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Examination of Wind Effect on Adss Cables Aging Test

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ABSTRACT

ADSS (All dielectric self supporting) cables are generally installed on high voltage transmission lines and mostly used under different environmental effects, such as temperature, wind, UV radiation, etc. In this study, wind affect on ADSS cables was investigated by using dry band arcing (IEEE 1222 Electrical surface degradation) test method. A wind source was implemented to the test setup to evaluate the performance of PE (Poly-ethylene) cable jacket on ADSS cable under different wind speeds. Test results indicate that life time of the ADSS cable decreases while the wind speed is increasing.

Keywords: Wind, ADSS, fiber-optic cable, aging, transmission lines

Introduction

ADSS cables are used in transmission lines and installed 3m-6m below the high voltage conductors [1]. Throughout their service life ADSS cables, stretched between poles of a high voltage transmission line, have to suffer several degradation mechanisms, such as humidity, pollution, ice load, wind, temperature variations, etc., which have a vital effect on the ageing and degradation process of the cable [2, 3]. In addition to the necessary tensile strength, cable manufacturers have also to consider the electrical stress mechanisms, which lead to accelerated aging and finally damage or destruction of the cable jacket [4].

Wind causes a mechanical stresses on ADSS cables and hence stretches the outer insulation of the fiber- optic cable. This mechanical effect together with the corona discharge decreases the lifetime of the cable jacket considerably. In this study the effect of wind speed on the aging behavior of ADSS cables is investigated.

Wind might oscillate ADSS cables and hence decrease the distance between the ADSS cable and HV conductor, which eventually increases the electrical field that an ADSS cable has to suffer [1, 5]. A severe and extreme wind loading is usually observed by hurricanes, cyclones or other ocean born storms. In this paper, according to Turkey's average wind conditions, several levels of wind forces are generated in the laboratory artificially. Generally wind speed will cause the cable to deflect horizontally, hence the vertical sag according to the wind speed will be very small [5].

The damage analysis has been performed in order to establish a relation between the wind speed and life time of ADSS cable. The cable damage was observed as an erosion of the cable's PE sheath between the clamps. Due to the rapid drying of the liquid, hot spots with a very high temperature are created on the surface of the cable. This process leads to the generation of dry ring zones and partial arcing. Damage is usually observed in the form of small holes and spongy residues similar to the classical tree pictures found in many tracking and erosion tests [6]. Wind forces the liquid contaminant to settle down behind the

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cable, in contrast to the normal conditions where the contaminant drops under the cable.

The main purpose of the present paper was to study the datasets produced according to IEEE 1222 test standard and to find out whether the effect of wind could be integrated in a simplified set of surface degradation test method [7].

Materials and Methods

In this study IEEE 1222 test standard 'Dry-Band Arcing' test method was used. To simulate the wind effect under laboratory conditions, a 24 W fan was added to the test set up and the wind speed is varied between 2,34m/s and 5,65m/s. The limits are chosen according to the average wind levels measured throughout Turkey [8]. The evaluated test system, which is given in Figure 1, includes a 220V/36kV HV (high voltage) transformer. To limit the current flowing on the ADSS cable, R and C components are chosen as 13.1 MΩ and 200 pF respectively. This RC values help to simulate medium pollution level for ADSS cables. To control the liquid contaminant spraying time and level, a flow control equipment was used. A similar test set up could be seen in some previous studies in more detail [9]. In order to vary the wind speed throughout the experiments, the distance between wind source and test sample was changed, where wind speed was measured by using YK-80AP Lutron Anemometer.

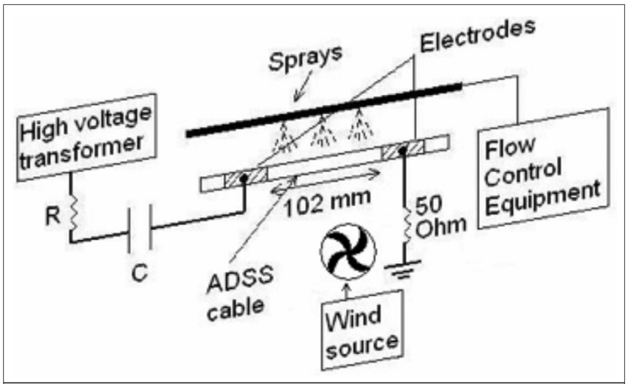

Figure 1. Block diagram of the modified test set up for measuring the wind effect

