Transformer Health Status Evaluation Model Based on Multi-feature Factors

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***Abstract*—During the entire period of transformer's service, the internal parts get ageing gradually. But the aging degree of each part cannot be observed directly. To correctly master the condition of the transformer contributes to the prediction of the risk and reliability of the transformer, and also, this is the foundation of making effective repairing strategies or replacement, ensuring the safe and reliable operation of transformers. However, the exact assessment result has not been acquired according to traditional assessments that based on only one of the state parameter. A new assessment model based on the multi-feature factors is proposed to overcome the disadvantage of traditional condition assessments. Firstly, in order to find out the rule that the characteristic of transformer changes, the factors that influence the state of the transformer health are researched with the method of the correlation analysis of Mathematical Statistics. These factors include DGA, breakdown voltage, dielectric loss, micro-water content, acid value, furfural content and so on. Secondly, determine the state information of the power transformer; establish the index system for health evaluation. Combining with qualitative analysis, the analytic hierarchy process method is adopted to determine the weight of each index, and the health status evaluation model of power transformer is established. As for a transformer that is in operation, as long as the corresponding experimental data is got, the health condition of the transformer can be obtained with the help of the health status evaluation model. Take transformers of a substation for instance. Using the proposed model, the corresponding experimental data is analyzed. The investigations results show that the new health status evaluation mode is effective.**

***Index Terms*—Analytic hierarchy process, Multi-feature factors, Power transformer, Status assessment**

I. INTRODUCTION

AS the centrum of the power transmission, the transformer is one of the most important equipment in the power system. The safe and stable operation of transformer is the basic requirement of power delivery. During the entire period of its service, the inner part ages gradually. The extent of aging degree of each device cannot be observed directly, but can be cognized indirectly by analyzing the various external characterizations and data records. Many factors can influence the aging process of the transformer, and the load of the transformer and the environment conditions are closely related. Factors that account for the transformer insulation aging include over-current, long time of high-load operation, overheating, moisture, oxidation, etc. Heat and moisture are the most important factors for liquid insulation aging, whereas oxidation can seriously accelerate the degradation of solid insulation. If the stage of insulation life can be de obtained effectively by means of the necessary monitoring and testing in the process of transformer operation, the service life of transformer can be maximized under the premise of reliability. This can not only guarantee the safe and stable operation of power system, but also reduce the operation costs. Evaluate the status of the transformer insulation correctly, predict the risk and reliability of its operation and then make effective economic management of maintenance and replacement strategy. This is the imperative trend of power industry development.

II. AGING MECHANISM AND CHARACTERISTIC PARAMETERS

Power transformers adopt the oil-paper insulation structure, and the health status of transformer is mainly manifested on the performance of insulation materials. Insulation oil is a mixture of different molecular weight hydrocarbons, and decomposes into hydrogen and low molecular weight hydrocarbon gases, such as methane, ethane, ethylene, acetylene, etc. The component of the decomposition varies with the different faults. When the fault energy is low, the decomposition products are mainly hydrogen and methane, and with the gradual increase of the energy, the main ingredient transfers to ethane, ethylene and acetylene. When the oil is oxidized, small amount of CO and CO_2 can be detected. But as time goes by, they can accumulate to a significant amount [1-3].

When the solid insulation materials like paper, cardboard and laminated wood decompose, along with the water, large amount of CO and CO_2, and small amount of hydrocarbon gas and furans can be formed[4-6]. The amount of CO and CO_2 grows up with the increase of the temperature, the increase of the oxygen in the oil and the increase of the moisture content in the paper.

According to the above analysis, the gas composition and