The effect of Source Data on Graphical Pentagons DGA Methods for Detecting Incipient Faults in Power Transformers

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***Abstract*— Detecting power transformer faults at an early stage is crucial for ensuring the safety and uninterrupted operation of electrical systems. Dissolved Gas Analysis (DGA) serves as a valuable strategy for diagnosing faults in oil-filled transformers. Oil plays a vital role in transformer operation, serving as both a cooling and insulation medium. It also acts as an indicator for assessing thermal and electrical stresses within the transformer by analyzing the composition of dissolved gases in the oil. In this paper, the graphical techniques of the Pentagons for each of Duval Pentagon method and Mansour Pentagon method were discussed at different data sources. The dataset comprises 357 samples, with 117 samples sourced from IEC TC 10 data and 240 samples obtained from Egyptian laboratories. The Duval Pentagon method demonstrates superior performance, achieving a diagnostic accuracy of 69.23% when applied to the IEC TC 10 data. Conversely, the Mansour Pentagon method outperforms the Duval Pentagon method with a diagnostic accuracy of 68.75% when applied to the Egyptian laboratory data. This paper is a proposal to find a new graphical method that adapts to the variables of the source data. The proposed approach aims to address the challenges posed by diverse data sources and provide a more comprehensive and adaptable framework for transformer fault diagnosis.**

Keywords*— *oil-filled transformers, Fault diagnosis, Duval Pentagon method, Mansour Pentagon method.

I. INTRODUCTION

Electrical power transformers play a crucial role in power networks, whether they are employed in generation, transmission, or distribution. These transformers are highly valuable but also costly components. A fault in a transformer can result in an abrupt disruption of the electrical supply [1] [2], leading to escalated repair expenses and diminished reliability within the industry system [3]. The risk of catastrophic faults and unplanned outages is heightened due to the natural aging process of transformer groups [4]. The longevity of a transformer is predominantly determined by the condition of its insulation. As insulation ages, its ability to withstand various abnormalities such as short circuit faults, overvoltages, and arcs diminishes [5]. The degradation of insulation in oil-immersed transformers leads to the decomposition of the oil, resulting in the production of a variety of dissolved hydrocarbons. These hydrocarbons include hydrogen (H_2), ethylene (C_2H_4), ethane (C_2H_6), methane (CH_4), acetylene (C_2H_2), carbon dioxide (CO_2), and carbon monoxide (CO) [6]. Currently, numerous methods have been suggested for this purpose; however, the Dissolved Gas Analysis (DGA) method remains the most widely adopted approach [7].

Dissolved Gas Analysis (DGA) is a diagnostic and maintenance tool employed in the assessment of oil-immersed electrical equipment. It helps identify potential issues by analyzing the generation of gases within the equipment, even in minuscule quantities [8]. The presence of gases indicates the presence of stress, which can be attributed to various factors such as chemical, electrical, mechanical, or thermal stress [9]. DGA is a non-invasive monitoring technique that offers valuable insights into the condition of the insulation system as well as the internal components of the equipment [10]. In order to accurately identify the type of fault, various methods exist for interpreting the results of dissolved gas analysis. These methods include ratio techniques and graphical techniques [11].

Various methods have been developed for interpreting the analysis of dissolved gases. The Dornenburg method [12] is considered one of the earliest approaches in this field. It was followed by the IEC method [13] and the Rogers ratios method [14].More recently, the three ratios techniques [15] have emerged. However, despite their contributions, these methods are still considered intermediate when compared to graphic methods.

Among the graphic methods, the triangle Duval's method [16] stands out as one of the pioneering techniques. It was later followed by the graphical Pentagons methods, including Duval Pentagon [17] and Pentagon Mansour [18]. A recent addition to these graphic methods is the Gouda' triangle method [19].

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