

A Review of Dissolved Gas Analysis Measurement and Interpretation Techniques

Key words: dissolved gas analysis, gas chromatography, hydrogen on-line monitoring, photo-acoustic spectroscopy

Introduction

Dissolved gas analysis (DGA) is used to assess the condition of power transformers. It uses the concentrations of various gases dissolved in the transformer oil due to decomposition of the oil and paper insulation. DGA has gained worldwide acceptance as a method for the detection of incipient faults in transformers.

Due to the thermal and electrical stresses that the insulation of operating transformers experience, paper and oil decomposition occurs, generating gases that dissolve in the oil and reduce its dielectric strength [1]–[6]. Gases generated through oil decomposition include hydrogen (H_2), methane (CH_4), acetylene (C_2H_2), ethylene (C_2H_4), and ethane (C_2H_6). On the other hand, carbon monoxide (CO) and carbon dioxide (CO_2) are generated as a result of paper decomposition [7], [8]. Faults such as overheating, partial discharge, and sustained arcing produce a range of gases, the concentrations of which can be used to identify faults and estimate their severity.

In 1978 IEEE published guidelines for the detection of gases in oil-immersed transformers, known as ANSI/IEEE C57.104-1978 [9]. It covers instrumentation, sampling procedures, methods for extracting and analyzing gases, and data interpretation. In 1992 IEEE published further guidelines (IEEE Std C57.104-1991) [8] that deal mainly with interpretation of DGA data. This standard was revised in 2008 (IEEE Std C57.104-2008) [10]. In 1977 IEC published guidelines for the sampling of gases and oil in oil-filled electrical equipment and the analysis of free and dissolved gases. In 2009 ASTM issued ASTM Standard D3612-02 [2], which deals with analysis of gases dissolved in electrical insulating oil using gas chromatography (GC).

GC measurements are always conducted in a laboratory environment because of the complexity of the equipment required; oil samples are collected from operating transformers and transported to the laboratory for gas extraction and analysis. Vacuum extraction, stripper extraction, and headspace sampling are currently used to extract gases from the oil [2]; the shake test can also be used [11]. After extraction the gases are analyzed using

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A review of several techniques for measurement of the concentrations of dissolved gases in transformer oil, and of several interpretations of dissolved gas analysis (DGA) data, is presented.

GC. Due to the time and costs involved, DGA using GC is usually performed only once a year on operating transformers. More frequent testing is performed only if significant concentrations of fault gases are detected during routine tests [12].

Various techniques for interpretation of DGA data have been developed, e.g., the key gas, Doernenburg ratio, Rogers ratio, IEC ratio, and Duval triangle methods. Each of these techniques relies on the accumulated knowledge and experience of vari-

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Ceramics also known as fire clay is an inorganic non metallic solid article which is produced by the art or technique of heat and subsequent cooling The ceramics industry in India came into existence about a century ago and has matured over time to form an industrial base From traditional pottery making the industry has evolved to find its place in the market for sophisticated insulators electronic and electrical items The ceramic industry has been modernizing continuously by newer innovations in product design quality etc Glass is an inorganic product typically produced by melting a mixture of silica soda and calcium compound with desired metallic oxides that serves as coloring agents Indian glass industry will increase on the sidelines of real estate growth across retail residential and office estate Glass production involves the fusion of several inorganic substances These various substances include products such as silica sand soda ash dolomite and limestone representing together 99% of all the raw materials excluding recycled glass Glass ceramics are mostly produced in two steps First a glass is formed by a glass manufacturing process The glass is cooled down and is then reheated in a second step In this heat treatment the glass partly crystallizes In most cases nucleation agents are added to the base composition of the glass ceramic These nucleation agents aid and control the crystallization process Glass ceramics are fine grained polycrystalline materials formed when glasses of suitable compositions are heat treated and thus undergo controlled crystallization to the lower energy crystalline state It is important to emphasize a number of points in this statement on glass ceramics Glass ceramics has helped the electronics industry build much smaller and highly efficient transistors leading to advances in all types of devices The book covers almost all important aspects of Glass and Ceramic Industry Properties Applications Manufacturing Processing and Photographs of Plant Machinery with Supplier s Contact Details The major contents of the book are types of glasses silicate glasses boric oxide and borate glasses phosphorus pentoxide and phosphate glasses germanium dioxide and germanate glasses titanate glasses nitrate glasses glasses based on water halide glasses modern glass working monax and pyrex glass electric welding photo electric cells glassy metals analysis of glass glass ceramics ceramics as electrical materials analysis of ceramics etc The book will be useful to the consultants technocrats research scholars libraries and existing units and new entrepreneurs who will find a good base to work further in this field TAGS applications of Ceramics Best small and cottage scale industries Boric Oxide and Borate Glasses Business guidance for glass ceramics Business Plan for a Startup Business Business start up Ceramic and glass

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