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Electromagnetic detectors of partial discharges

Abstrakt.Príspevok sa zaoberá možnosťami diagnostických meraní čiastkových výbojov v praxi. Popisuje detektory vyvinuté a vyrobené na základe štúdia pôsobenia týchto výbojov v izolačných vysokonapäťových systémoch káblov a zvlášť ich koncoviek. Detektory sú však použiteľné na detekciu a lokalizáciu čiastkových výbojov aj u iných zariadení.

***Abstract**. This article deals with partial discharges and possibilities of their diagnostic measurement s in praxis. Describe of measuring detectors which are develop and realise on the basis of study of acting these discharges on insulation systems of high voltage cables and especially their endings. This detectors is suitable for detection and location of places with partial discharges activity also on another appliances with partial discharges.*

Kľúčové slová: čiastkový výboj, detekcia, kábelová koncovka, detektor čiastkových výbojov
Keywords:partial discharge,detection,cable ending, partial discharges detectors

Introduction

High voltage transmission systems and distribution networks are especially realise in cities and enterprises in the form of cable net. Urgent problem is reliability and lifetime of this net, cables and their endings. On Lifetime of insulations and connecting systems influence of various operating factor. In the first place there are this meteorological factors from which most significant is ambient and operating temperature, humidity and surface of insulation pollution. Important factor, that influencing of high voltage (HV) insulation lifetime is also discharging activity and first of all partial discharges (PD) [1].

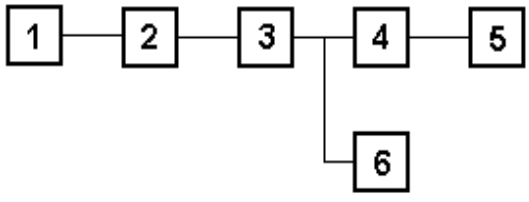
Detection of Partial Discharges

Partial discharge is a local discharge on parts of surface or intraocular insulation. This is the combination of arcing within voids in an insulating material and potential corona discharge in the air over the insulating material. These problems originate by production but mainly occurred at operation. Discharging activity is step by step degrading insulation system and finally causes his destruction This process has definitely different course at various insulate materials and constructional solution. All HV insulating materials and systems inhalt unhomogenous fields and parts, for example cavity, in which exists of partial discharges. Discharges of activity product O_3 which is very aggressive and cause significant degradation mass of materials [2],[3].

Partial discharges (PD) detection is an important possibility for evaluation and monitoring insulation conditions in high voltage (HV) power systems devices. Isolation of the HV device is aging under the influence of mechanical, thermal and electrical stress. Gradually evolving disorder of insulating state terminating breakdown breach and impacts to Therefore it is important to have a system that is capable of warning device users of potential insulation problems so that they may be repaired during a scheduled shutdown. In order to design a system to detect and locate this phenomenon within HV devices, it is important to understand why PD occurs and what methods are currently employed to detection and location PD [3].

The PD phenomenon is manifested in a variety of physically observable signals including electric, optic and acoustic pulses. This effect is currently detected using a host of exterior measurement techniques. On change monitoring facilities insulanting materials on relation with effecting PD were on their monitoring develop several methods and equipments sensitive to some of phenomenon who their attend. On change monitoring facilities insulants materials on relation with effecting PD were on their monitoring develop several methods and equipments sensitive to some of phenomenon who their attend. Electrical detection focuses on capturing the electrical pulse created by the current streamer in the vacuole[2]. These pulses last on the order of single nanoseconds and have measurable frequency components in excess of 1 MHz [1]. The pulse shape, its relative phase location within the AC cycle of the measurement object mains supply, and the signal intensity all lead to information about the type of PD fault and the severity of the insulation damage. Electrical measurements are grouped into two categories, direct probing and RF emission testing. The direct probing method requires that capacitive couplers be connected to the HV phase terminals [3].

The measuring apparatus was constructed according to block diagram on the fig.1, [4]. At the end of isolating bar with length 2,3m and working voltage to 35kV, is located electromagnetic sensor **1**. Signal from sensor input to amplifier **2** onto follow detector **3**. Measuring amplifier **4**, to adapt signal for display **5**. From detector **3** come signal to audible part **6**.



Mechanical solution of the partial discharges detector is according to fig.2. Instrument consist from sensor 1 measuring circuit 2 and insolating bar 3 on which is handle

4. Service hold instrument within handle 4 and with changing sensor position look up on high voltage facilities for finding places with increase discharging activity. Disadvantage this construction is problem with connection other apparatus to prepare measuring signal, because part 1 and 2 can by under high voltage.

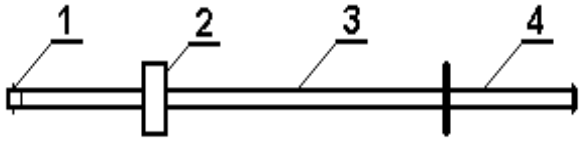


Fig.2

Therefore to elimination this disadvantage was constructed next instrument with information transfer by the help of glass optical fibre cable, which have very good insulation ability. This instrument was constructed according to block diagram on the fig.3. At the end insulanting bar, is located electromagnetic sensor 1. Signal from sensor input to amplifier and detector 2 onto optical transceiver 3 from which by the help of glass optical fibre cable measuring signal come to receiver and measuring amplifier 4, to adapt signal for display 5. From receiver 4 come signal to audible part with output for other measuring devices and headphones 6.

