교류전압 인가 상태에서 저압 진공관의 방전현상

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Ion Transport and High Frequency Dielectric of the Hollandite $Nax(Ti_{8-x}Cr_x)O_{16}$

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Abstract : We experimentally investigated discharge phenomena inside vacuum interrupter at 1 to 20 Torr to simulate the vacuum leakage. We used glass type of vacuum interrupter where the internal pressure and the type of gasses can be varied according to requirement. The experiment is conducted under ac applied voltage and the experimental circuit is constructed to simulate the actual circuit used in cubical type insulated switchgear. We used two types of gases such as air and SF_6. The use of glass type vacuum interrupter allowed us to measure discharges occurring in vacuum interrupter optically. We measured and discussed the discharge occurring in both gases with a current transformer and ICCD camera. We also revealed that electromagnetic wave spectra emitted by the discharge have same frequency range for both gasses.

Key Words : Discharge phenomena, Vacuum interrupter, Vacuum leakage, Insulated switchgear

1. Introduction

Vacuum circuit breaker (VCB) has an alternative to contribute reduction of usage of SF_6 gas insulated devices in future [1, 2]. This information indicates that the use of VCB in power distribution and transmission will be expanded. Nowadays VCB is widely used in electric power distribution such as cubicle-type gas insulated switchgear (C-GIS). Thus, the stability and reliability of the system operation should be maintained for the consumer satisfaction. One of the methods is detecting the performance of VCB.

An abnormality of vacuum degree in vacuum interrupter (VI) is one of the items in the assessment for degree of obsolescence of VCB [3]. There are numerous reports on the developed diagnosis technique on detecting vacuum performance [4] but the diagnosis technique based on discharge emission in low vacuum of VI is still not well developed. The reports on monitoring vacuum performance based on partial discharge are still insufficient. In this paper we focused on investigation of the phenomena of discharge in low vacuum of VI as a fundamental towards development of a technique for monitoring the performance of VI.

2. Experiment

Fig. 1 shows the equivalent circuit for closed contact condition used in measurement of discharges to simulate an actual condition in C-GIS. A capacitance C_1 is connected to the high voltage side of transformer in parallel with VI. C_1 has value of 3000pF to simulate the capacitance of an actual cable used in the field which has 0.2'ㅅF/km. C_S is a stray capacitance between the shield and the tank wall used in actual C-GIS. The gap distance was calculated by using an electric field software.

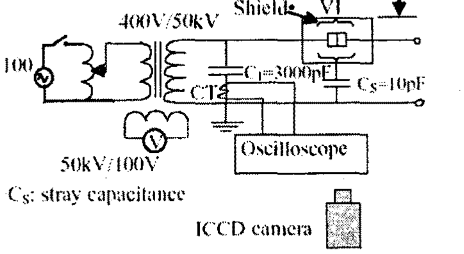
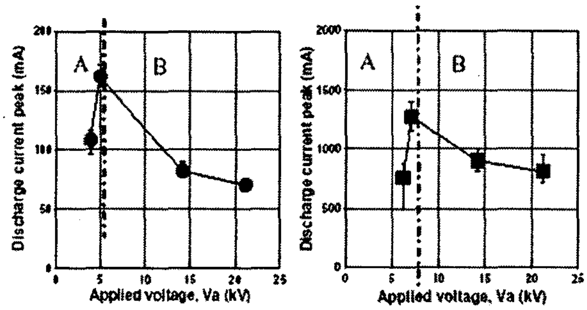


Fig. 1. Equivalent circuit of closed contact condition.

3. Result and Discussion

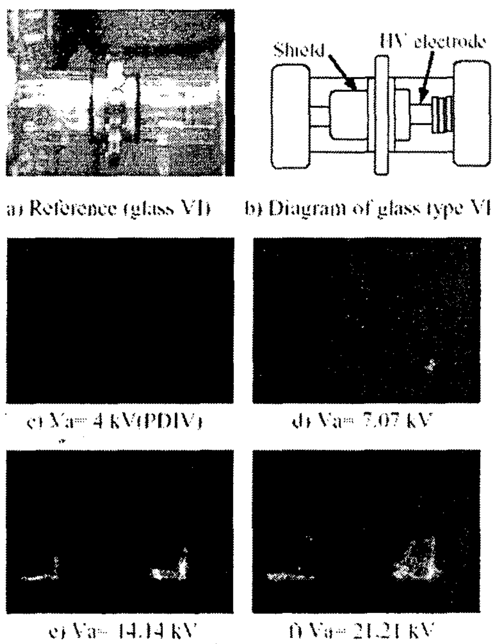
Figs. 2 (a) and (b) show discharge current peak against Va at 10 Torr of air and SF_6 gas, respectively. The graph indicates that the current peak initially increases with the increase of Va, from PDIV up to 1.3 times of PDIV (region A) for air and 1.14 times of PDIV for SF_6 gas, then decreases as Va increases further (region B). These phenomena can be explained by results of phase angle dependence of discharge pulses accumulated in 15 cycles of different ac applied voltage.



(a) Air (b) SF_6

Figs. 2. Discharge current peak against applied voltage at 10 Torr.

Further confirmation has been done by observing light emission of discharge in VI. Figs. 3 shows the light emission of discharge occurring in VI at 10 Torr of air and SF6 gas measured by ICCD camera. The result shows that the light emission of discharge occurring inside region A for both gases cannot be observed. When Va increases further, the light emitted by discharge in VI is observed obviously. The result shows that light emission cannot be observed in region A even though discharge current peak is measurable.



Figs. 3. The light emission of discharge measured by ICCD camera at 10 Torr in air.

4. Conclusion

In this paper, discharge phenomena are reported in low vacuum region of glass type VI with air and SF_6 under ac applied voltage at closed contact condition. The discharge current peak increased with increase of applied voltage up to 1.3 times of PDIV, then decreased as the applied voltage increased further. These results indicate that 2 different modes of discharge occur in low vacuum region of VI.

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