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NEW APPROACH FOR PREDICTION THE DC BREAKDOWN VOLTAGE USING FUZZY LOGIC CONTROLLER

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Abstract

High voltage device design needs predicting the withstanding voltage to assay conditions as pulses, surges and the DC voltage. There is a great designer needed to have reliable design requirements and well-defined simulation procedure for the development of the apparatus. In this paper, Fuzzy Logic (FL) method is used to model breakdown voltage, based on experimental data generated in the laboratory. Different models are proposed with different membership functions for the FL under both DC voltage conditions. The purpose of this article is to investigate the discharge phenomenon for an air gap-point plan at with insulation barrier between themselves. Obtained results are encouraging. Proving that fuzzy logic is a powerful tool that can be used in predicting the properties of the barrier.

Keywords: Fuzzy logic Controller, Number of partitions, Breakdown voltage, Barrier, Point-Plane.

1. INTRODUCTION

Barriers are used in largely several high-voltage devices. It has been known that the dielectric of the strength of the long gap is significantly increased by inserting an insulating barrier. Each insulating structure gives particular discharge phenomenon [1-4].

Knowing the ionization state and the spread of electric discharge are of great importance to fully understand the mechanism behind the breakdown [5-9].

The insertion of the barrier near the sharp electrode has a great influence on the dielectric strength [10-15].

The effectiveness of the barrier depends on the geometry and position and the physical nature of the barrier. The survey has been simulated and conducted experimentally and to study the barrier breakdown phenomenon [16-22].

As a result, three materials have the same effect on the barrier. The breakdown voltage varies with the size of the barrier, and the maximum flashover voltages is observed where the barrier is positioned at the closest point the electrode [23-31].

The small size of barrier becomes effective in very small air spaces.

Based experimental results, a Sugeno fuzzy logic system is modelled to predict DC breakdown voltage, in terms of the relative position of the barrier, the hole, the width of the barrier, and the nature of the barrier. In fact, the breakdown phenomenon depends on this variable [32-34].

In this paper, details of a proposed method for the prediction of electric discharge in air using fuzzy logic.

The use of the fuzzy logic technique allows us to have a numerical system that can predict the electric discharge using the fuzzy reasoning.

The difficulty of obtaining a mathematical model which can reflects the evolution of the electric discharge in the field of high voltage has obliged several researchers to introduce different analysis and methods to study such a subject [35-36]. In this work, to use the fuzzy logic technique based on experimental data to predict the electrical discharge in a point-to-plane system.

The used database are collected from tests conducted at the high-voltage laboratory of the University of Biskra.

2. EXPERIMENTAL SETUP

The experimental set-up consists of a high-voltage test transformer 100kV/5kVA/ 50Hz, a capacitive voltage divider. Fig 1 and Fig 2 (the experiences have been performed in the laboratory of high voltage University of Biskra).

Shows the arrangement of electrodes and insulating barrier it contains a point–plan electrode arrangement mounted vertical. The HV electrodes consist a steel needlepoint on copper of conical in shape 30°. The grounded plan electrode is a circular steel plate of 30 cm long, 2.8 cm diameter.

The plexiglas barriers ($\boldsymbol{\varepsilon r}$=3.3), the second type of barrier used is bakelite ($\boldsymbol{\varepsilon r}$=5.82), and The third type of barrier used is Glass barriers ($\boldsymbol{\varepsilon r}$=6), are squares of different widths (5 cm, 10 cm, 15 cm) and different holes (4mm, 8mm and 12mm) and its thicknesses is 1mm, an aluminium plan grounded. To change the positions for several barriers, carriers Bakelite are used.

