



## Reliability Based Maintenance of Paper Insulation in High Voltage Power Transformers

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### ABSTRACT

Over the past years, ASTM International developed several new test methods for assessing the analytical properties of new and in-service aged transformer oils of petroleum origin. Enhanced maintenance methods were also developed to avoid the premature decay of oil-paper insulation. Now, a quantitative relationship can be established between the amounts of oil-born impurities responsible for the formation of incipient electrical failures inevitably followed by the gassing of oil. These improvements provide maintenance planners of high voltage power transformers an unprecedented possibility to economically hinder the decay process of liquid insulation under the impact of electrical, thermal and chemical stress. As a result, the service reliability can be significantly enhanced and the life expectancy extended by keeping the liquid insulation in pristine conditions for the entire lifetime of power transformers.

Key words: Oil-paper insulation, Oil analysis, Oil stability, Predictive maintenance

### INTRODUCTION

Currently, the decay in service condition of internal insulation of windings is established based upon the outcome of Dissolved Gas Analysis (DGA). The focus is to diagnose the nature of incipient electrical failures by establishing the rate and analysing the chemical composition of fault gases evolved. Instead of determining the real cause of this deficiency the emphasis is to empirically interpret the particularities of gassing, according to the IEEE Guide for the Interpretation of Gases Generated in Oil-Immersed Transformers [1].

The slow change of total acid number, interfacial tension and dissipation factor of oil in the early stage of transformers life, gives the impression that no decay products arise due to the so-called induction period. This is why the gassing of oil is attributed solely to an incipient electrical failure. In reality, oil-born decay products arise from the first day in service but are adsorbed on the large surface of paper insulation. If the decay products of oil are determined as trace impurities by using the new ASTM methods, it is obvious that such an induction period does not exist.

### THEORETICAL BACKGROUND

This view is based on recognizing that free radicals are intermediary decay products, that don't affect oil dielectric properties but are chemically very active. These are potential precursor of final decay products like oxidized molecules, ionized molecules, sludge and x-waxes.

Their strong oxygen affinity accelerates oxidation process, that's why oxygen must be avoided inside transformer to the maximum extent possible.