Time Transition of Partial Discharge Characteristics on Miniature Model of Self Contained Fluid Filled Cable with Copper Compound

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ABSTRACT

Discoloration and carbonization of insulating papers were found on dissection surveys of decommissioned self contained fluid filled (SCFF) cables, and it has been reported that discoloration can be copper compounds such as copper sulfide and can be a cause of the ignition of partial discharge (PD). In this study, the time transition of PD characteristics was investigated in a miniature model of the SCFF cable with copper compounds on the insulating papers. As a result, PD continued for about a half day from PD ignition to the breakdown, and PD characteristics were measured at that time.

KEYWORDS

Self Contained Fluid Filled Cable; Partial Discharge; Miniature Model; Copper Compound;

INTRODUCTION

It has been said that self contained fluid filled (SCFF) cables rarely deteriorate in their normal operations. However, some faults have occurred in SCFF cable joints at the extra-high voltage class in Japan [1]-[2]. In addition, discoloration and carbonization of insulating papers were found on dissection surveys of discommissioned SCFF cables under long operation for around 30 years and more in Japan [1]-[4]. It was reported that discoloration can be copper compounds such as copper sulfide from chemical analyses and can be a cause of the ignition of partial discharges (PD) [3]-[4]. Hence, PD measurements have been drawing attention more and more as one of the diagnosis techniques for SCFF cables [2].

When applying PD measurements to electrical equipment as the diagnosis technique and breakdown prediction, it is important to understand the time transition of PD characteristics. In the insulation system of SCFF cables, it was revealed that PD continued for a certain duration before the breakdown occurred [5]-[6]. Therefore, there will be a time margin for judging whether PD occurs or not and observing its condition and progress. However, the time transition of PD characteristics has not been measured in the insulation system of SCFF cables with copper compounds on the insulating papers so far. Hence, in this study, the time transition of PD characteristics was investigated in a miniature model of SCFF cables consisting of insulating papers with partial deposition of copper compounds.

DEPOSITION METHOD OF COPPER COMPOUNDS ON INSULATING PAPER

A deposition method of copper compounds on insulating papers is shown in Fig. 1. Firstly, copper plates are appressed against the edge or the surface of insulating papers. Then, they were soaked in the synthetic insulating oil usually used for SCFF cables, but with 1000 ppm Dibenzyl disulphide (DBDS) and 4000 ppm 2,6-ditert-butyl-p-cresol (DBPC) [7] and they were heated at 150 ºC under atmospheric conditions for 1 day to promote the deposition of copper compounds on the insulating papers. After that, the insulating papers were deoiled with acetone.

Fig. 2 shows the result of SEM-EDX analysis for a discoloration area on an insulating paper made by the above method. Cu and S peaks appeared. Therefore, it was estimated that copper compounds such as copper sulfide were deposited on the discoloration area.

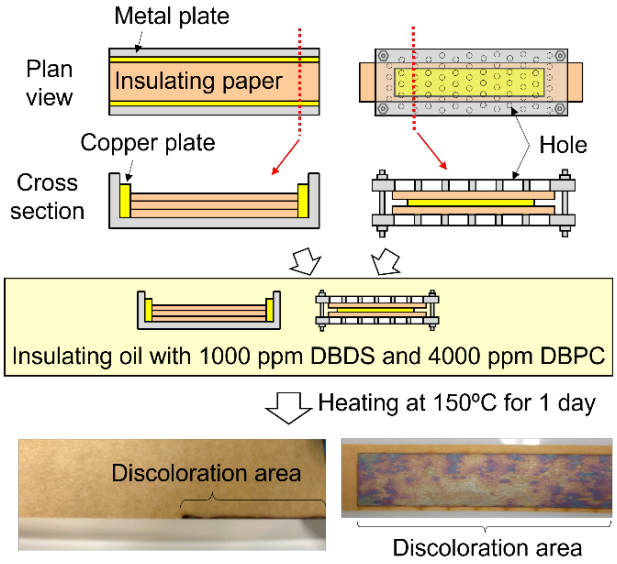

Fig. 1: Deposition method of copper compounds on insulating papers.

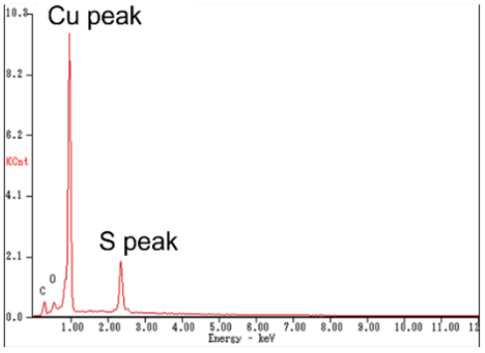

Fig. 2: Result of SEM-EDX analysis for discoloration area.