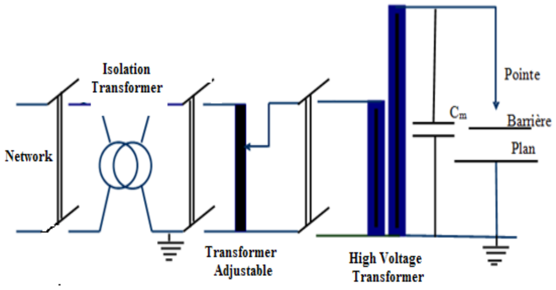

Fig. 1. Circuit probationary industrial realizes a frequency

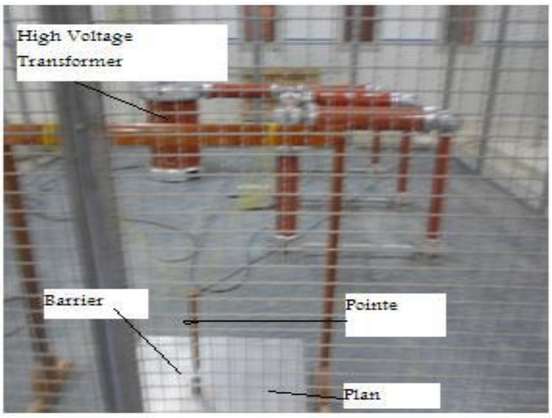

Fig. 2. View of real test cell

The barrier is mounted vertically between the electrodes Fig 2. Its surfaces are checked after each breakdown. The position of the barrier is defined by the ratio (a /d), where (a) is the point–barrier distance and dis the point–plan electrode gap.

3. DESIGN OF A FUZZY SYSTEM FOR PREDICTION

In this paper a hierarchical structure of Sugeno model was adopted to predict the breakdown voltage in terms of the relative position R and the Width of the barrier, for two values of relative permittivity and the hole Fig. 3 (Fuzzy logic system).

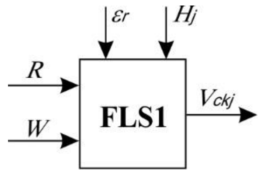

Fig. 3. Fuzzy logic system

Each input variable (R or W) is quantified into their fuzzy subsets: small S, medium M and large L.

Memberships of these subsets have triangular shapes (Fig. 4 and 5).

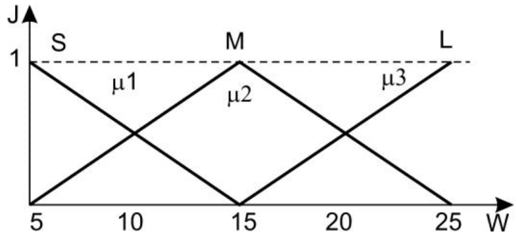

Fig. 4. Function of membership of the width W (cm) of the barrier

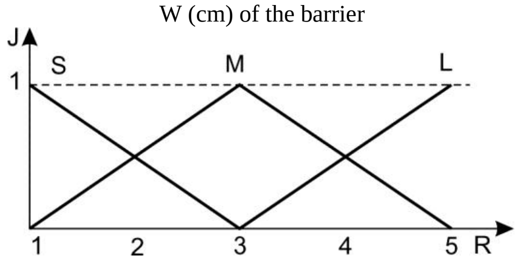

Fig. 5. Function membership of the distance R (cm)

Tab.1. Rule base of the fuzzy systems FLS_{kj}

W(mm) / R(cm)	S	M	L
S	V_{11}	V_{12}	V_{13}
M	V_{21}	V_{22}	V_{23}
L	V_{31}	V_{32}	V_{33}

Where: Vij are values of the output of the fuzzy rules, for $\varepsilon_r = \varepsilon_k$ and $H = H_j$

The expression of the output of the value fuzzy system is

$$V_c(kj) = \frac{\sum \quad \mu_j\,(R)\gamma_l(W)Vjl\,(kj)}{\sum \quad \mu_j\,(R)\gamma_l(W)} \quad (1)$$

Membership function as a function of distance:

$$\mu_1(R) = \max(\frac{3-R}{2}, 0\,) \rightarrow e^{-(\frac{R-1}{\sigma})^2}$$

$$\mu_2(R) = \max\left[\,\min\left(\frac{R-1}{2}, \left(\frac{5-R}{2}\right)\right), 0\,\right] \rightarrow e^{-(\frac{R-3}{\sigma})^2} \quad (2)$$

$$\mu_3(R) = \max(\frac{R-3}{2}, 0\,) \rightarrow e^{-(\frac{R-5}{\sigma})^2}$$

Membership function as a function of Width

$$\gamma_1(W) = \max(\frac{15-W}{10}, 0) \rightarrow e^{-(\frac{W-5}{\sigma})^2}$$
$$\gamma_2(W) = \max\left[0, \min\left(\frac{w-5}{10}, \left(\frac{25-w}{10}\right)\right)\right] \rightarrow e^{-(\frac{w-15}{\sigma})^2} \quad (3)$$
$$\gamma_3(W) = \max(0, \frac{w-15}{10}) \rightarrow e^{-(\frac{w-25}{\sigma})^2}$$

The relative permittivity ε_r has been quantified into two fuzzy values (3.3 and 6).

