optical) were analyzed. Also in [12,19], the substantiation of spectral methods of analysis of media (photoactive) and photometer principles was carried out. In [5,16] the application of spectroscopy (photoelectron) methods in chemistry is considered. This allows you to get information about, adsorption, structure, quantitative analysis and evaluation of chemical shifts. Methods of designing optoelectronic systems are considered in [12, 14]. Unfortunately, the problem of synthesis of laser-based systems has not been considered.

The effect of high voltage on the oil (on the cooling environment of the transformer) affects its molecular

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structure, dielectric instability and leads to the appearance of components of electron and ion conductivity. It stimulates breakdown of isolation and emergency situations.

Control of electrotechnical, thermodynamic and physicochemical parameters in the high voltage zone is difficult to implement by direct measurement methods. This, accordingly, contributes to the search for contactless methods for diagnosing oil conditions. One of the possible effective methods for solving this problem is the laser probing of technical oil samples (transformer oil) in cuvettes.

To perform such monitoring, it is necessary to calibrate the parameters at different laser radiation capacities.

The purpose of the work is to substantiate the methods for controlling the dielectric properties of technical (transformer) oils by the method of laser projection sounding in the process of operation of the transformer. Tasks of the research:

1. To substantiate the physical model of quality control of the transformers cooling environment (oils) .
2. To detect the influence of the laser photon flux on the molecular structure of transformer oils.
3. To develop a method and means of creating laser systems for controlling the quality of transformer oils dielectric characteristics.
4. Identify the factors of changing electrical parameters in working mode.

III. Process of Laser Sensing of the Technological Environment

During the operation of the transformer, it becomes necessary to quickly control the quality of the oil. To solve this problem, a laser-based sample sensing system was developed.

Literary sources [1-12,19] and authors' research [13,15,17,18] were used to construct the structure of the laser measuring system. The block diagram of the laser system is presented in Fig. 1.

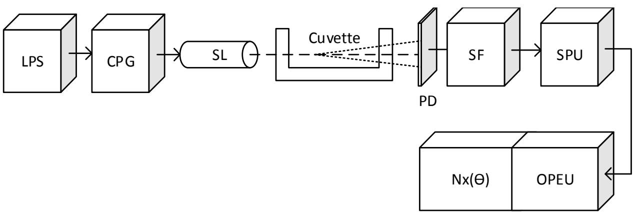

Fig. 2. Scheme of the developed laser system

On Fig. 1: LPS – laser power supply, CPG – clock pulse generator, SL – semiconductor laser, C – cuvette with oil, PD – photodetector, SF – selective filter, SPU – unit for processing signals, OPEU – unit for evaluating the parameters of the oil.

A. Composition of technical (transformer) oil

Transformer oil is a refined oil fraction obtained during distillation, which boils at 300-400 C. Transformer oil has a complex hydrocarbon composition with an average molecular weight. Transformer oil of the brand "Penta TRMS-110" is a heat-resistant silicon-organic compound. Paraffins, cycloparaffins – provide low electrical conductivity and high electrical power [20].

Aromatic carbohydrates increase resistance to partial charges in the volume of oil. Asphalt-resinous compositions are responsible for the appearance of sediment in oil and its color. Sulfur, nitrogen compounds and petroleum acids are responsible for the processes of corrosion of metals in transformer oil.

B. Assessment of the Concentration of Impurities in Technical Oils

During the experimental study of the quality of technical oils, a photometer with two channels was created. The photometer works on the basis of the difference method. Fig.

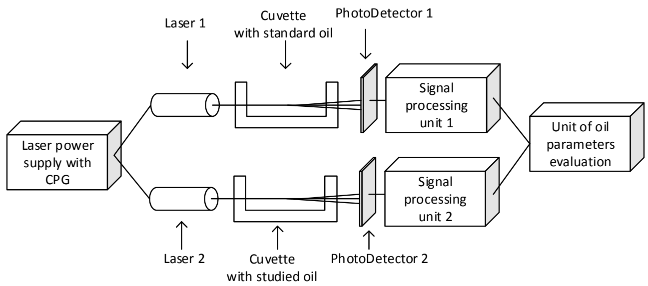

Fig. 1. Scheme of a used laboratory laser system with two channels

2. Represents scheme of a used laboratory laser system with two channels.

Parameters of the experimental cuvette represented on Fig. 3.

