Reliability Indexing Analysis of HTV Silicone Rubber Insulator

Ms.Ballavi Mishra#, Ms.Beena Singh*
#M.Tech Student,-Department of Electrical Engg., #Asstt.Professor- Department of Electrical Engg
*# * Lingaya's University*
Faridabad,Haryana,India
#Mrani.1989@gmail.com

***Abstract*— Life span of the Insulator will depend on the surroundings condition and to applied voltage in the form of gradient and this will depend on the type of coating and the life span of the coating. Due to Change in the Operating Condition application of Insulator the trend of use of insulators is also changing from Porcelain Insulator to Silicone rubber Insulators. The application of HTV Insulators in the outdoor application are now widely used because of the good operating performance and the other polymeric Silicone rubber insulator like Liquid Silicone rubber is also widely used because of good physiological Characteristics..In this paper we are trying to analyze the HTV Silicone rubber insulator reliability by change of various parameters using matlab/simulink.**

***Keywords*—RTV,HTV, INDEX FACTOR,ECR,LSR Flashover.**

I.INTRODUCTION

Reliability of the Power system now a days is the major concern for providing safe and reliable Power supply to the end customer. Insulators are the integral parts of the Power Transmission and distribution system. The auxiliary part which is associated with the Power system is the Integral Parts of the Equipment. Design of Insulator is such a way that the chances of the flashover are very minimum [21]. A long term association of the equipment reliability is associated with all parts of the Power system [2]. Reliability of the Insulators [16] is actually depend on the two parameter of Insulator is.

1. Mechanical strength
2. Electrical strength
3. Operating condition

The application of the Polymeric insulators are more and normally silicone rubber are widely used as a polymeric insulators [6][10]. Thus efficiency and reliability of these systems will depend directly Silicone rubber Performance [19].High Temperature performance of the polymeric Insulators were depend on the Type of application and the techniques use for wide applications are

1. High Temperature Vulcanizing(HTV)
2. Room Temperature Vulcanizing (RTV)
3. Liquid Silicone Rubber(LSR)

These insulators are made of organic Material and whenever they are going to operate for outdoor application there life span is going to reduced. Polymers [3] Insulator mainly silicone rubber insulators tried to maximum eliminates the problem of Bio-contamination [10]. Bio-contamination is a process of development of several type of Small organism on the outer surface of the insulators which is termed as the fungi and algae but on the silicone rubber insulators they are having very less effect on the performance. However the ability of polymeric insulators to resist physical and chemical degradation due to voltage gradient, Thermal heat, Acid rain, salt fog, pollution[9][18] and ultraviolet radiation is major concern for Reliability[15].ECR glass (Electrical- and corrosion-resistant glass) is having low reliability.

II.RELIABILITY OF POLYMER INSULATORS

A housing material should be able to protect the load-bearing core and provide sufficient pollution withstand[7]. The reason of use of rubbers instead of ordinary plastics is simply the fact that the housing must be flexible enough to follow the changes in dimension caused by temperature or mechanical load. In the area of substation where the pollution is the relevant problem there we can use the RTV[1] Silicone Rubber Insulator as thin coating insulators[4][5].

Silicone rubber is appropriate material for manufacturing Insulators for outdoor applications. Composite power line insulators using HTV [3] silicone rubber insulators are now general application, replacing porcelain [22] and glass insulators in many application

Figure-1 Polymeric Insulator with End Fittings

III. RELIABILITY INDEXING

Due to Power system Reliability concern the trends of use of polymeric insulators are now increasing in comparison to the ceramic insulators because of the some advantage are mentioned below

1. Polymeric Insulators mechanical strength is high.
2. Polymeric Insulators weight are reduced up to 80 % Reduced weight (up to 80% lighter)In comparison to conventional insulators.
3. Polymeric Insulators are Robustness and shock resistance.
4. Polymeric Insulators are protected from Chemical, Atmospheric pollution.
5. Life of Polymeric insulators is having long.
6. Silicone rubber is widely used as a Polymer Insulators.
7. It is also Posses the quality of emissions and toxicity.