The hole H has been quantified into two values (4mm and 12 mm).

Their membership function are presented in Fig 6 and 7**.**

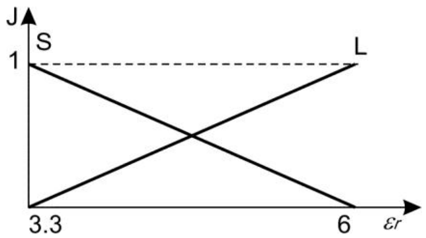

Fig. 6. Membership function of the nature of the barrier material

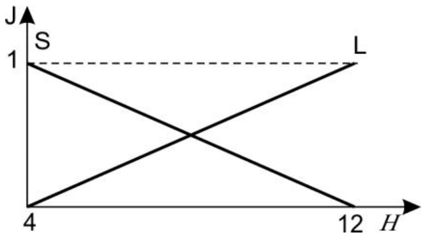

Fig. 7. Membership function of the hole H (mm)

Rule of inferences of the fuzzy system FLC control:

FLC$_i$ $1 \leq i \leq h$

IF(R and S) and (W and M) so V_C = (R=1, W=15) $\Rightarrow S$
IF(R and S) and (W and H) so V_C = (R=1, W=25) $\Rightarrow S$
IF(R and S) and (W and S) so V_C = (R=3, W=5) $\Rightarrow M$
IF(R and S) and (W and S) so V_C = (R=3, W=15) $\Rightarrow M$
IF(R and S) and (W and t S) so V_C = (R=3, W=5) $\Rightarrow M$
IF(R and S) and (W and S) so V_C = (R=5, W=25) $\Rightarrow H$
IF(R and S) and (W and S) so V_C = (R=5, W=15) $\Rightarrow H$
IF(R and S) and (W and S) so V_C = (R=5, W=25) $\Rightarrow H$

The whole fuzzy system can be presented by Fig 8.

Tab. 2. Inference of the Sugeno Fuzzy Controller (FLC)

R \ W	S	H	M
S	$V_{Cm}(1,5)$	$V_{Cm}(1,15)$	$V_{Cm}(1,25)$
H	$V_{Cm}(3,5$	$V_{Cm}(3,15)$	$V_{Cm}(3,25)$
M	$V_{Cm}(3,5)$	$V_{Cm}(3,15)$	$V_{Cm}(3,25)$