Mechanical solution of the partial discharges detector with optical transmission of signal is according to fig.4. Instrument consist from sensor 1 , measuring and sender circuit 2, optical fibre cable 3 receiver amplifier with output of signal and display 4. Base of instrument compose bearing insulation bar 5 within what is axial situate optical cable.

Sensitivity of the apparatuses to achieve 10 μV. Sufficient selectivity in frequency range 1-10Mhz to obtains.

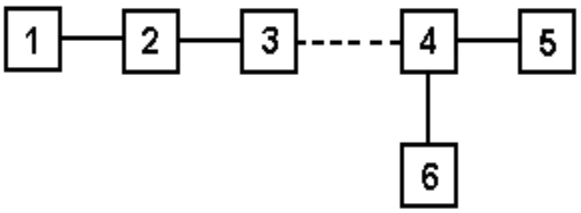


Fig.3

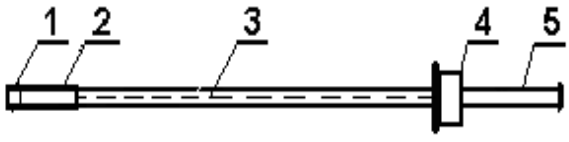


Fig.4

With apparatuses we work under high voltage to 22kV, therefore to need fulfil all the asking instructions for like this work. Operator is equipped with insulate footwear and protective insulating gloves with valid certificate about examination. Operator holds measuring bar by the hand-grip and manipulate with him so, that sensor in successive steps converge to measuring object. Step by step search places with PD, which are indicate characteristic acoustic signal and his intensity is equivalent deviation of pointer reading. Measurement we realize in three steps. The first step is qualitative and serves on orientation location, if to occur on insulation places with increase discharging activity. In second period we quantitative evaluate level PD in particular places and obtained value inscribe in card file measuring furnished. Normally has been measure value around 30μV.

Measurement values of 50μV can be considered satisfactory. If measured values are above 50μV it is necessary to implement appropriate measures to reduce the discharge activity. Most frequently we utilize cleaning of insulation surface, impregnation, refilling of impregnate oil, preventive exchange etc. In some cases, discharge activity was also observed at 20 m distance from the measuring device. If not done the necessary corrections were of the fault within 14 days.

In case serious defect has been discharging activity indicate already near by entrance on measuring area. In this cases, when hasn't done corresponding arrangements, come about too failure in range 14 days.

Conclusions

Developed apparatuses was examined and tested under laboratory conditions and also in service Slovak power establishment. She was prepared guide and instructions for using the device, which were confirmed by the Occupational Safety Inspectorate. Most frequently failure of energetic facilities is failure insulate status. Existence of such defects depends to also from level of operating voltage and action of another operating factor.
Therefore is very important question if partial discharges presence and how their size and quantity in high voltage devices is. Small level of PD activity is not dangerous, but it is necessary from time on time to verify.
Sometimes level of discharging activity, in the working condition often fluctuates. Reasons there are alternating conditions on surface otherwise also at inside insulating material.

In consequence of working temperature change insulating material properties and change also homogenity of insulant material. Most sensitive is in this case combining insulation paper oil which is usage at cable and transformer. By raising temperatures there is a change of to expansion volume of insulant oil . Near cooled incoming to depression volume insulant oil and in the case insufficient quantities of insulant oil to absorption air into channel laminated insulation. Air in vacuole is effortful a few multiple higher voltage consequently lower permittivity whereupon discharging activity to occur and damage insulation. Action is but reversible and it is possible remove timely refilling of impregnant. Internal discharge at solid plastic, or composite insulating material is possible eliminate only with repair. After repair it is possible by the help of apparatus examine of repair effect.

There were realised 1344 measurements cables endings, connectors and other equipments. Besides measurements the detailed analyses of these endings were carried out. From the analyses the reasons of faults are resulting. Causes of failures can be divided into two groups

1. assembly failures
2. service failures.

With measurements were located facilities and places with discharging activity. Some discharging places were to immediately repaired. For example when we was measured on the cable ending value 90μV we was tried at first cleaning of surface insulation mechanical next chemical.

Very oft after mechanical cleaning value of discharges decrease into 50 μV and after chemical cleaning decrease into normal value 30 μV. Evaluation of measurements of discharging activity intensity showed typical dependence on the service time.

High discharging activity could be indicating on safe distance 3–5m also at appliances with higher operation voltage. Despite this fact the instrument is good resistant to strong electromagnetic field in energetic area. This device also to enable testing different high voltage devices, include generators, motors and transformers [5]. This detector of partial discharges, also to enable testing quality of maintenance. Advantage this devices is on the simple operation without galvanic connection with measurement object.

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