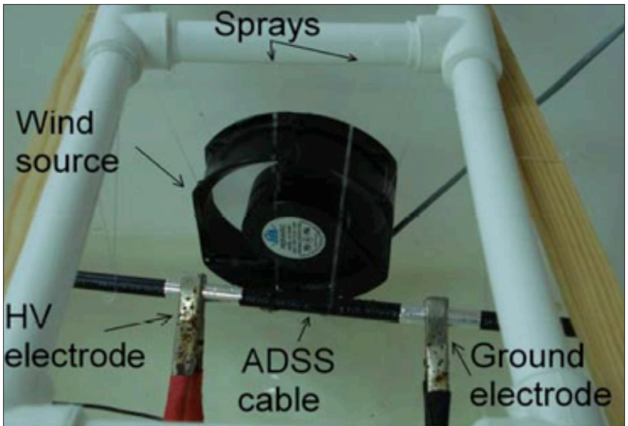

Figure 2. Wind source added to the test set up

Wind effect produce a tensile strength on the ADSS cable, which eventually decreases the service life of ADSS cable. All tests are performed with samples prepared 46 cm in length. The distance between two electrodes was fixed 10.2 cm and they were placed on the middle of the test samples. By using an aluminum foil as an electrode, 25kV HVAC was applied one of the electrodes, where the other electrode is connected to the ground with a 50Ω resistor. [7]. The conductivity of the liquid contaminant, which is prepared by adding salt to deionized water, is measured as 17.2 mS ± %3 by using YK-22CT Lutron conductivity / TDS meter. During experiments initially test samples were sprayed by liquid contaminant up to 2 minutes and then allowed to dry for 28 minutes. The total 30-minute time period is called as one cycle and the measurement of the arc resistance is defined by the number of cycles needed to puncture the jacket.

According to IEEE 1222 standart, experiments were done until the ADSS cable get failed. The number of cycles determine the lifetime of the cable.

In the second part of the study a wind source was added to test set up. Initially wind speed is measured as a function of distance of the wind source (external fan) to test sample. Table 1 shows the variation of wind speed according to the distance between the wind source and cable samples. During experiments temperature was continuously recorded and kept steady at 28 °C.

HV insulators and transmission lines located at mountains or similar rural areas are usually subjected to severe wind force, which cause an additional weight on the whole mechanical system. Especially by severe windstorms an HV transmission line located between two poles, might move considerably either to the left or right compared to its original position, which eventually reduces the security distance between lines and also alters the electromagnetic field. However since the wind force is applied perpendicular (from one side) to the transmission line and the weight of the conductor is quite high compared to the wind speed the HV transmission line can change its location only at high wind pressures. As shown in Table 2, the ADSS cable (D=16.5mm) has a unit weight of 2,2kg/m, hence with the application of artificial wind, the cable has altered its location up to 0,86 degree, which seems eventually has not any affect on the total electrical field.

Test set up with the wind source is given in Figure 2 and the measurement technique is shown in Figure 3.

Min.5 cables were tested for each wind speed level, which were selected as 0, 2.34, 2.61, 2.76, 3.21, 4.03, 4.70 and 5.65 m/s to

Table 1. Wind speed (m/s) and distance to the wind source

Distance to the wind source (cm)	Measured wind speed (m/sec)	Temperature (°C)
5	5.65	28
10	4.70	28
15	4.03	28
20	3.21	28
25	2.76	28
30	2.61	28
35	2.34	28

Table 2. Wind force and maximum deviation

Measured wind speed (m/s)	Wind pressure (kg/m²)	Wind force (kg/m)	Unit weight (kg/m)	Deviation (degree)
5.65	1.99	0.0328	2.2	0.85
4.70	1.38	0.0227	2.2	0.59
4.03	1.01	0.0166	2.2	0.43
3.21	0.65	0.0107	2.2	0.27
2.76	0.47	0.0077	2.2	0.20
2.61	0.42	0.0069	2.2	0.18
2.34	0.34	0.0056	2.2	0.14

Table 3. Life time of ADSS cables at different wind speed.

Measured wind speed (m/s)	Average lifetime of the ADSS cable(cycle)
5.65	16.70
4.70	17.44
4.03	19.20
3.21	19.91
2.76	21.10
2.61	23.56
2.34	24.09
0	26.80

simulate the different regions in Turkey respectively. Each time the number of cycles for total failure was recorded and finally the average number of cycles and standard deviation were calculated.