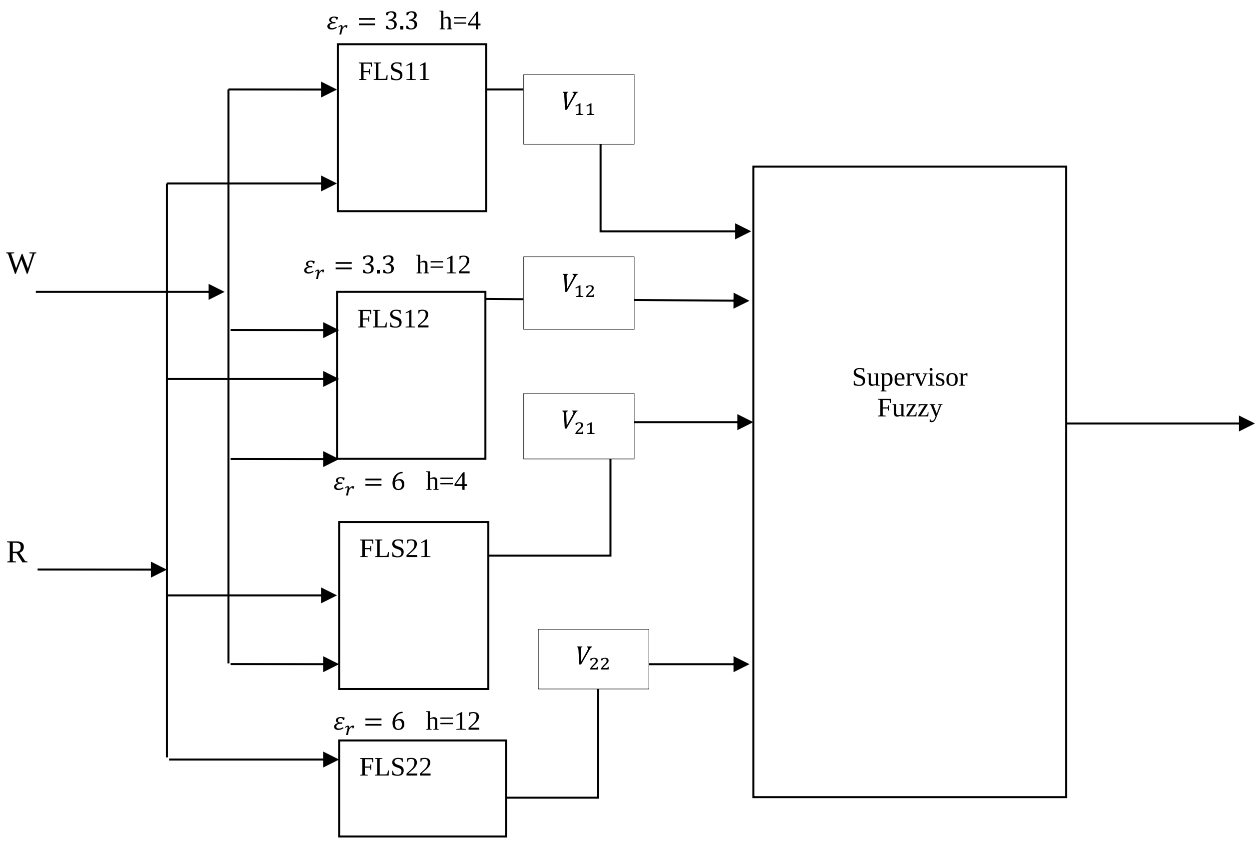

Fig. 8. Supervisor fuzzy

Tab. 3. Fuzzy Controller

H \ ε_r	S	H
S	V_{C1}	V_{C2}
H	V_{C3}	V_{C4}

4. RESULTS AND DISCUSSION

4.1 Prediction of the permittivity relative of the barrier Bakelite $\boldsymbol{\varepsilon_r}$=5.82 and the hole H=8mm

Figures (9, 10, 11 and 12) present results of the training phase for different couple of values of H and $\boldsymbol{\varepsilon_r}$:(H, $\boldsymbol{\varepsilon_r}$) = (12, 6), (4, 6), (12, 3.3), (4, 3.3).

The validation phase consists in the prediction of the DC breakdown voltage for ε_r =5.82 and H =04 mm, 8 and 12 mm and for ε_r =3.3 and 6 for H=8mm obtained results are compared to experimental ones in, figures (13 - 17).

Observing these figures, it is clear that the obtained prediction values of the DC breakdown voltage are close to experimental ones.

4.2 Influence of the permittivity relative of the barrier on the breakdown voltage

Figures (10, 12, and 16) shows the experimental and predicted breakdown voltage as a function of the relative position of the barrier values of the barrier for different width (5cm, 10 cm, 15 cm, 20 cm and 25 cm) of the barrier. The hole in the barrier is (4 mm). Different permittivity is (3.3, 5.82 and 6). Different distances between the point and the barrier (1cm to 5 cm) were studied.

The insertion of the barrier has a significant influence on the breakdown voltage. This means that the founded model by the fuzzy logic method is perfect.

4.3 Influence of the hole in the barrier on the breakdown voltage

In this test, Figures (9, 10, and 13) holes in the middle of the barrier varies (4mm,8mm and 12mm) the relative position of the barrier values for (1cm to 5 cm), different width (5cm 10cm, 15cm, 20cm, and 25cm), the permittivity of the barrier is (ε_r = 6).

Figures (14, 15, and 16) holes in the middle of the barrier varies (4mm,8mm and 12mm) the relative position of the barrier values for (1cm to 5 cm) different width (5cm, 10cm, 15cm, 20cm, and 25cm), the permittivity of the barrier is (ε_r = 5.82) . In reviewing figures, we observe that the decrease of the breakdown voltage with the increase of the holes in middle of the barrier. This result could be interpreted by the fact that the electric charge that passes through the hole is low. When a diameter of hole is greater, a large part of the charging space passes through the hole as well. This can be interpreted by the fact that increasing the diameter of the hole.

