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The need of creating a new nominal creepage distance in accordance with heaviest pollution 500 kV overhead line insulators

Ricardo Manuel Arias Velásquez*, Jennifer Vanessa Mejia Lara

Pontificia Universidad Católica del Perú (PUCP), Doctoral Engineering Program, Peru

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ABSTRACT

The flashovers on insulators, caused by severe pollution, has posed the biggest threat on the safe operation of power systems the insulators contamination, and it is an important problem, special in polluted. The aperiodic occurrence of widespread contamination related outages cause serious damages to the transmission lines, the worst behavior is up to 500 kV overhead lines.

The exceptional level of pollution measured on those insulators, especially for the bottom surface for the non-soluble salt deposit density (NSDD) component, where the values are outside of the standard limit given in the currently IEC standard. The results provide important reference for the insulators design, maintenance of operational transmission line insulators and flashover warnings. It should be highlighted that results fall out of the limit of the IEC standard and that in order to plot those values in the graph the limits for the highest NSDD values have been increased from 4 to 20 g/cm^2. This clearly shows the unusually high values of the NSDD components measured on those insulators. The case study has been realized on 837,000 insulators for 9000 towers in 500 kV powers lines. This clearly shows the unusual characteristics of the coast and desert environment of the 500 kV overhead lines, and the needs of update in the IEC standards has been researched.

1. Introduction

The problem of insulators pollution flashover has posed a great threat on the safe operation of power system, Ref. [1]. The research by IEC has encouragement of the use of site pollution severity measurements, preferably over at least a year, in order to classify a site instead of the previous qualitative assessment. Recognition that “solid” pollution on insulators has two components, one soluble quantified by equivalent salt deposit density (ESDD), the other insoluble quantified by non-soluble salt deposit density (NSDD).

The ESSD is the amount of sodium chloride (NaCl) that, when dissolved in demineralized water, gives the same volume conductivity as that of the natural deposit removed from a given surface of the insulator divided by the area of this surface and the NSDD is the amount of non-soluble residue removed from a given surface of the insulator divided by the area of this surface.

However, for the purposes of standardization, Ref. [2,3], five classes of pollution characterizing site severity are qualitatively defined, from very light pollution to very heavy pollution as follows:

a – Very light.
b – Light.

* Corresponding author.
E-mail address: ricardoariasvelasquez@hotmail.com (R.M. Arias Velásquez).

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c – Medium.
d – Heavy.
e – Very heavy.

In the last decades, many researches have reviewed the scope and problems with pollution in overhead lines with CaSO4 according to Ref. [4], saturated moist, Ref. [5], among others. Researches have shown that there was a close relationship between the leakage current and pollution withstand voltage. Besides, the convenience of online monitoring also draws the attention of insulator operation monitoring field to leakage current by Ref. [6].

Insulators contamination in polluted area is an important problem. The program for washing is a traditional method; however, it is not suitable for unusual characteristics (coast and desert environment). Even, the problem could get worst, because of the water restriction, considered in the environmental impact studies. Insulators contamination in a polluted area, is an important issue. The aperiodic occurrence of widespread contamination related outages, causes serious damages in transmission lines according to Ref. [7]. Thus, determination of accumulated pollution level is necessary, by traditional methods or engineering methods, according to Ref. [8,9].

Although it is an important practical issue, this research is an exceptional situation similar to other found in the real applications worldwide, because of it, it's important the knowledge contribution for the insulation IEC standard. In this research, it introduces a high NSDD values can be explained by the dry and desertic direct environment of the tower on 500 kV overhead lines, present in dry and desertic direct environment, it has developed a new proposal for update the Ref. [2,3]. The authors inquire for changes in the IEC Standard, this research responds to the following question: Would be necessary, to implement an extension in the ranges of the pollution severity of the characterization curve, in the IEC standard? Would be appropriate to implement this new characterization curve in the IEC standard for insulators?

Due to the pollution severity, a new level of pollution shall be considered. This has been proved by a significant study case, it has been realized on 837,000 insulators for 9000 towers in 500 kV powers lines.

2. Test method

2.1. Test method

The relevant test method to be used is selected according to the type of pollution at the site, the type of insulator and the type of voltage. The tests given by Ref. [10] and CIGRE 158, Ref. [11] are directly applicable to ceramic and glass insulators, in the Fig. 1.

As a general rule, the solid layer test is recommended for type A pollution and the salt-fog test for type B pollution, according to Ref. [2]. The pollution severity used in the laboratory test is determined in three steps:

1) The pollution type present and the site pollution severity are determined by assessing the pollution at a site.

2) The site pollution severity level is corrected for any deficiency or inaccuracy in the determination of the site pollution severity (SPS). The correction factors shall compensate for:
   - – Differences in pollution catch of the insulator used for the site pollution severity measurement and the insulator to be tested, e.g. the influence of shed profiles and diameters.
   - – Differences in types of voltage applied on the insulator used for the site pollution severity measurement and the insulator to be tested, e.g. d.c. or a.c. voltage.
   - – Other influences of importance.

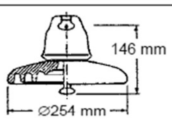
Insulator type and number of units per string	Unified specific creepage distance	Applied voltage (r.m.s.)	Salt fog test method	Solid layer methods			
				Procedure A a)		Procedure B	
			Maximum withstand salinity	Maximum withstand layer conductivity	Maximum withstand salt deposit density	Maximum withstand salt deposit density	Maximum withstand layer conductivity
	mm/kV	kV	kg/m^3	μS	mg/cm^2	mg/cm^2	μS
	27,8 (= 16 × √3)	95	7 to 14	7 to 14	0,02 to 0,04	0,035 to 0,07	
9 units Overall creepage distance: 2 630 mm	34,7 (= 20 × √3)	76	20 to 40	14 to 28	0,04 to 0,1	0,1 to 0,2	

Fig. 1. Ranges of values of withstand characteristics insulators in artificial pollution test, Ref. [10].