INVESTIGATION OF POWER FREQUENCY CURRENT TRANSFORMER AS PARTIAL DISCHARGE SENSOR IN MEDIUM VOLTAGE CABLES

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ABSTRACT

Partial discharge diagnostics are the most widely used tool to diagnose insulation defect in medium voltage cables thereby informing required maintenance planning so that such ageing assets life span can be extended. High frequency current transformers installed in the earth strap at the cable termination are widely used to detect fast varying pulses resulted from partial discharges which occurs in the cable. Earth strap accessibility in cable is often limited due to several reasons which make the PD detection difficult to achieve.This paper investigates the possibility of using preinstalled conventional power frequency current transformers (CT) meant for protection and measurement purposes to detect PD. This investigation involves frequency response analysis of CT followed by onsite measurements of PD in PILC cables using conventional CT with the developed system.

I. INTRODUCTION

Regulatory incentives exist for all UK electrical utilities to continuously improve network performance, with a greater onus being placed on the use of 'smarter' methods of monitoring, operating and controlling the network and so reducing associated costs that will ultimately improve the value of service provided to the customers. In this context there is a clear requirement for more informed asset management and maintenance planning utilising on-line condition monitoring technologies and techniques [1] [2]. In UK, majority of cable installation was done in between 1950's and 1960s. Typically, the design life of medium voltage (MV) cable prescribed by manufacturers is around 70 years in which it is almost approaching its life span. This is likely to lead to an increased prevalence of circuit faults resulting directly from insulation degradation and breakdown due to ageing. A program for the wholesale replacement of vast cable networks is impracticable and not economically viable – and most likely unnecessary. A more pragmatic and affordable approach to extending the life time of these ageing assets, and informing targeted cable replacement, may be achieved through the use of condition based maintenance strategies utilising online monitoring technologies. Online condition monitoring with partial discharge diagnostics is the most widely used tool to assess the insulation degradation of these ageing assets thereby condition based maintenance strategies can be formulated. This paper addresses the various technical problems associated with PD measurement and solution to those problems is proposed.

The term "partial discharge" is defined by IEC 60270 (Partial Discharge Measurements) as a localized electrical discharge that partially bridges the insulation between conductors and which may or may not occur adjacent to a conductor. These discharges induce fast varying pulses into the cable conductors which travel through the whole length of the cable and undergo attenuation and dispersion. There are various types of sensors for detecting these PD pulses namely, capacitive, inductive, and acoustic . This paper is focused on inductive couplers, which is the most widely used for non intrusive technique. Rogowski coils, high frequency current transformers are commonly used as inductive couplers which are installed in the earth strap near the cable termination. This type of PD measurement has two requirements. Cable earth conductor needs to be isolated from switchgear earth conductor otherwise no PD signals should be available [3]. In older substation design, earth strap of the cable is not accessible. These two requirements are not satisfied always which forces to install sensors at cable core which needs to isolate the supply for the sensor installation which is not viable.

This paper investigates the possibility of using pre installed power frequency current transformers for protection/measurement purposes to detect fast varying PD signals. This paper has been organized into three sections. Section 1 describes introduction. Characteristics of PD signals are covered in section 2. Theory and operation of current transformer are included in section 3. Section 4 describes experimental setup and frequency response analysis. Section 5 describes hardware developed to monitor PD across CT. Data analysis of on-site measurements is included in section 6 and section 7 concludes the paper.

KEYWORDS

Partial discharges, Curent transformer, Frequency response

II. CHARACETRISTCS OF PD SIGNALS

(Partial Discharge as a localized electrical discharge that partially bridges the insulation between conductors and which may or may not occur adjacent to a conductor. These discharges induce fast varying pulses in the neighboring conductors which can be used as variable to quantify the discharge magnitude. Figure 1 shows PD signal measured in an 11 KV PILC cable using High Freuency Current Transformers (HFCT) installed in earth strap. Rise time and pulse width of the PD pulse recorded are few hundreds of nano seconds as shown in Figure 1. In order to capture these fast varying pulses, it is necessary to have data acquisition systems with high sampling rates. PD pulses travel through the whole length of the cable and get reflected at the termination due to impedance mismatch. These reflected pulses are quite useful to locate the discharge source. Far end reflections of the PD pulse are seen in Figure 1. Amplitude of these