Now a days the outdoor application of the insulators is going to increased and it require the protection from the external atmospheric condition to operate in good condition for a long time and provide a better pollution performance [8].

Due to the presence of dust and moisture in combination will develop electrical stress causes and lead to degradation [11] of material due to treeing and tracking, erosion. Thus for protecting the Insulator from these outer causes proper coating [4] is to be provided on the surface of the insulators [17]. IEC 61109 used for Composite suspension and tension insulators for a.c. systems with a nominal voltage greater than 1,000 V (Insulators for overhead lines).

Figure-2 Silicone Rubber Insulators

.

Table-1 Comparison of Silicone Rubber In High Voltage Insulation Application

High Temperature Vulcanizing	Room Temperature Vulcanizing	Liquid Silicone Rubber
Cured at High Temperature and Pressure	It is cured at Room Temperature and Pressure	It is mixture of two component
It is soft and easily deformable	Coating is of thin layers	It is fully elastic material
Surface is Sticky	Condensation and reaction as one component system.	Viscosity is very high
Tensile Strength is good	Chance of Ingres sing of Moisture from Outer surface	It color is milky white
After vulcanizing the material become elastic. and High Silicone Relative Permittivity	Hydrophobicity chances is higher	No Toxic or aggressive components are formed when using LSR.
Temperature Control in Injection Unit is considerably lower.		Good physiological Characteristics

.

A. *Ageing Factors Indication for Life of Insulators[20]*

1. Long Life Natural Causes.
2. Multi Factor Causes
3. Degradation of Electrical Parameter due various factors.
4. Operating Temperature effect on life of Insulator
5. Contamination Effect on Outer Surface of Insultor
6. Partial leakage current effect [14].

B. *Analysis of Residual Life*

The Actual process of the degradation state and residual life [12] of Insulator is measured by the following indication factor

1. X-Ray Photoelectron Spectroscopy
2. Secondary Ion Mass Spectroscopy
3. Thermal Gravimetric Analysis
4. Surface Inspection by Scanning Electron Microscopy
5. Hydrophobicity
6. Acoustic measurement, etc

.

C. Performance Indicator of HTV Insulator

1. HTV Silicone Rubber Insulator is having Better Performances in Pollution Environment[13].
2. HTV Silicone Rubber Insulator is having good protection layers from Moisture attacks.
3. HTV silicone rubber Insulator is having Good reliability during hard service condition.
4. HTV Silicone Rubber Insulator is having less chance of Flashover due to dust and water accumulation.

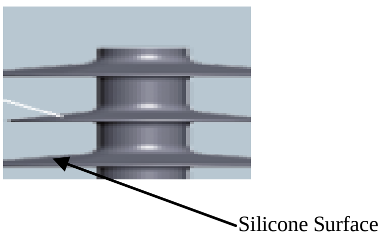

Figure-3 HTV Silicone Rubber Insulator

In the view of the design application will make the design in such a way that the performance[8] in all the cases and condition remains good.

The Major factors associated with the design performance is

1. Voltage
2. Number of Sheath
3. Length of Sheath
4. Creepage Distance

For analyzing the variation in the sheath profile we have calculated Index Factor (Ш) as below

Index Factor (Ш) = Length of Sheath/ No of Sheath

IV. RESULT AND ANALYSIS

Different Cases are considered according to Voltage Level and no of Sheath

Table-2 HTV Silicone Insulator Parameter

Case-1

Voltage in KV	Approx No of Sheath	Approx Length of Sheath(M)	Index Factor
35	8	0.48	0.060
110	25	1.14	0.046
220	48	2.2	0.046
500	92	4	0.043

Case-2

Voltage in KV	Approx No of Sheath	Approx Length of Sheath(M)	Index Factor
35	10	0.45	0.045
110	28	1.08	0.039
220	50	2.08	0.042
500	94	3.8	0.040

Case-3

Voltage in KV	Approx No of Sheath	Approx Length of Sheath(M)	Index Factor
35	12	0.42	0.035
110	30	1.06	0.035
220	52	2.02	0.039
500	96	3.4	0.035

