PD MONITORING SYSTEM FOR H.V. CABLES BY MEANS OF POWERFUL DIGITAL TOOLS TO DISCRIMINATE NOISE AND TO PERFORM EFFICIENT PD DIAGNOSIS

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ABSTRACT

A new PD monitoring system with very efficiency noise discrimination capabilities and complementary power diagnosis tools have been developed. The filtering tool has been developed on basis of Wavelet transform plus a statistical analysis. PD pulses with amplitudes of a hundred times smaller than broadcasting noise and superimposed white noise up to twice greater than PD pulses can be identified. The noise power suppression capability allows perform on line PD measurements with efficient diagnosis results.

After noise suppression transient pulses remain in a phase-solved PD pattern and PD clustering analysis can be applied to identify power electronic pulses from different types of PD sources (corona, cavity, surface partial discharge, etc.).

This new monitoring system has been installed in 220 kV cable systems belonging to gas natural fenosa utility.

KEYWORDS

PD monitoring, on line PD measurements, PD clustering, HFCT PD sensors, insulation condition, h.v. cable systems diagnosis.

INTRODUCTION

Different PD monitoring systems have been developed in the last years for high voltage cable systems [1] and [2]. Non conventional PD methods operating in the high frequency band are usually used when PDs must be monitored. Frequency band of PD signals in the range of 3 MHz to 20 MHz are transmitted along h.v. cables of hundred meters length with not significant attenuation. However, significant noise interferences can appear superimposed on PD signals to be measured. The most complicated challenge to be solved by present PD monitoring systems is removing interference signals form PD pulses.

This paper presents powerful digital tools developed to remove different types of interferences. Applying a digital filter developed on the basis of an improved Wavelet transform [3] and [4], continuous radio frequency waves from broadcasting and TV stations and cell phones are easily removed. Background white noise can be also removed by the developed digital filter. Periodical pulses caused by rectifiers and frequency converters are rejected by means of a digital tool developed on the basis of PD clustering.

However, any filtering process to remove noise and interferences provokes attenuation in PD pulses to be measured. For this reason a robust test to analyse attenuation of PD signals after applying the filtering process have been carried out for different types of superimposed noises: modulated sinusoidal frequency noise, white noise and combination of both. PD amplitudes more than 100 times smaller than noise amplitude can be easily discriminated from modulated sinusoidal noise superimposed whit white noise.

Additional software tools have been developed for PD diagnosis purposes: A PD mapping is automatically generated by means of the time delay analysis between PD signals received from two sensors placed in two correlative accessories. PD clustering techniques are also very useful [5] and [6] to discriminate different PD sources placed in the same cable site. Additionally a neuronal network has been also developed to distinguish different phase-resolved patterns. The aim of the neuronal network is to discriminate corona pulses from internal cavities and surface partial discharges, especially in cable ends where corona pulses can be appear. The neuronal net work is applied for each PD cluster.

The paper presents in detail the developed monitoring system that has been implemented in different 220 kV high voltage cable systems. Specific operation performances of the developed digital tools for noise discrimination and for PD diagnosis are explained in the paper. The paper also shows the tests performed to analyse the performances of the individual elements of the monitoring system and the sensitivity of monitoring diagnosis tools.

DESCRIPTION OF MONITORING SYSTEM

The PD monitoring system of a high voltage line is composed by several Measuring Systems (MS's) distributed along the cable system. They are controlled by a Control and Analysis System (CAS) placed in the substation where a cable end is connected (figure 1).

HFCTs inside of link boxes are used as PD non intrusive sensors (see figure 2), but integrated sensors inside joints or ends can be also used. The output of each PD sensor is connected to a channel of a digital recorder. The electronic components associated to the digital recorder are placed in a shielded box close to each link box.