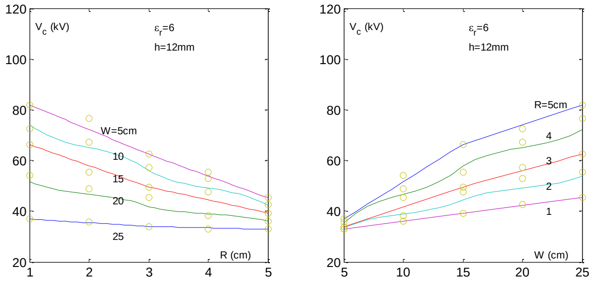

Fig. 9. Influence of the position and the width of the barrier on the DC voltage disruptive voltage for the hole H= 12 mm and the relative permittivity $\varepsilon_r = 6$

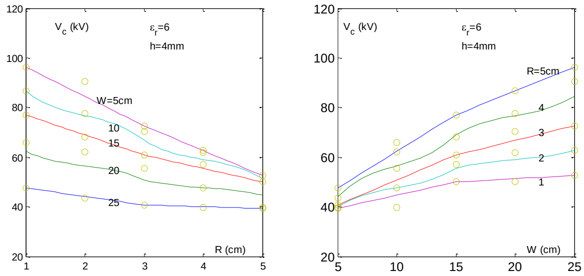

Fig. 10. Influence of the position and the width of the barrier on the DC voltage disruptive voltage for the hole H= 4 mm and the relative permittivity $\varepsilon_r = 6$

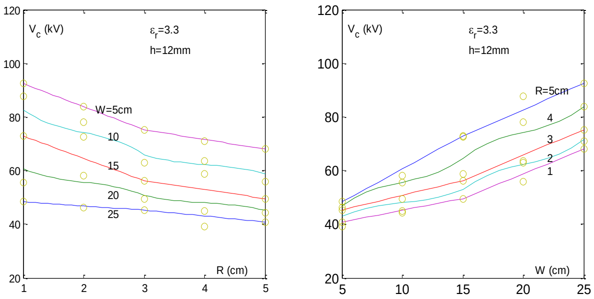

Fig. 11. Influence of the position and the width of the barrier on the DC voltage disruptive voltage for the hole H= 12 mm and the relative permittivity $\varepsilon_r = 3.3$

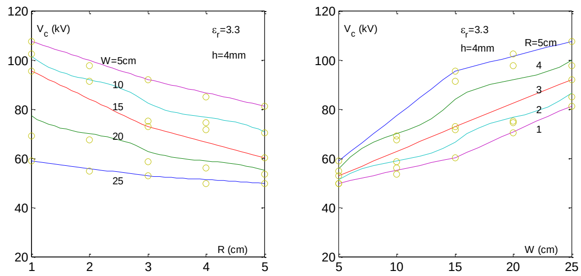

Fig. 12. Influence of the position and the width of the barrier on the DC voltage disruptive voltage for the hole H= 4 mm and the relative permittivity $\varepsilon_r = 3.3$

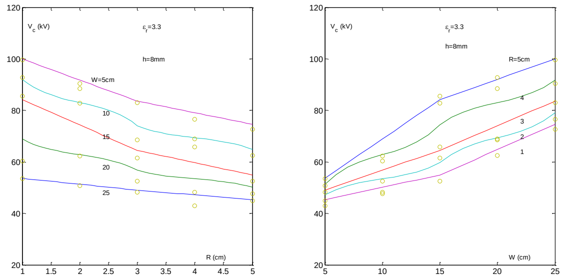

Fig. 13. Prediction of the breakdown voltage in terms of R and W for the hole H= 8mm and the relative permittivity $\varepsilon_r = 6$

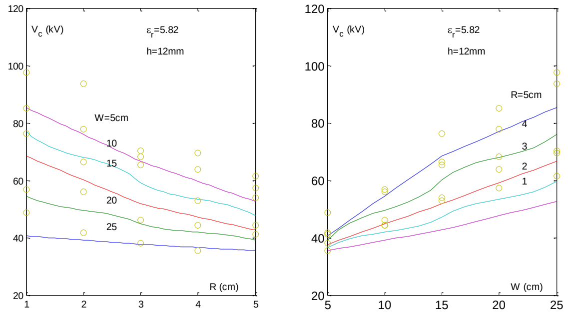

Fig. 14. Prediction of the breakdown voltage in terms of R and W for the hole H= 12 mm and the relative permittivity $\varepsilon_r = 5.82$

