AN IMPROVED PREVENTIVE MAINTENANCE TECHNIQUE FOR FREELY BREATHING POWER TRANSFORMER

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Abstract: Since the aggressiveness of oxygen negatively affects the chemical stability of oil by generating decay products which are detrimental to the solid insulation, the elimination of oxygen was considered to be a more efficient preventive maintenance procedure. Therefore, a new nitrogen blanketing system was developed that allows the removal of dissolved oxygen, while maintaining the free breathing character of a power transformer. This paper describes the outcome of the technical solution tested in Alberta to demonstrate the possibility of ARRESTING the oxidation decay process of oil-paper insulation in a free breathing transformer, by using an alternative nitrogen blanketing procedure. Unlike the current use of oxidation inhibitors which are able only to retard the oil-paper insulation deterioration process; this economically affordable procedure successfully prevents the premature aging of these expensive machines.

1. INTRODUCTION

Laboratory and field experiences have demonstrated worldwide that paramagnetic nature of oxygen can adversely affect the dielectric properties of solid insulation. Thus, it is even more obvious that the quantitative removal of dissolved oxygen from the oil of power transformers is not a choice, but a must! Taking into account the aggressiveness of oxygen that negatively affects the chemical stability of oil by generating decay products which are detrimental to the solid insulation; researchers have developed various technical solutions. Inhibitor additive is blended into the oil during manufacturing process or can be introduced during routine transformer servicing. Sadly, oxidation inhibitors are consumed with time; therefore the remaining amount has to be monitored periodically. Two mechanical solutions are available for hindering the contact of oil with the outside atmosphere. One alternative is an elastic rubber or plastic bag that separates in the conservator the surface of oil from the gas space. Another choice adopted especially in the United States is to seal transformers under a nitrogen cushion. There is no doubt that by limiting oxygen access to the oil more effectively prevents the premature deterioration of the insulation. However, the dissolved gases generated by the decomposition of oil under electrical stress are forced to remain dissolved in the oil with no possibility of being eliminated by diffusion into the gas space of the expansion chamber and subsequently to the surrounding atmosphere. Thus, the raising amount of so called fault gases is misleading.
In this contribution, the outcome of an industrial experiment designed to demonstrate a new nitrogen blanketing system [1, 2] is presented.

2. THE IMAPACT OF DISSOLVED OXYGEN

According to Henry's law, the amount of gases dissolved in mineral oil is dependent upon the partial pressure of existing gases above the surface. This is the reason why the oil in contact with air at atmospheric pressure dissolves 10% air by volume.
The heat produced by the core of the transformer and the natural property of oil to dissolve air, associated with the catalytic effect of copper, are other sources of energy. The content of dissolved oxygen in an oil sample taken from the tank of a freely breathing transformer, shows values between 5,000 and 40,000 ppm [1]. Basically, two electrons are missing in the oxygen molecule. Such molecules, with unpaired electrons are known as free radicals and are very active chemically. Moreover, an oxygen molecule, being a ground state triplet, will quench some of the excited states [3]. This would result in the formation of singlet oxygen molecules that are very reactive, and unlike other excited singlet molecules, are known as having an exceptionally long lifetime. In addition to this, one of the two unpaired electrons of these molecules can catch a free electron, thus becoming charge carriers and causing an increase in the dissipation factor of the oil.

3. LIMITATIONS OF CURRENT PREVENTIVE MAINTENANCE PROCEDURES

Basically, due to the natural property of oil to dissolve 10% air by volume, the oxidation decay of liquid insulation is a major problem. Recognizing the need to avoid this deficiency, researchers have developed various technical solutions. The Use of Sealed Expansion Chambers