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Abstract

Application of optical methods in diagnostics of high power transformers insulation

Limitations of the used temperature measurement methods cause that the obtained results are not completely reliable, and the thermal calculations based on estimations carried out with many coefficients do not guarantee sufficient accuracy and reliability in assessing the remaining lifetime of the transformer. The author within this dissertation has analyzed the disadvantages and limitations of the current methods of measuring the temperature of the transformer active parts. The main disadvantage of the current methods is lack of possibility of their safe application in high voltage zones. As a result of development of optical measuring technologies and application of optical fibers for temperature measurements in the transformers, it is possible to measure effectively the temperatures of any transformer active part elements. Optical temperature measurement systems based on fiber optics are constantly improved since the 1980s. The author carried out his own research works by installing optical fibers directly in the windings of high-voltage transformers. Based on the results of numerical modeling of the temperature distribution, the author effectively identified the hot spots to install fiber optic sensors. In order to do safe measurements the author presented the method of safe installation of the measuring system.

As part of the conducted researches, the author accomplished the general goal of this dissertation, specifying the possibilities of using the optical temperature measuring method in the diagnostics of high power transformer insulation, based first on calculating, and then on indicating the points where the optical temperature sensors should be placed in the transformer windings. Giving consideration to the limitation that the sensors allow measurement only in one previously defined point, which cannot be changed after the installation, the author focused on correct and precise determining of the installation points. The author also assessed the effectiveness of the implemented optical fibers in comparison to the methods used until now.

The dissertation presents how to implement and verify the fiber optics to measure the transformer temperatures on-line. Based on the carried out experimental tests, there were selected the installation points of the fiber optics and they were practically verified during transformer final tests in terms of correctness of the hottest phase and selection of the hottest coil in the winding. The author carried out and presented the results of calculations and tests of two different types of high-power transformers: TONRLc 31500/120 and TONRLa 120000/225. In the tested transformers, the author used two different ways of locating the optical fibers.

The researches were practically implemented by the author in 16 transformers in last seven years. The measuring results confirmed that application of fiber optics enables precise determination of real temperatures of transformers active parts. The measuring process is carried out immediately, allowing quick estimation of transformer operating condition.

The dissertation is a proposal how to conduct the correct fiber optics installation to measure the temperatures in the oil transformers.