Design and Implementation of SF6 Gas Insulated Medium Voltage Instrument Transformer

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INTRODUCTION: The main goal of the proposed model is to design the modular measurement voltage transformer at medium voltage level and to operate it safely within the distribution panel. In this respect, it is one of the main objectives of this paper to raise the level of safety of the technical personnel who fulfil the responsibilities of commissioning, maintenance etc. of metal-enclosed medium voltage panels to the highest level (in terms of work safety and worker health). The design principles of the SF6 gas insulated voltage transformer (optimized) have been drawn in line with the results obtained from computer simulations.

In this paper, SF6 gas insulated voltage instrument transformer (VIT) is designed and implemented and also tested electrostatically. A complex model consisting of air bubbles inside the epoxy cast resin is used for computer tests. The standard lightning over voltages is applied according to IEC 66076-3 and IEC 61869-3-2011. Computer tests show that SF6 gas insulated VIT is cost effective, lighter than that of epoxy cast resin, and environmentally friendly.

COMPUTATIONAL METHODS: SF6 gas is used as insulating material inside the VIT due to its properties such as high dielectric strength, chemical stability and non-toxicity. Critical points between the high voltage winding and core material are defined and the associated electric field and breakdown voltages are calculated by simulation. Analytically, Eq. (1) is then used to obtain the breakdown voltage of SF6.

$$V_{SF6} = 1321 pd^{0.915} \text{kV} \qquad (1)$$

V_{SF6} is calculated analytically using Eq. (1) and COMSOL® simulations. Since the electric field is non-uniform, the multiplication of SF6 pressure and distance between the selected points is calculated within a range of for the simulations. The standard lightening impulse voltage is defined in Eq. (2) .

$$V_L = 175000(e^{-14600t} - e^{-2469135t}) \text{ V} \qquad (2)$$

The model (Fig. 1) is prepared using SOLIDWORKS® and exported to COMSOL Environment. To see the effect of air inside the transformer a few air bubbles are located around high voltage conductor and core section. The materials used are air, aluminum, copper, SF6 gas, epoxy cast resin, acrylic plastic and soft iron. Electrostatic physics is chosen to see electric fields between the critical points and stationary solution is done.

RESULTS: SF6 gas will easily reach all the coils as it is pressed into the housing under pressure in the pressurized environment (after drying for the body, after necessary pretreatments such as gas pressure under negative pressure). On the other hand, compared with the traditional model, the weight will be reduced to a great extent and will occupy less space in the panel due to its small size. The outer body will be earthed as long as the metal is shielded. This means the safety of touch (if necessary) for the working personnel. The following figures shows the model and computer simulations of SF6 gas insulated VIT.

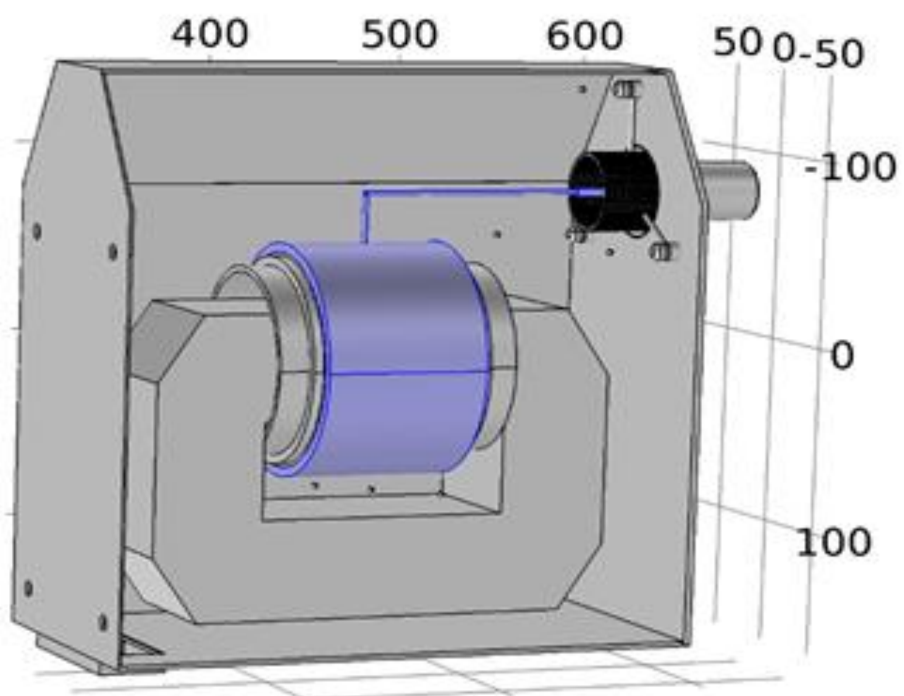

Figure 1. Inner parts of the SF6 gas insulated VIT with air bubbles

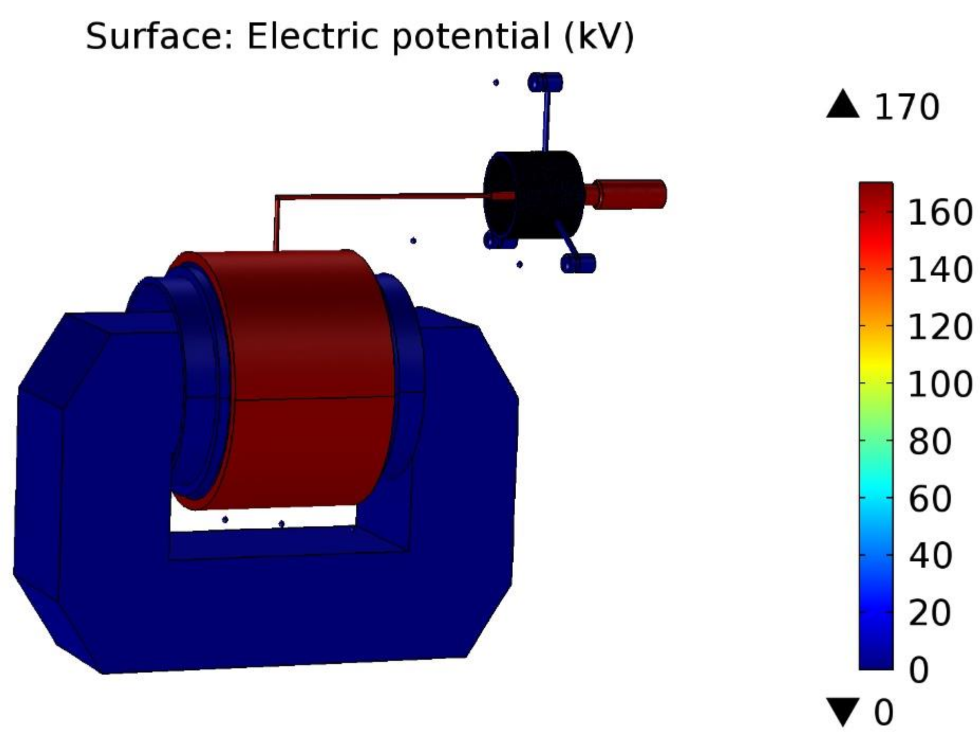

Figure 2. Electrostatic analysis of VIT under lighting condition

Partial discharge test results are given in Table 1.

Voltage (kV)	**1.2Un**	**1.2Un/$\sqrt{3}$**
Level (pC)	10	5

CONCLUSIONS: SF6 gas insulated measurement type voltage transformer is electrostatically analysed using COMSOL® and the obtained outcomes reveal that the proposed model is safe and has many advantages compared to traditional epoxy cast resin samples.

REFERENCES:

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