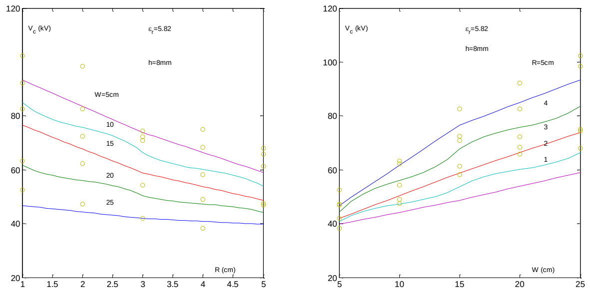

Fig. 15. Prediction of the breakdown voltage in terms of R and W for the hole H= 8 mm and the relative permittivity $\varepsilon_r = 5.82$

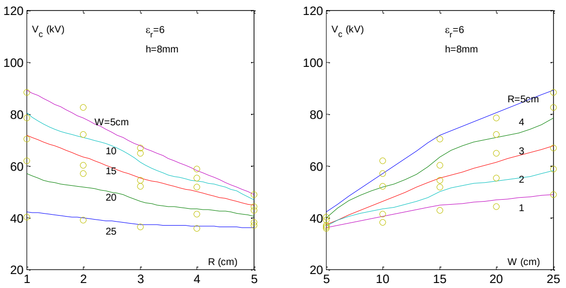

Fig. 16. Prediction of the breakdown voltage in terms of R and W for the hole H= 4 mm and the relative permittivity $\varepsilon_r = 5.82$

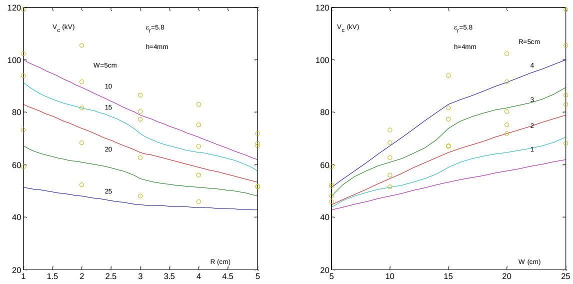

Fig. 17. Prediction of the breakdown voltage in terms of R and W for the hole H= 8 mm and the relative permittivity $\varepsilon_r = 3.3$

5. Conclusion

In this paper, a new approach based on an expert system of fuzzy logic modelling has been proposed to predict the behaviour point-plan with different barrier used in high voltage. It is to value of the breakdown of the point to plane interval is close to experimental results. In this study the breakdown mechanism has been investigated with help of point-plan with barrier both experimentally and by simulation with MATLAB environment. In this study considering no change of physical condition like temperature and pressure. The effect of breakdown voltage on different insulation like (glass, bakelite and plexiglas), has also been studied. To observe the effect on insulation due to breakdown mechanism. The optimized maximum breakdown voltage is reduced as the holes on the barriers are made wider to a point where the barrier effect is not felt. The width of the hole depends on the length of the space. With a very small air gap a small hole on the stopping surface leads to a significant reduction in the breakdown voltage. It also depends on the location of the hole. If it is located at the central point of the barrier, it eliminates all the beneficial effect of the barrier.

For practical purposes, porous barriers are not recommended for voltage optimization. Sugeno models and adaptive fuzzy logic are some of the recent trends. These also provide better estimation and better tuning techniques. Has been very effective in predicting the breakdown voltage under DC conditions. As cannot claim about the optimality of the system, so it is better to model with all the available and algorithm choose the best estimate, gives very encouraging results. The simulation and experimental results confirmed that using a dielectric barrier in high voltage system configuration significantly increases the breakdown voltage.

6. REFERENCES

1. Iwata T, Okubo H, Kojima H. Positive streamer propagation and breakdown characteristics in non-uniform air gap. In High Voltage Engineering and Application (ICHVE), 2010. International

Conference on. IEEE, 377-380. https://doi.org/10.1109/ICHVE.2010.5640749.

