Effects of Voltage Type and Polarity on Flashover Performances at Low Atmospheric Pressure on an Ice Surface

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ABSTRACT

The effects of voltage type and polarity as well as the conductivity of freezing water on the critical flashover voltage of a triangular ice sample were examined under different air pressure simulating to high altitudes. The results obtained show that the effect of voltage polarity on the minimum flashover voltage is more obvious at sea level than at high altitudes. The results reported in the present study will help to understand the effects of high altitude on the critical flashover voltage of actual insulators employed on DC and AC transmission power lines under icing conditions.

KEY WORDS: insulator, ice, flashover, low pressure

INTRODUCTION

The flashover phenomenon of insulators under high altitude conditions has been studied since the 60's (Fryxell and Ludvika, 1966). Following a number of investigations, it is generally agreed that the critical flashover voltage of outdoor insulators decreases as the altitude increases (Kawamura et al., 1982; Rudakova and Tikhodeev, 1989; Mercure, 1989). The scale of the decrease generally depends on voltage type, insulator profile, pollution severity and even voltage application methods (Meier and Niggli, 1968; Ishii, et al., 1983; Guan and Huang, 1994). For polluted insulators, the change of arc E-I characteristics was considered as a main reason for the decreases in flashover voltage under high altitude conditions (Kawamura et al., 1982; Ishii, et al., 1983).

On the other hand, the high altitude regions are normally subject to ice and snow conditions during cold periods. Under such environmental factors, the decrease in critical flashover voltage becomes more severe and, sometimes, will result in flashover on the insulators.

Up to now, most of the studies on the flashover performance of ice-covered insulators, used on AC or DC power lines, were performed only under the reference pressure. It has been reported that the flashover voltage of ice-covered insulators under DC- is lower than under DC+ (Watanabe, 1978; Bui, et al., 1984) while the value of minimum flashover voltage under AC, falls in-between those of DC+ and DC- (Farzaneh, 1990 and 1991).

There is almost no fundamental study on the flashover performance of ice surfaces under high altitude conditions. This oversight has motivated the present study, which aims to examine the influence of the type and polarity of the applied voltage on the critical flashover voltage and the leakage current of ice samples under low pressure conditions analogous to high altitudes.

TESTING FACILITIES AND ICE SAMPLES

The experiments were carried out in an evacuated chamber depicted schematically in Fig. 1. A cylindrical chamber with a diameter of 610 mm and a height of 760 mm was constructed to achieve the low pressure found at high altitudes. Using a vacuum system, the internal air pressure can be lowered to any given value between 101 and 30 kPa, thus simulating any altitude from sea level to 9000 m. The chamber is transparent to allow observation and photograph taking. Control of the air temperature was achieved by placing the evacuated chamber in a temperature-controlled room as described in a previous paper (Farzaneh and Kiernicki, 1997a).

Fig. 1. Schematic diagram of the evacuated chamber