Case-4

Voltage in KV	Approx No of Sheath	Approx Length of Sheath(M)	Index Factor
35	14	0.4	0.029
110	32	1.02	0.032
220	54	2	0.037
500	98	3.2	0.033

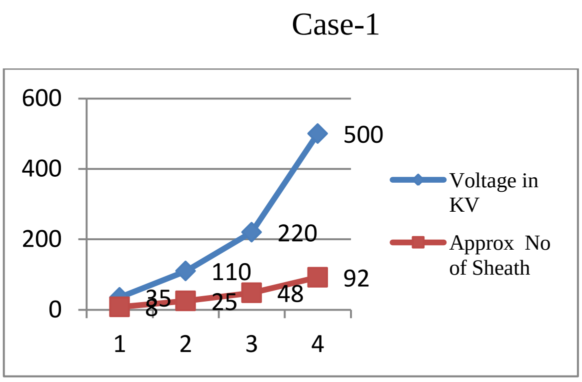

Figure-4 Voltage Vs No of Sheath Changing Curve

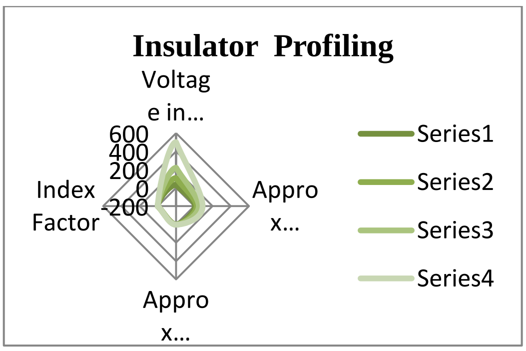

Figure -5 Insulator Profiling Curve

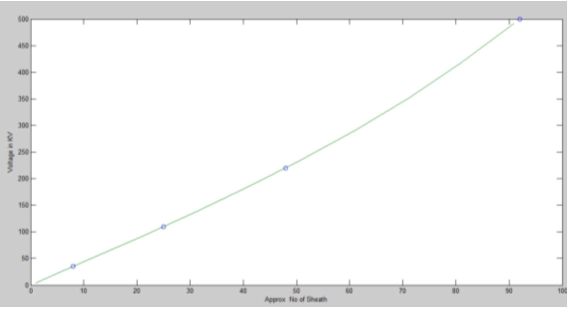

Figure-6 Voltage vs Sheath Number

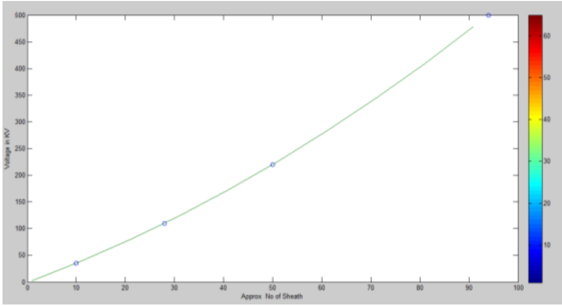

Figure-10 Voltage vs Sheath Number

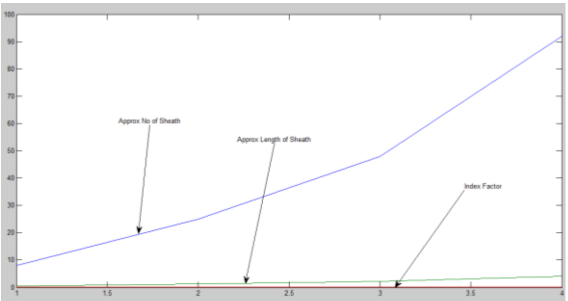

Figure-7 Index Parameter Variation Curve

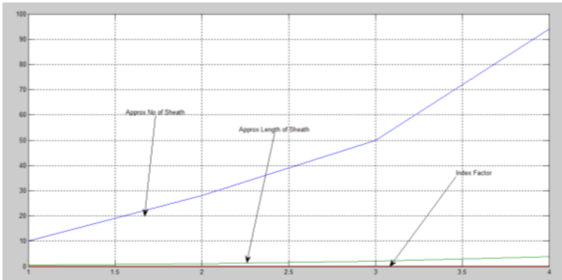

Figure-11 Index Parameter Variation Curve

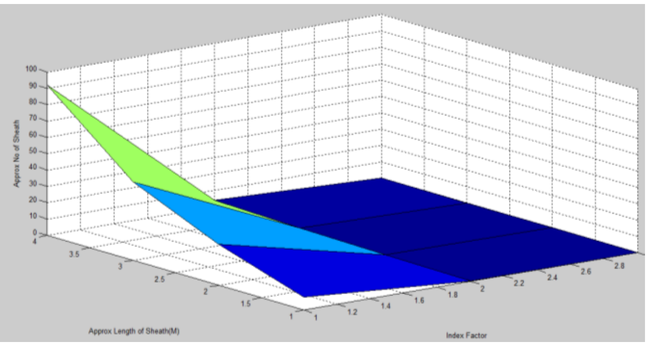

Figure-8 Sheath Variation Curve

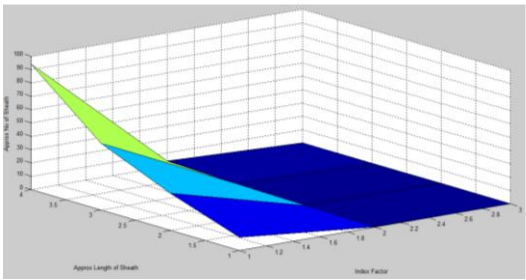

Figure-12 Sheath Variation Curve

Case-2

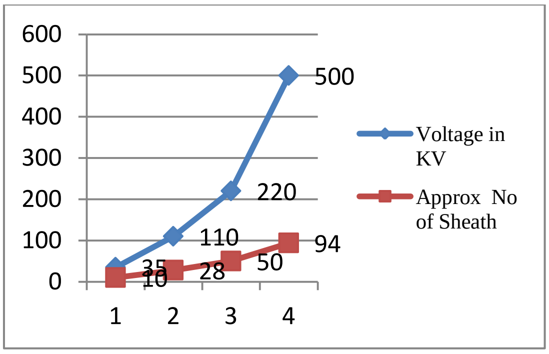

Figure-9 Voltage Vs No of Sheath Changing Curve

Case-3

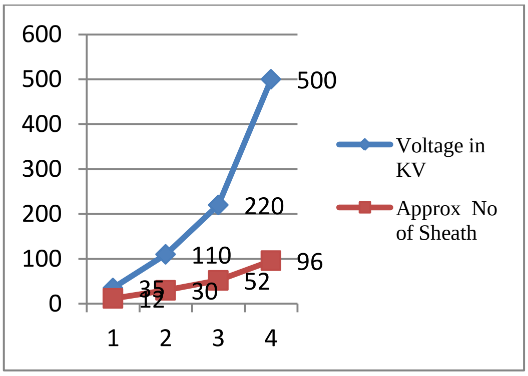

Figure-13 Voltage Vs No of Sheath Changing Curve

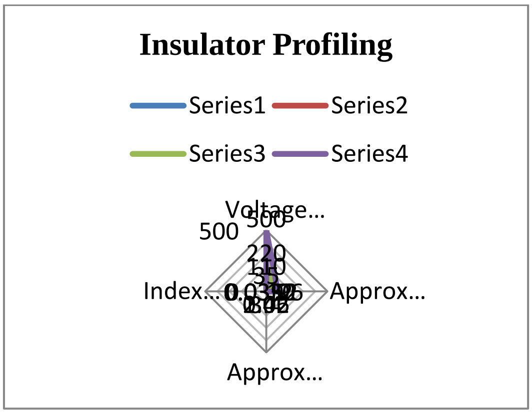

