Improving The Fault Diagnosis Of Oil-Filled Transformers Based On Feature Selection Of Multiple Input Vectors

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Abstract: Ensuring the reliable and uninterrupted operation of power system networks relies on the early and accurate detection of faults in oil-filled transformers. Dissolved gas analysis (DGA) is a widely employed technique for diagnosing transformer faults by analyzing the dissolved gases present in the insulating oil, which serve as indicators of electrical and thermal stresses. This paper presents a comprehensive review of various DGA methods used for fault diagnosis in oil-filled transformers, with a specific focus on improving the accuracy of fault diagnosis through feature selection of multiple input vectors. Techniques such as the Duval Triangle method, Rogers' ratios method, and IEC standard 60599 are evaluated in terms of their effectiveness in identifying transformer faults, and the study explores the selection of optimal features that contribute to enhanced fault diagnosis. By investigating the strengths and limitations of these techniques and incorporating feature selection approaches, this research aims to improve the accuracy rates in the early diagnosis of power transformer faults, ultimately leading to enhanced reliability and efficiency in power system operations.

Keywords oil-filled transformers · Dissolved gas analysis · fault diagnosis · feature selection · multiple input vectors ·

1. Introduction

The power transformer holds significant importance as a crucial component in electrical power systems. Therefore, ensuring the early detection of transformer faults becomes vital in enhancing the overall reliability of the power system [1, 2]. In addition, it is crucial to diagnose incipient faults in power transformers as early as possible to prevent the escalation of transformer issues [3]. The replacement of a power transformer is not only expensive but also time-consuming. Therefore, timely detection and diagnosis of faults are essential in order to mitigate the likelihood of further damage to the transformer [4, 5]. During the occurrence of an incipient fault in a transformer, such as arcing, partial discharge, or overheating, hydrocarbon gases are produced and dissolved into the transformer oil [6]. These gases include hydrogen (H2), methane (CH4), acetylene (C2H2), ethylene (C2H4), and ethane (C2H6). In cases where cellulose decomposition takes place, carbon monoxide (CO) and carbon dioxide (CO2) can also be generated [7]. Dissolved Gas Analysis (DGA) has emerged as a widely used technique for diagnosing faults in power transformers. By analyzing the dissolved gases present in the insulating oil, DGA provides valuable insights into the internal condition of the transformer [8]. The presence and concentration of specific gases can indicate the presence of electrical discharges, overheating, insulation degradation, and other potential faults [9]. Therefore, DGA serves as a powerful tool for early fault detection and diagnosis [10]. Numerous DGA methods have been proposed in the literature to improve the accuracy of fault diagnosis in power transformers [11]. These methods involve the analysis of various gas ratios, such as the Duval Triangle method [12], the Rogers' ratios method [13], and compliance with the IEC standard 60599 [14]. While these techniques have shown promise in identifying different fault types, the selection of appropriate features from the DGA data becomes crucial for achieving higher accuracy rates.

Feature selection is a critical step in enhancing fault diagnosis systems , as it involves identifying the most relevant and informative features that contribute to accurate fault classification [15]. By carefully selecting features from the DGA data, the noise and irrelevant information can be reduced, leading to improved fault diagnosis performance. Consequently, the selection of optimal features becomes a key factor in enhancing the accuracy and reliability of fault diagnosis in power transformers.

This paper presents a comprehensive review of various DGA methods used for fault diagnosis in oil-filled transformers, with a specific focus on improving fault diagnosis accuracy through feature selection of multiple input vectors. The objective is to evaluate the effectiveness of different DGA techniques, such as the Duval Triangle method, Rogers' ratios method, and IEC standard 60599, in identifying transformer faults. Moreover, this study aims to explore the selection of optimal features that contribute to enhanced fault diagnosis performance.

By investigating the strengths and limitations of these DGA methods and incorporating feature selection approaches, this research aims to improve the accuracy rates in the early diagnosis of power transformer faults. The findings of this study will provide valuable insights into the selection of optimal features for fault diagnosis based on DGA, ultimately leading to more reliable and efficient fault diagnosis systems for power transformers. This research contributes to the ongoing efforts in enhancing the performance of fault diagnosis techniques and improving the reliability and efficiency of power system operations.