of wires in a phase during splitting; adjusting the voltage mode to the value of corona losses; changing the wire surface; changing the wire material and its structure; applying special coatings to the outer surface of the wire and others.

Analysis of experience with the listed measures in electrical networks shows that the most commonly used ones are increasing the number of wires in a phase when splitting and applying special coatings to the outer surface of the wire. The use of on-line voltage regulation based on current real-time measurements of corona losses in wires, which is costly but very promising with respect to the potential for improving network efficiency, is also being actively pursued.

Thus, the investigation of the value of corona discharge power losses of ETLs is necessary for the development and implementation of organizational and technical measures aimed at reducing power losses, which is an important practical task, the solution of which will contribute to improving the efficiency of electrical networks in Ukraine.

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A METHOD OF EARLY DETECTION OF DEFECTS IN HIGH-VOLTAGE OIL-FILLED EQUIPMENT BASED ON ANALYSIS OF THE DYNAMICS OF CRITERIA USED TO INTERPRET THE DGA RESULTS

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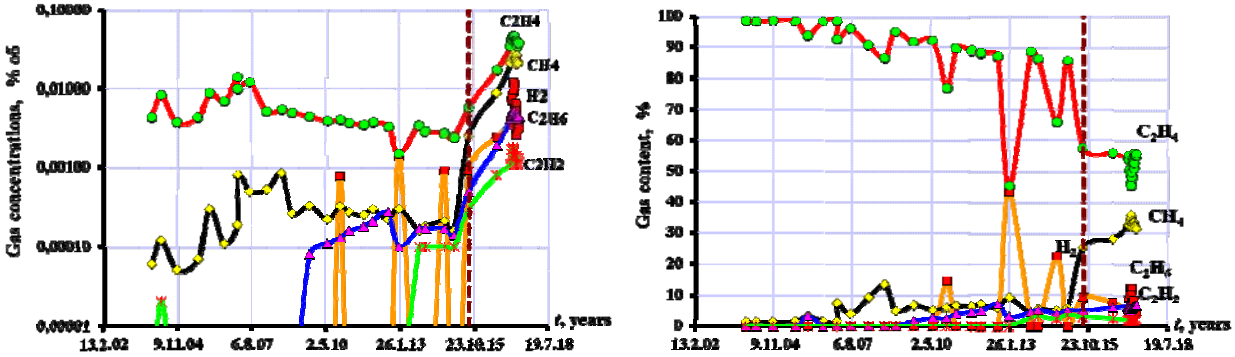
At present, the following criteria are used to diagnose the condition of high-voltage oil-filled equipment based on the results of the analysis of gases dissolved in oil (DGA): values of gas concentrations, values of gas growth rates, values of gas ratios, values of gas percentages, and values of gas-to-gas ratios with maximum content. The first two criteria are used to detect a defect and the last three criteria are used to recognise the type of defect. It should be noted that only the numerical values of the listed criteria are analysed in the diagnostic process, without taking into account the nature of their change over time. This makes it impossible to detect devel-

oping defects at an early stage when the numerical values of the criteria are within the range of permissible values. At the same time, the studies carried out show that the occurrence of a defect in oil-filled equipment of a non tight design leads not only to changes in the numerical values of these criteria, but also to a significant change in the nature of their change over time.

In particular, if there is no defect in high voltage power transformers of non tight design [1], the dependence of gas concentrations, gas build-up rates and gas ratios is random stochastic. Graphical images based on the DGA results of defect-free equipment also change randomly. Random nature of changes in time, diagnostic criteria used to interpret the results of chromatographic analysis of gases dissolved in oil, in normally functioning transformers, is due to both the processes of diffusion of gases from oil into the atmosphere and the peculiarities of gas formation in the presence of free oxygen. In the case of emergency actions on the network side, a short-term predominance of a systematic component over a random component is observed depending on gas concentrations and gas growth rates [2, 3]. At the same time, the ratio values of gas pairs are temporarily stabilised in the area of the characteristic energy impact level, which is the consequence of this emergency mode. There is also a short-term stabilization of graphical defect images, in which the images obtained coincide with the images of defects characteristic of this level of energy impact.

The development of the defect in power transformers [3, 4] is characterised by the appearance of a significant systematic component in the dependencies of gas concentrations on the operating time, the appearance of a significant systematic component in the dependencies of integral values of gas growth rates on the operating time, and the stabilization of the ratio values of gas pairs and graphical images of defects in the area typical for this type of defect. Moreover, as shown in [5], when the defect develops, the percentage of gases is also stabilised at a certain level corresponding to the defect of this type. In other words, the criteria used to detect the defect have a non-stationary nature depending on the operating time. At the same time, the values of the criteria used for the detection of the type of defect are stabilised in the area strictly related to the type of defect.

Identified changes in the nature of the time dependencies of these diagnostic features take place even before the concentration of at least one of the gases exceeds the limit values (Fig. 1), i.e. it is possible to detect defects early both in periodic and continuous monitoring of the gas content.



a *b*

a – value of gas concentrations; *b* – gas percentage;

Figure 1 – Dynamics of gas content in transformer oil with 40 MVA and 110 kV, where high-temperature overheating with temperatures above 700°C were detected

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