Figure -14 Insulator Profiling Curve

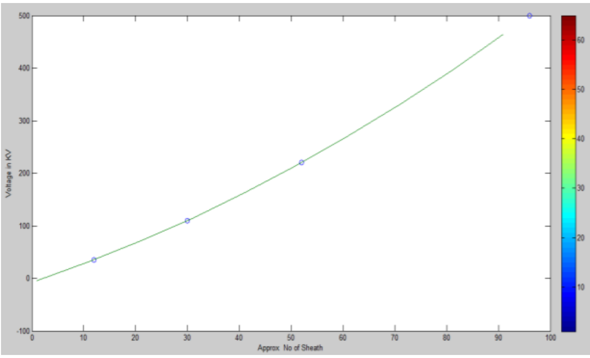

Figure-15 Voltage vs Sheath Number

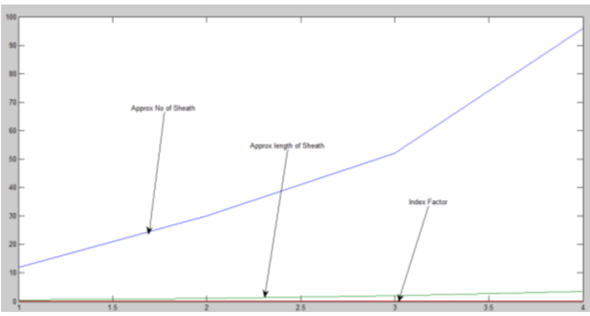

Figure-16 Index Parameter Variation Curve

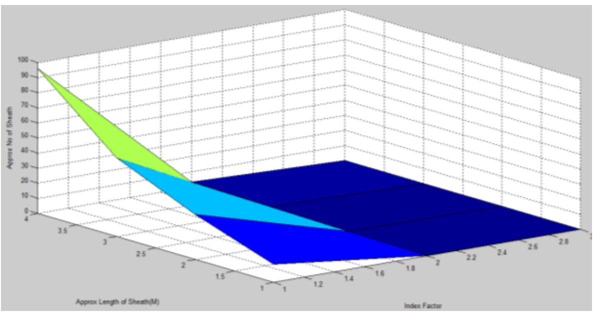

Figure-17 Sheath Variation Curve

V.CONCLUSION

From the above cases of HTV Insulator, the profiling was done to check the no of sheath variation will lead to change the Sheath length as well as voltage gradient. As the voltage is very high the change in number of sheath is also relatively high. For analyzing the actual performance the sheath variation curve is also analyzed for the same to check the indexing.

REFERENCE

[1] E.A. Cherney, “RTV Silicone - A high tech solution for a dirty insulator problem”, IEEE Electr. Insul. Mag., Vol. 11, No. 6, pp. 8- 14, 1995.

[2] D.Devendranath N.S.Mohan Rao C-eshava AD. Rajkwnar “Ageing Studies On RTV Coated Insulator In Salt-Fog Pollution” 0-7803-5935-6/00/$10.00 (c) 2000 IEEE.

[3] Isaias Ramirez, Ramiro Hernandez, and Gerardo Montoya “Salt Fog Testing of RTV Coated Ceramic Insulators and Comparison with HTV Silicone Rubber
