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Study on Bubble Evolution in Oil-paper Insulation during Dynamic Rating of Power Transformers

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Solid insulation tends to absorb moisture during the operation and maintenance of oil-immersed transformers, which could be dangerous to the insulation especially in dynamic rating conditions.As has been reported, insulation with much moisture could cause bubble effect in turn-to-turn insulation when the load of transformer increases rapidly.
Primarily, this study theoretically analyzed the degradation of dielectric strength caused by gas bubbles generated from oil-paper insulation. The results showed that bubbles with diameter over 10μm in strong electrical field could easily lead to the partial discharge in turn-to-turn insulation under the lightning invasion. This paper mainly focus on clarifying the evolution of thermal bubble formation. The experimental platform consist of an oil-paper insulation system and an adjustable heating system was established to study the influence of water content on bubble evolution temperature, the variation of the amount of bubbles and the deformation of bubbles with temperature. Results showed that the inception temperature of bubble formation was greatly influenced by gas content and moisture content in paper, which could well explain the high probability of bubble evolution in old and wet oil-impregnated transformers. Then, a mathematical model was founded to calculate the bubble evolution temperature considering the solubility of gas and moisture in transformer oil at a certain temperature, and the probability of insulation failures was assessed. Finally, based on above results, this paper provided a strategy for managing the risk of insulation failures in oil-immersed transformers caused by thermal bubbles in dynamic rating conditions.

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