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3-D Numerical Study of Internal Free Convection of a High Voltage Measuring Transformer

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ABSTRACT

This paper has probed into the 3-D numerical study of the internal free convection of transformer oil inside of a high voltage measuring transformer partially filled with a porous media. Incompressible, steady-state, low Reynolds κ-ω turbulent model for capturing relaminarization as well as Boussinesq approximation for density variation have been applied to the problem. Geometry of transformer consists of an annulus-shaped active part through which high current passes, porous media as to be more economical of using costly oil, electrical insulator and an extended finned surface as the cooler. The study has focused on various working conditions such as different convection coefficients and ambient temperatures and half/full load operation. Results according to the corresponding standard show an excellent agreement with the thermal requirements. In addition, results reveal the share of each part in dissipating heat and other useful information.

INTRODUCTION

High voltage measuring transformers are those used for converting high voltage and current in a power network to a measurable value for watt meters, ampere meters, etc. From mechanics point of view, the major problem of these transformers is dissipating the generated heat of primary conductor.

This study has focused on the investigation of the buoyancy-induced flow developing in a high voltage measuring transformer. It is partially filled with pressurized-fluid saturated porous medium.

The performance of transformer under different free stream conditions (different free convection coefficients for air as well as different ambient temperatures) and full/half load operation is explored.

DESCRIPTION AND MODELING

The studied transformer is a 245KV measuring transformer manufactured by NIROUTRANS Company and consists of 1) an active part, 2) electrical insulator, 3) oil tank, 4) expansion tank and 5) top cooler which is a cylinder with extended surfaces covering the expansion tank. The porous region consists of transformer oil and transformer sand. Fig. 1 shows the geometry of the studied transformer.

RESULTS

The main goal of this paper is 1) to visualize the fluid flow and heat transfer under numerous operating conditions for a 245KV measuring transformer, 2) flow rate of oil in hairpin, 3) average temperature of oil, and 4) share of each component in dissipating heat from the transformer. Because of limitation of two-page abstract only one result is shown and it is the temperature distribution on external surfaces of the transformer (Fig. 2).

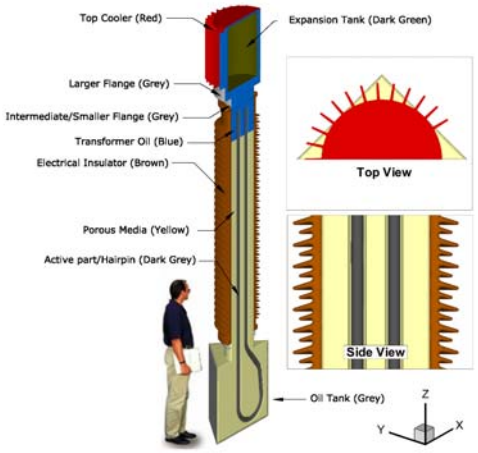

Fig. 1. Geometry of 245KV measuring transformer

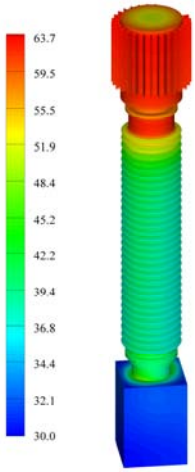

Fig. 2. Temperature distribution of external surfaces of transformer.

CONCLUSION

Performance of a 245KV measuring transformer was numerically investigated for different operating conditions. The results are in good agreement with IEC standard (thermal requirement). The effect of full and half load, different ambient temperatures, and different convection coefficients for air have been studied. The channel in the active part and finned surfaces of top cooler play an indispensable role in dissipating heat.

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