The differential comparison procedure (1) was used to calculate the photometer measurement results. This procedure is also called the differential method.

$$\Delta\alpha(C_K,\theta)=\left|\alpha_e(C_K,\theta)-\alpha_i(C_{Ki},\theta_i)\right|\cdot K_F \qquad (1)$$

where α_e – scattering coefficient of the reference oil samples, α_i – scattering coefficient control sample oil, KF – photometer ratio.

IV. Results of Experimental Study of Technical Oils Quality by Laser Sensing Method

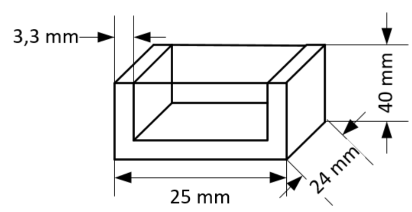

Fig. 3. Experimental unit cuvette dimensions (scheme)

Experimental studies were conducted in several stages. At the first stage, the photometer was calibrated to obtain a photometric coefficient (refractive index of the glass cuvette). The calibration of the system was carried out using a single glass plate and two glass plates.

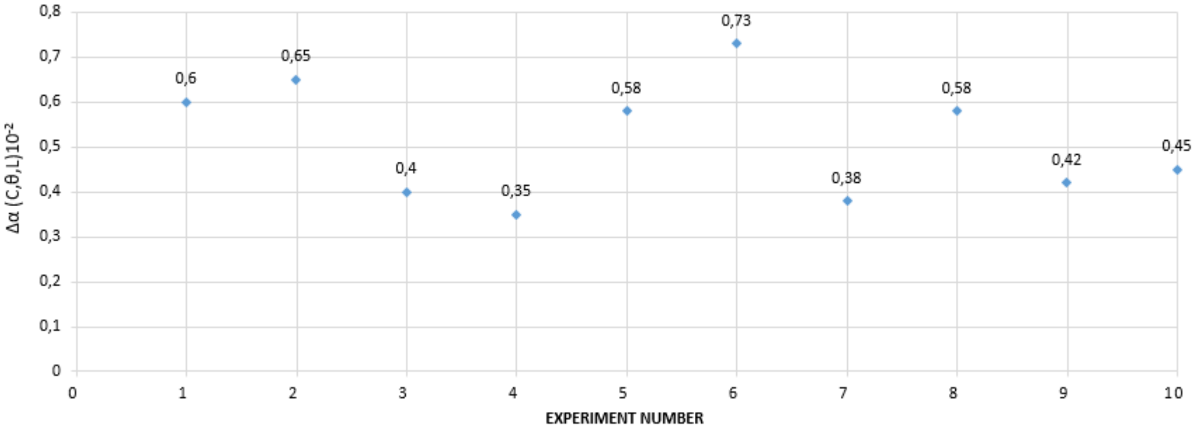

Fig. 4. Photometric calibration results (one glass plate) (X axis represents the number of the experiment; Y axis – represents the value Δα – measured coefficient of scattering)

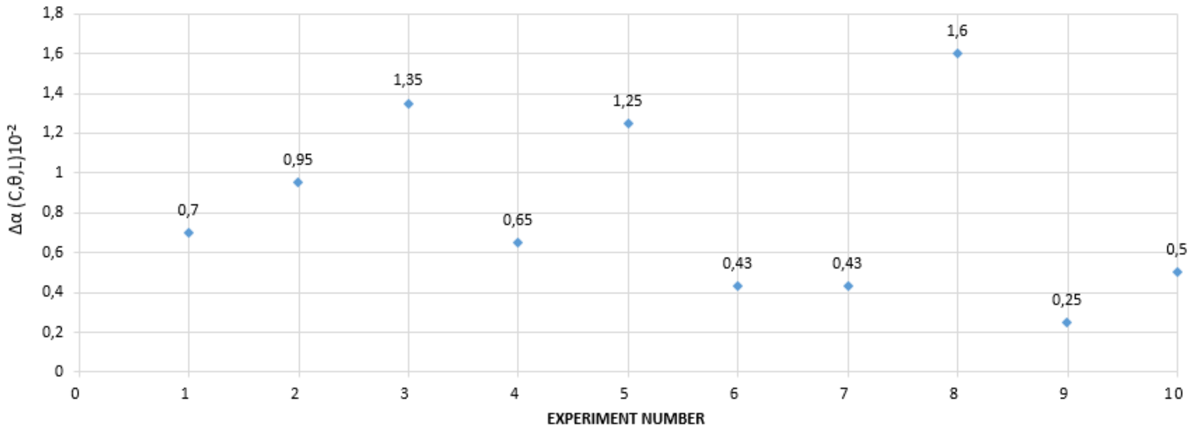

Fig. 5. Photometric calibration results (two glass plates) (X axis represents the number of the experiment; Y axis – represents the value Δα – measured coefficient of scattering)