Insulators” 978-1-4673-1252-3/12/$31.00 ©2012 IEEE.
.
[4] E.A. Cherney, R.S. Gorur, M. Marzinotto, A. El-Hag, L. Meyer, JM. George, S. Li and I. Ramirez, “RTV Silicone Rubber Pre-coated Ceramic Insulators for Transmission Lines” IEEE Trans. Dielectr. Electr. Insul., Vol. 20, No.1, pp, 237-244, 2013.

[5] A. Naderian, E. A. Cherney, S. H. Jayaram, L. C. Simon, "Aging Characteristics of RTV Silicone Rubber Insulator Coatings”, IEEE Trans. Dielectr. Electr. Insul., Vol. 15, No. 2, pp. 444 - 452, 2008.

[6] R.S. Gorur, J.W. Chang and O. G. Amburgey, “Surface Hydrophobicity of Polymeric Materials used for Outdoor Insulation Applications”, IEEE Trans. Power Delivery, Vol. 5, No. 4, pp. 1921-1933, 1990.

[7] IEC 62073, “Guidance on the measurement of wettability of insulator surfaces”, edition 2003-06.

[8] K. Shenoi and R. S. Gorur, “Evaluating Station Post Insulator Performance from Electric Field Calculations”, IEEE Trans. Dielectr. Electr. Insul., Vol. 15, No. 6, pp. 1731-1738, 2008.

