FREQUENCY EFFECTS IN ALTERNATING CURRENT CORONA

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INTRODUCTION

Corona phenomena upon overhead high voltage lines have detrimental influence in terms of power loss and noise. Present design work relies heavily upon tests in experimental cages or on full scale lines. In this study a controlled laboratory experiment has been performed to measure a wide range of corona parameters under variable voltage and frequency of a.c. excitation. The results have then been used to validate an existing corona model.

TEST CAGE MEASUREMENTS

The test apparatus is shown schematically in Figure 1. An a.c. signal source and power amplifier are connected via the step up transformers T1 and T2 (overall ratio of 1:649) to the test cage. The magnitude of the high voltage is measured by both the electrostatic voltmeter E.V. and the capacitors C1 and C2, which also provide its phase. The test cage itself is of special construction as described in [1,2]. The central conductor (radius 92.5 μm or 156.5 μm) is coaxial with an electrode system consisting of two sets of interleaved grid wires (each of radius 1 mm) 5 mm inside a plain cylindrical sensor electrode of radius 100 mm. The measurement section has a length of 254 mm.

A bipolar bias voltage (+ Vb) is applied to the two grids, creating a strong d.c. electric field, which attracts the corona ions to the grid and prevents any reaching the sensor. Synchronous current measurement at the sensor and grid electrodes then allows the conduction and displacement components of the corona space charge current to be distinguished which is not possible with a conventional test cage. Modification of the experimental procedure from that used in [1 and 2] by utilising opto-isolators has allowed these simultaneous measurements. The displacement current corresponds to the rate of change of surface charge (field), and may be integrated to determine the absolute magnitude of the electric field. The U—Function meter measures the corona power loss from the voltage and total corona current.

Optical data from a photomultiplier have been used to measure the start and finish times of the corona in each half cycle.

![Diagram of A.C. corona test cage system]

**Fig. 1.** A. C. corona test cage system.

S.G. Signal generator; P.A. Power amplifier; F1 quick blowing fuse; T1 L.V. transformer (0.7/1 p.u.); T2 H.V. transformer (220/100 kV); E.V. electrostatic voltmeter; C1,C3 loss free H.V. capacitors; C2 standard capacitor box; R1 geometric current resistor (500 Ω typical); R2 grid resistor (3 kΩ typical); R3 sensor resistor (31.5 kΩ typical); Vb 1400 V d.c. power supply.

**MODELLING THE A.C. CORONA PROCESS**

The model adopted here, first proposed by Gary et al. [3], is based upon simplifying assumptions because the fundamental phenomena, determined by the Poisson and continuity equations, are intractable to exact solutions. Corona space charge is therefore assumed to be emitted as discrete infinitesimally thin rings at each time step in the cycle, if required to limit the electric field at the corona wire to the critical field given by Peek's Law (or similar). These rings then drift with constant mobility in the total electric field calculated at their spatial location unless neutralised at either electrode. Recombination although allowed for in [3] has been neglected in this implementation.