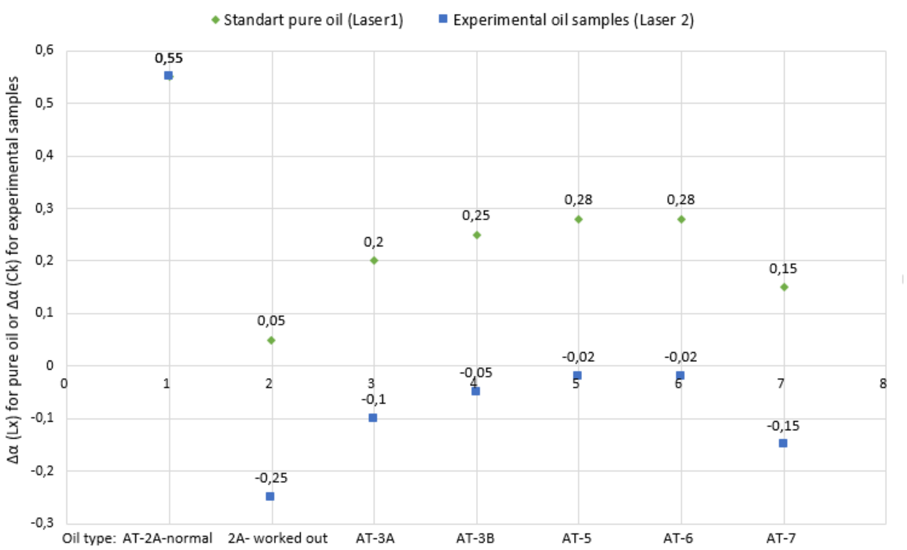

Fig. 6. Graphical representation of the results of experiments №1-7 (X axis represents the number of the experiment (type of oil tested); Y axis – represents the value Δα (Lx) for pure oil or Δα (Ck) for experimental samples)

Fig. 4 shows the results of calibration of the photometer using a single glass plate. Fig. 5 shows the results of calibration of the photometer using a two glass plate. All results were obtained experimentally.

$$\Delta\alpha \cong \alpha_e - \alpha_i \quad (2)$$

where α_e – transmission factor of the standard, α_i – i-sample transmittance.

The main study of experimental oil samples was carried out at the second stage (after the photometer calibration step).

Cuvette №1 was filled with a reference pure model of oil. Various types of oils (AT-2 reference, AT-2 spent, AT-3A, AT-3B, AT-5, AT-6, AT-7) were introduced alternately in the cuvette №2.

In experiment No. 1, both cuvettes contained a reference sample of pure oil.

In experiments №2-7, the cuvette number 1 contained the reference oil, and the cuvette number 2 was the corresponding samples (AT-2 worked out, AT-3A, AT-3B, AT-5, AT-6, AT-7).

In all experiments, the coefficient of refraction of glass (cuvette) Kα0 = + 0.30.

The sign (+) in result determines the active environment that amplifies the laser signal – pure oil; the sign (-) is a loss due to impurities.

Fig. 6 shows a graphical representation of the results of experiments №1-7.

V. Conclusion

The considered system of laser monitoring of the technical oil condition enables to carry out research in conditions where standard estimation methods will not be able to carry out the assessment (or the evaluation will be complicated from the technical point of view).

The obtained results show that the system of laser control of technical oils through the method of probing through a cuvette makes it possible to estimate the state of oil (to estimate oil impurities).

The developed system is an important component for monitoring the technological state of aggregates of power-generating objects (in our case - transformers at power plants).

The system of laser control of technical (transformer) oils can help to avoid (prevent) the emergence of an emergency due to excess temperature regime of the transformer during its operation.

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