A CABLE TERMINATOR FOR PARTIAL DISCHARGE AND DIELECTRIC LOSS MEASUREMENTS

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ABSTRACT

This paper presents a design of the cable connector used in partial discharge and dielectric loss tests. The body of the connector is constructed using the PVC and the oil is used as an insulating medium. In order to implement the connector, partial discharges and the dielectric loss (tan δ) of a cable are tested according to IEC standards. It is found that the cable connector proposed can give the satisfactory and reasonably accurate results from the measurements. In addition, the cost of the construction of the connector developed is cheaper than that of the commercial module.

INTRODUCTION

Nowadays, electrical solid insulations have been used extensively in electrical power devices; particularly in cables. Most solid insulations are developed from polymeric materials. There are two important electrical characteristics for polymeric insulations, which are the partial discharge level and the dielectric loss (tan δ)[1,2]. It is necessary manufacturers to perform tests on the partial discharge level as well as on the dielectric loss. In order to perform such tests, a cable connector is required [1,2,3,4]. The cable connector is available from the commercial sectors. However, it is difficult for small cable companies to acquire such a device due to the price.

This paper is aimed to present a development and a construction of the cable connector using local components available in Thailand. Three types of insulating materials: air, palm oil and transformer oil, are used in the connector. The Connector, then, is implemented in partial discharge and dielectric loss tests for an underground cable. Results measured from the tests are shown.

CONSTRUCTIONS OF A CABLE CONNECTOR

When performing partial discharge tests and dielectric loss tests for a cable, outer parts of the cable have to be taken off. The conductor of the cable, then, is covered by a terminator and is connected to terminals of a transformer which is a supply for performing partial discharge tests and

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dielectric loss tests. The requirement of the cable termination is that the termination needs a sufficient clearance distance between the conductor and the ground part. The inner part of the connector was designed to have a sufficient length to cover all the bare conductor of the cable. The insulating medium was filled into the inner part.The material used for the inner part was acrylic tube so that the inner part was transparent for checking a level of the insulating medium. A solid cylindrical aluminium was connected at the end of the inner part of the con nector in order to provide a socket for one terminal from the transformer. The joint between the acrylic tube and the cylindrical aluminium was sealed using polyester resin in order to reduce the electricstress around the joint, and also protected the leakage of the insulating medium. At the joint between the inner part and the terminal from the transformer, a stress control device in a shape of toroid was placed. The outer part of the connector was PVC, and this was a base to support the inner part of the connector. Figures 1, 2 and 3 show the detail of the constructed cable connector while Figure 4 illustrates an arrangement of the connector for performing cable tests.

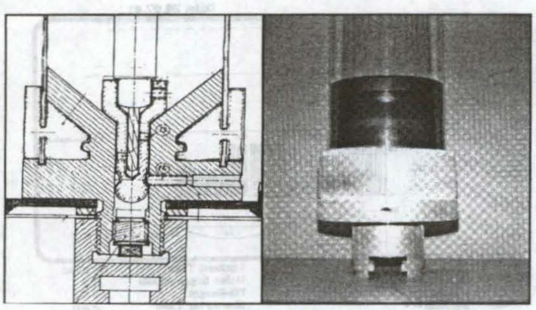


Figure 1. The joint between the tube and the cylindrical aluminium at the inner part of the connect