[9] Raji Sundararajan, Victor Godinezand Muhammad Amin “Performance of Thermoplastic Elastomeric and Thermoset Insulators under Accelerated Acid Rain Multistress Conditions” Fifteenth National Power Systems Conference (NPSC), IIT Bombay, December 2008.

[10] R. J. Hill, “Laboratory Analysis of Naturally Aged Silicone Rubber Polymer Insulators from Contaminated Environments, 138 to 765 kV,” IEEE Transmission Distribution Conf., Texas, pp. 488–493, 1994.

[11] K. Eldridge, J. Xu, Wl Yin, A. Jeffery, J. Ponzello and S.A. Boggs, “Degradation of a silicone-based coating in a substation application,” IEEE Trans. Power Delivery, Vol. 14, No.1, pp. 188- 193, 1999.

[12] E. A. Cherney, Chair, M. Marzinotto, R. S. Gorur, I. Ramirez, S. Li, A. El-Hag “End-of-Life and Replac
ement Strategies for RTV Silicone Rubber Coatings” IEEE Transactions on Dielectrics and Electrical Insulation Vol. 21, No. 1; February 2014.

[13] Muhammad Amin and Mohammad Akbar “Performance of HTV SiR as Outdoor insulation at High Altitudes” Pak. J. Engg. & Appl. Sci. Vol. 11, July., 2012 (p. 34-46).

[14] K.Wieczorek "Resistance of Silicone Rubber High Voltage Insulation to Leakage Current in Modified Inclined Plane Test" Institute of Electrical Engineering Fundamentals of the Wroclaw University of Technology 50-370 Wroclaw, Poland.

[15] Muhammad Tariq Nazir , Jiang Xingliang , Shakeel Akram "Laboratory Investigation on Hydrophobicity of New Silicon Rubber Insulator under Different Environmental Conditions" International Journal of Electrical & Computer Sciences IJECS-IJENS Vol: 12 No: 03.

[16] A. D. Germano1*, J. M. Seifert2 and J. Kindersberger "INFLUENCE OF NANOSILICA ON THE PERFORMANCE OF HTV SILICONE RUBBER FOR OUTDOOR INSULATION" Technische Universitaet Muenchen, Arcisstrasse 21, 80333, Munich, Germany. LAPP Insulators GmbH, Bahnhofstrasse 5, 95632, Wunsiedel, Germany. *Email: andre.germano@tum.de.

[17] E.MOAL G. ROCCHETTIA. PIGINI "Design and application of composite insulators in AC and DC systems with special attention to severe environment" 21, rue d'Artois, F-75008 PARIS A3-303 CIGRE 2012.

[18] Majid REZAEI Mohammd Reza SHARIATI Sasan JABBARI " Assesment of In service composite Insulators in very harsh Coastal Environement in Iran: Laboratory and field Testing" C I R E D 21st International Conference on Electricity Distribution Frankfurt, 6-9 June 2011.

[19] S.Thong -Om, W .Payakcho , J . Grasasom, A. Oonsi vilai and B. Marungsri "Comparison of Ageing Deteriora ti on o f Silicone Rubber Housing Mateial for Out door P olymer Insulators" International Scholarly and Scientific Research & Innovation 5(12) 2011.

[20] M. A. R. M. Fernando, S. M. Gubanski "M. A. R. M. Fernando and S. M. Gubanski: Ageing of Silicone Rubber Insulators in Coastal and Inland Tropical Environment" 1070-9878/10/$25.00 © 2010 IEEE.

[21] J. M. Seifert1*, D. Stefanini and H. Janssen2 "HTV SILICONE COMPOSITE INSULATORS FOR HVDC APPLICATIONS LONGTERMEXPERIENCES WITH MATERIAL AND DESIGN FOR 500KV AND ABOVE" ISBN 978-0-620-44584-9.

[22] J. P. Holtzhausen, Kato Engelbrecht, Petrus Pieterse "INCLINED PLANE TESTS ON RTV-SILICONE RUBBER COATED PORCELAIN AND CYCLO-ALIPHATIC EPOXY RESIN SAMPLES" University of Stellenbosch.