2. Chvyreva A, Pemen AJM, Christen T. Investigation of streamer propagation along insulating surfaces. 31st International Conference on Phenomena in Ionized Gases (ICPIG), 2013; Granada, Spain.
3. Wang L, Meng X, Mei H, Guan Z. Characteristics of dstreamer propagation along insulation surface influence of dielectric material and shed configuration. 20th International Conference on Gas Discharges and their Applications, JUL 2014; Orleans, France.
4. Meng X, Mei H, Chen C, Wang L, Guan Z, Zhou J. Experimental research on influences of air pressure and humidity on characteristics of streamer propagation along insulation surfaces. Zhongguo Dianji Gongcheng Xuebao/ Proc. of the Chinese Society of Electrical Engineering, 2014; 34 (12): 1938-1947.
5. Mikropoulos PN, Zagkanas VN. A computational method for positive corona inception in the coaxial cylindrical electrode arrangement in air under variable atmospheric conditions. 16th International Symposium on High Voltage Engineering, Cape Town, South Africa, 2009.
6. Maglaras A, Kousiouris T, Topalis F, Katsaros D, Maglaras LA, Giannakopoulou K. Method of controlling corona effects and breakdown voltage of small air gaps stressed by impulse voltages. IEEE Electrical Insulation Conference (EIC), Ottawa, Canada, 2013.
7. Afa JT. Defective barrier on voltage optimization for small air gap. British Journal of Applied Science & Technology, 2013; 3(4): 1301-1310. https://doi.org/10.9734/BJAST/2013/3653
8. Abderrazzaq MH. Analysis of electrical tree propagation through glass fiber barrier. IEEE Trans. Dielectr. Electr. Insul. 2012; 19(1): 305-311. https://doi.org/10.1109/TDEI.2012.6148532
9. Eduard P, Ivan P. Master time Dependent Modelling and Simulation of the Corona Discharge in Electrostatic Precipitators. University Linnaeus Sweden, 2014.
10. Karmakar S. An experimental study of air breakdown voltage and its effects on solid insulation. Journal of Electrical Systems, 2012;8 (2): 209-217
11. Maglaras A, Kousiouris T, Topalis F, Maglaras LA, Giannakopoulou K. Optimization of corona onset and breakdown voltage of small air gaps stressed by DC and impulse voltages. IEEE Euro Con, Zagreb, Croatia, 2013, 1207-1214. https://doi.org/10.1109/EUROCON.2013.6625134
12. Hotta K, Iwata T, Kojima H. Impulse breakdown mechanism based on discharge propagation process under non-uniform electric field in air. In Electrical Insulation and Dielectric Phenomena (CEIDP), IEEE, 2011. Annual Report Conference: 534-537. https://doi.org/10.1109/CEIDP.2011.6232712
13. Shah BS, Parmar SB, Rathod JN, Pandya AS. Measurement of air breakdown voltage and electric Field using standard sphere gap method. International Journal for Research in Applied Science and Engineering Technology, 2014, 2 (VI): 180-186.
14. Phloymuk N, Pruksanubal AT, Thanuch, N Investigations on breakdown voltage of solid barrier under non- uniform electric field simulation and experiment. In Electrical Engineering/Electronics, Computer. Telecommunications and Information Technology (ECTI- CON), 10th International Conference on Electrical Engineering/ Electronics, 2013:1-5 https://doi.org/10.1109/ECTICon.2013.6559489
15. Rouini A, Mahi D, Seghier T. Prediction the AC Breakdown Voltage in Point/Plan Air Gaps with Barrier Using Design of Experiments Journal TELKOMNIKA Indonesia Journal of Electrical Engineering 2014;12 (12): 8033-8041. https://doi.org/10.11591/telkomnika.v12i12.6771
16. Topalis FV, Danikas MG. Breakdown in air gaps with solid Insulating barrier under impulse voltage stress, Facta Unversitas, SA, Electrical Engineering, 2005;18: 87-104.
17. Rouini A, Mahi D, Seghier T. Modelling of the AC breakdown voltage of point- plane air gaps with insulating barrier. International Journal of Electrical and Computer Engineering (IJECE), 2015; 05 (03): 391-402. https://doi.org/10.11591/ijece.v5i3
18. Subrata Karmakar. An experimental study of air breakdown voltage and its effects on solid insulation. journal of electrical systems,2012: 209-217.
19. Afa JT. Impulse breakdown of small air gap in electric field. Part I: Influence of barrier position. J. Appl. Sci. & Technol; 2011;16(1 & 2):58–62.
20. Hosokawa T, Kaneda T, Takahashi T, Yamamoto T, Morita T, Sekiya Y. DC breakdown characteristics in the gap with thin dielectric sheet in air. IEEE Transactions on Dielectrics and Electrical Insulation, 2011;18(3):822-832. https://doi.org/10.1109/TDEI.2011.5931071
21. Elham F, Hamid V. The Investigation of dielectric barrier impact on the breakdown voltage in high voltage systems by modelling and simulation. Power & Energy Society General Meeting, 2015. https://doi.org/10.1109/PESGM.2015.7285653
22. Starikovskiy A, Nikipelov A, Rakitin A. Streamer breakdown development in undercritical electric field. Plasma Science, IEEE Transactions on, 2011; 39(11):2606-2607. https://doi.org/10.1109/TPS.2011.2160740
23. Mavroidis PN, Mikropoulos PN, Stassinopoulos CA. Impulse behavior of dielectric-covered rod-plane air gaps. IEEE Trans. on Dielectrics and Electrical Insulation, 2012;19 (2): 632-640. https://doi.org/10.1109/TDEI.2012.6180258
24. Mavroidis PN, Mikropoulos PN, Stassinopoulos CA. Lightning impulse behaviour of short rod-plane gaps with a dielectric-covered rod. IET Sci. Meas. Technol, 2010; 4 (2): 53-62. https://doi.org/10.1049/iet-smt.2008.0137
25. Lazaridis LA, Mikropoulos PN. Positive lightning impulse discharges along cylindrical insulating surfaces bridging a short rod-plane gap. IET Sci. Meas. Technol. 2010; 4(2): 63-75. https://doi.org/10.1049/iet-smt.2009.0082
26. Atten P, Adamiak K, Khaddour B, Coulomb JL. Simulation of corona dischargein configurations with a sharp electrode. Journal of Optoelectronics and Advanced Materials, 2004; 6: 1023-1028.
27. Lazaridis LA, Mikropoulos PN. Negative impulse flashover along cylindrical insulating surfaces bridging a short rod-plane gap under variable humidity. IEEE Trans. on Dielectrics and Electrical Insulation, 2010; 17 (5): 1585-1591. https://doi.org/10.1109/TDEI.2010.5595561
28. Mauseth F, Pedersen A. Streamer inception and propagation for air insulated rod-plane gaps with