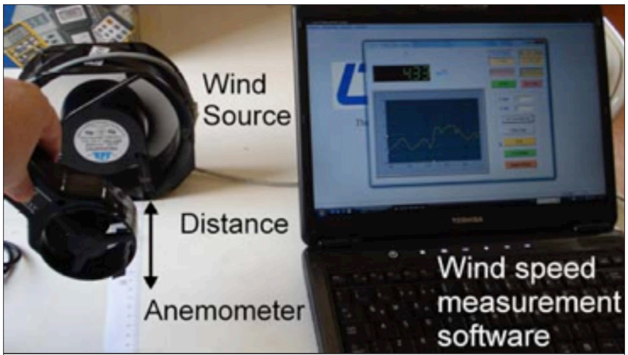

Figure 3. Wind speed measurement system

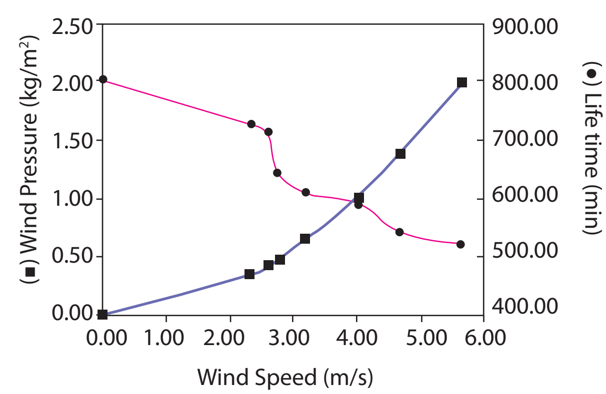

Figure 4. Wind pressure and the life time of ADSS cables according to wind speed

Results

In this study the effect of wind speed on ADSS cable degradation process is studied. The ADSS cables are generally located at 10m above the ground, hence according to standards the minimum wind level for this height should be selected as 12,2 m/s. However in order to simulate the real average wind speeds measured in Turkey much lower values are used throughout the experiments [10,11]. The measured lifetime of ADSS cable according to wind speed is given in Table 3. During the experiments the wet layer observed after spraying process is drifted through the back of cable surface depending on the pressure of the wind speed. This wind pressure forced the drops to stay on the cable and hence produce a conducting channel between HV and ground electrode. As a result, due to the heat increase, the cable damaged faster than the conditions without wind pressure. The measured life cycles according to wind speed is given in Figure 4.

Conclusion

This study represents the actual behavior of ADSS cables used in Turkey at different wind speed levels. All the experiments were done under isolated conditions in the laboratory. Aging tests indicate that life time of ADSS cables decrease with increasing values of wind speed. The wind speed of 2.61m/s, which is the average value for east region of Turkey, is the critical level for decrease of life time for ADSS cable. Over this value the aging process is accelerated rapidly. During experiments without any wind effect, water drops take place under the cable jacket. Continuous sparks and arcs damage the cable sheath after approximately 26,80 cycles. For higher wind speeds, water drops split to the back of the cable jacket which is opposite to wind direction, and hence the arcs occur behind the cable jacket. Wind can establish a lateral force on ADSS cables, which can cause mechanical fatigue and also alter the electrical field. However as stated in Table 2, at low wind speeds, only the location of the wet layer is changed rather than the position of the whole conductor, hence in such cases the cable is only degraded due to continuous arcs. Low values of wind speed changes the electrical field and tensile force slightly, hence they do not have any considerable effect on the lifetime of the ADSS cable.

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References

1. G. Karady, E. Al-Ammar, B. Shi, M.W. Tuominen, 'Experimental Verification of The Proposed IEEE Performance and Testing Standard for ADSS Fiber Optic Cable for Use on Electric Utility Power Lines', IEEE Trans Power Del, vol. 21, no. 1, pp. 450-455, Jan. 2006.
2. G. Karady, D. Srinivasan, 'Algorithm to predict dry-band arcing in fiber-optic cables', IEEE Trans Power Del, vol. 16, no. 2, pp. 286-291, Apr. 2001.
3. NASA Scientific and Technical Aerospace Report, Volume 42, Issue 5, March 12, 2004.
4. US Patent 6519396, 'Aerial cable containing optical transmission elements and process for the manufacture of an aerial cable', US Patent Issued on February 11, 2003.
5. Applications Engineering Note, Sag and Tension, Corning Cable Systems, November 2002.
6. F.G. Kaidanov, 'ADSS Cables Recognizing the Problems and Solutions', Transmission and Distribution World, Oct 1, 2002.
8. IEEE 1222 standarts 'IEEE Standard for All Dielectric Self Supporting Fiber Optic Cable', 2004.
9. R. Kose, M.A. Ozgur, O. Erbas, A. Tugcu, 'The Analysis of Wind Data and Wind Energy Potential in Kutahya, Turkey, Renewable & Sustainable Energy Review; vol. 8(3), p.277- 288, 2004.
10. S. Kucuksari, Gunes I., G. Karady, 'A Novel Method to Test the Quality of ADSS Fiber Optic Cables Installed in Transmission Lines', IEEE Powertech 2009, Bucharest, Romania , 28 June-2 July 2009.
11. G.G. Karady, Q. Huang, D. Srinivasan, M. Tuominen, M. Reta-Hernandez, 'Sensor Design for Leakage Current Measurement on ADSS Fiber-Optic Cable', Power Engineering Society Winter Meeting, IEEE, 28 Jan-1 Feb 2001

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