Figure 2. The electric stress control

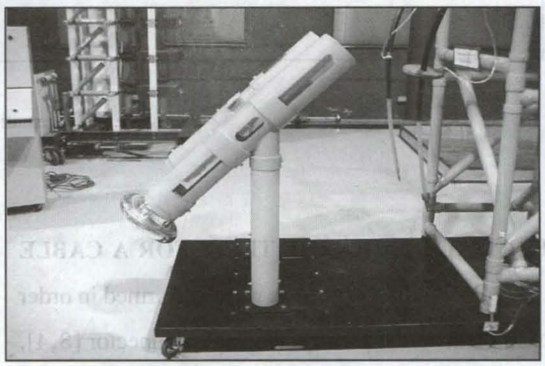


Figure 3. The constructed cable connector

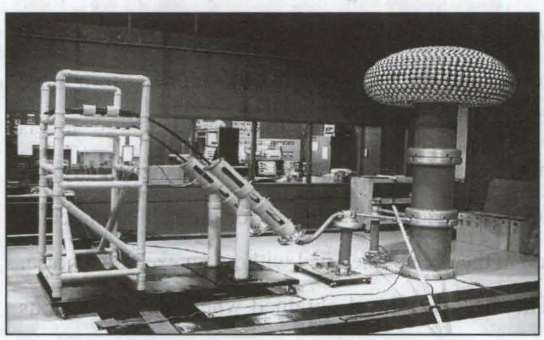


Figure 4. An arrangement of the cable connector in cable tests

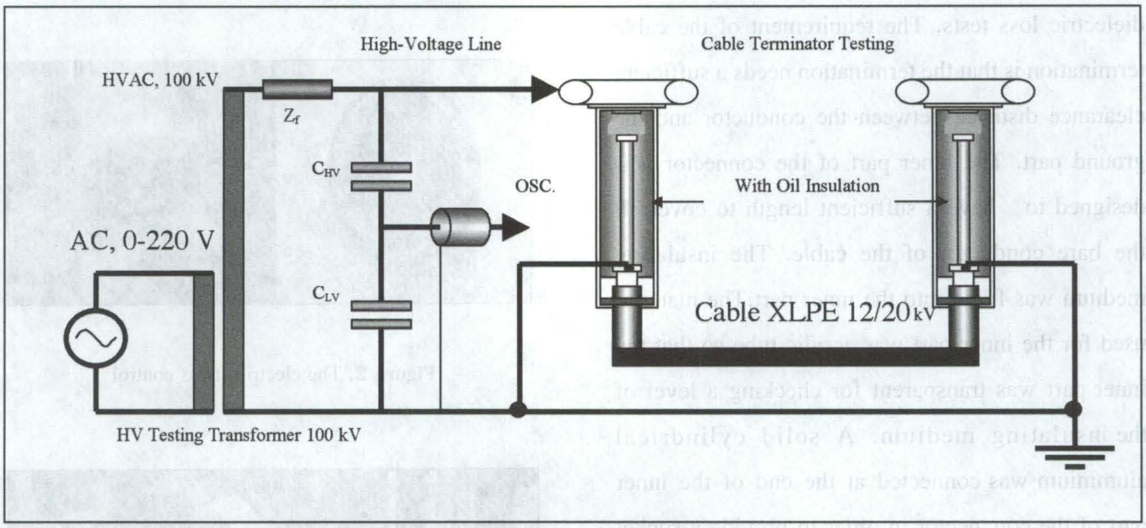
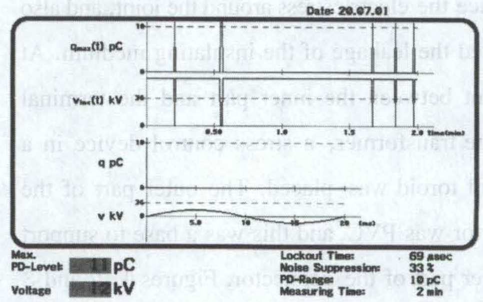


Figure 5. Schematic diagram for cable tests

PARTIAL DISCHARGE TESTS FOR A CABLE

Partial discharge tests were performed in order to implement the constructed cable connector [3,4]. The cable used in the tests was the XLPE 12/20 kV underground cable. Three types of insulating materials for the cable connector were used : air, palm oil (vegetable cooking oil) and trans former oil. Partial discharge tests were performed at the voltage levels of 12 kV and 21 kV. Experimental results are shown in Figures 6,7 and 8. From these Figures , it can be found that the discharge levels obtained when using the palm oil and the transformer oil as an insulating medium for the cable connector are in the acceptable level without an excessive noise. The discharge level obtained when using the air as an insulation for the connector is higher than the normal discharge level for a cable. This is due to the excessive noise from the corona discharges within the connector.



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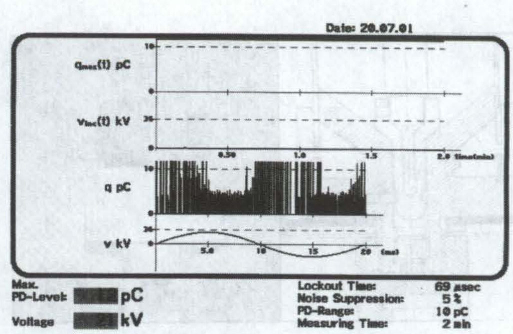
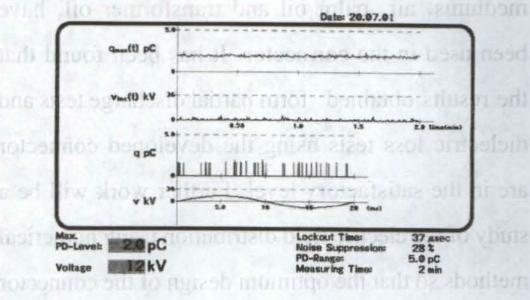


(b)

Figure 6. Partial discharge results with air as an insulating material (a) at 12 kV (b) 21 kV



