

Static Electrification and Partial Discharges Induced by Oil Flow in Power Transformers

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ABSTRACT

This paper presents the study of the major parameters on static electrification, using full-scale shell type transformers (570 MVA, 405 kV and 100 MVA, 500 kV). The consequences of static electrification on the dielectric strength and the conditions of partial discharge occurrence also are studied with oil flow rate up to 5 times the nominal value. It shows that the leakage currents are strongly influenced by temperature, applied voltage and oil flow rate Q . The latter is the most influential parameter. The winding leakage current I varies as Q^n , where $1 \leq n \leq 3$. The maximum value of I is observed at room temperature (20°C) when the transformer is energized.

1. INTRODUCTION

IN modern HV transformers, the phenomenon of static electrification resulting of flowing oil through the insulated cooling ducts constitutes currently a major care for manufacturers and users. Numerous failures of power transformers have been attributed to this phenomenon [1, 2]. This is in relation with the observed traces of erosion and discharges on the surface of the insulating materials [3]. Different efforts have been undertaken to prevent these defects and to improve the reliability of the oil-cooled transformers. At higher power and voltage levels, electrostatic charges caused annoying and unexpected consequences.

Indeed, the measures adopted to attain a reliable insulation design using better materials, and with more sophisticated methods to purify the oils and minimize humidification, caused a reduction in the dimensions of power transformers. Consequently, to avoid hot spots, it seemed necessary to force oil to circulate in order to remove efficiently the heat generated by iron and copper

losses. As a result, the contact of streaming high resistivity oil on the solid surface of the highly dried paper generates a static electrification which can produce discharges and then affect the insulation of the design [4]. This static charge is controlled by generation, migration and relaxation phenomena.

Some parameters can be investigated when we consider test cells in a laboratory [5], but the complexity of the transformer structure makes the research difficult on static electrification phenomena which can be involved. This concerns the delivery of the pumps, the geometrical design, the oil and pressboard characteristics.

The purpose of this paper is to study the effects of the major influential factors on static electrification, using full scale transformers, such as flow velocity, temperature and applied voltage. The consequences of static electrification on the dielectric strength of power transformers is also studied. Partial discharge (PD) occurrence to quantify the safety margin and reliability of power transformers towards static electrification are considered.

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