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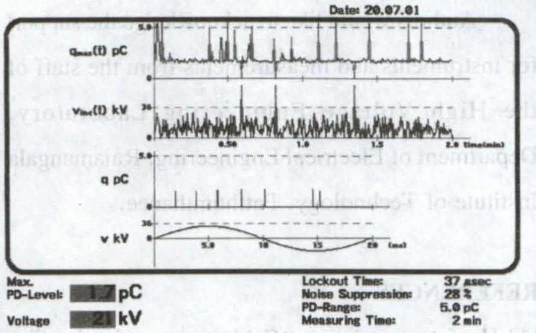
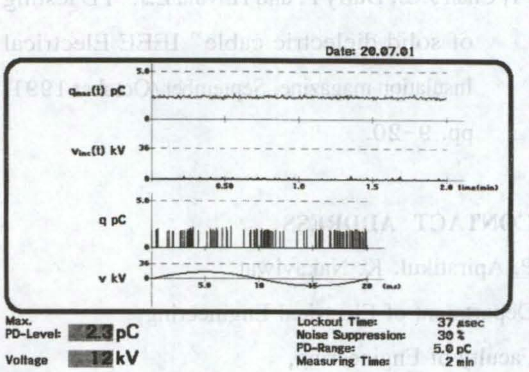
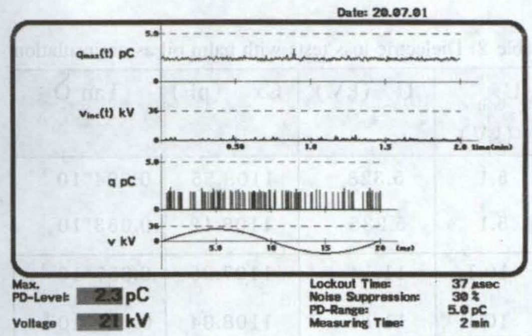


(b)

Figure 7. Partial discharge results with palm oil as an insulating material (a) at 12 kV (b) 21 kV



(a)



(b)

Figure 8. Partial discharge results with transformer oil as an insulating material (a) at 12 kV (b) 21 kV

DIELECTRIC LOSS TESTS FOR A CABLE

The cable connector was employed in dielectric loss tests on the XLPE cable as well. The insulating medium for the connector as well as the test voltage levels were the same as those employed in the partial discharge tests. Experimental results are shown in Tables 1,2 and 3.

Table 1. Dielectric loss tests with air as an insulation

$U_{control}$ (kV)	U_{test} (kV)	Cx_{test} (pF)	Tan δ
5.1	4.854	1105.95	$1.011*10^{-3}$
5.1	5.258	1105.88	$1.023*10^{-3}$
10.1	10.78	1105.47	$1.008*10^{-3}$
10.1	10.86	1106.63	$1.011*10^{-3}$
12	11.75	1104.66	$1.015*10^{-3}$
12	12.43	1106.13	$1.013*10^{-3}$
20.76	21.56	1105.97	$1.9874*10^{-3}$
20.76	21.58	1106.35	$2.132*10^{-3}$
20.76	21.58	1105.95	$2.215*10^{-3}$
20.76	21.63	1106.69	$2.211*10^{-3}$

Table 2. Dielectric loss tests with palm oil as an insulation

$U_{control}$ (kV)	U_{test} (kV)	Cx_{test} (pF)	Tan δ
5.1	5.328	1108.55	0.694*10^-3
5.1	5.235	1108.12	0.653*10^-3
10.1	11.14	1107.95	0.857*10^-3
10.1	11.15	1108.34	0.854*10^-3
12	12.95	1108.45	1.005*10^-3
12	12.15	1108.43	1.007*10^-3
20.76	21.56	1107.63	0.945*10^-3
20.76	21.63	1107.75	0.942*10^-3
20.76	22.57	1108.55	0.985*10^-3
20.76	22.05	1108.90	0.948*10^-3

Table 3. Dielectric loss tests with transformer oil as an insulation

$U_{control}$ (kV)	U_{test} (kV)	Cx_{test} (pF)	Tan δ
5.1	4.854	1325.95	0.790*10^-3
5.1	5.462	1324.88	0.769*10^-3
10.1	11.54	1426.86	0.426*10^-3
10.1	11.64	1434.86	0.424*10^-3
12	12.66	1421.26	0.511*10^-3
12	12.43	1428.29	0.521*10^-3
20.76	21.56	1421.06	0.562*10^-3
20.76	21.63	1332.13	0.488*10^-3
20.76	21.68	1330.86	0.484*10^-3
20.76	21.65	1330.88	0.477*10^-3

CONCLUSION

A cable connector has been constructed for using with a partial discharge detector and a Schering bridge. Components used in the connector are available from local suppliers in Thailand. The connector proposed in this paper, has been implemented in partial discharge tests and dielectric loss tests for the XLPE cable. Three insulating mediums: air, palm oil and transformer oil, have been used in the con nector. It has been found that the results obtained form partial discharge tests and dielectric loss tests using the developed connector are in the satisfactory level. Further work will be a study of the electric field distribution using numerical methods so that the optimum design of the connector can be obtained.

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