barriers. In Electrical Insulation and Dielectric Phenomena (CEIDP), IEEE 2012; Annual Report Conference on: 732-739. https://doi.org/10.1109/CEIDP.2012.6378884
29. Atten P, Adamiak K, Atrazhev V. Electric corona discharge simulation in the hyperbolic point—ground plane configuration. Annual Report Conference on Electrical Insulation and Dielectric Phenomena, 2002; Cancun, Mexico: 109–112.
30. Adamiak K, Atten P. Simulation de la décharge couronne en configuration pointe-plan. SFE3[eme] Congrès Annuel de la Société Française d'Electrostatique Toulouse, France:, 2002 ; 1–8.
31. Nourirad G, Izadi M, Gomes C, Ab Kadir MZA. Characterizing the breakdown behavior of Rod-plane air gap under impulse over-voltage. IEEE 8th International Power Engineering and Optimization Conference (PEOCO), Langkawi, The Jewel of Kedah Malaysia, 2014. https://doi.org/10.1109/PEOCO.2014.6814471
32. Mohanty S, Ghosh S. Modeling of the breakdown voltage of Manila Paper in the presence of voids using adaptive fuzzy logic techniques. Proceedings of IEEE, 2009 , 3rd International Conference on Power Systems, Kharagpur, India: 1-6. https://doi.org/10.1109/ICPWS.2009.5442738
33. Kolev NP, Chalashkanov NM. Modeling of partial discharge inception and extinction voltages using adaptive neuro-fuzzy inference system (ANFIS).2007, Proceedings IEEE 9th International Conference on Solid Dielectrics, U.K: 605-608. https://doi.org/10.1109/ICSD.2007.4290886
34. Mohanty S, Ghosh S. Modeling of breakdown voltage of White Minilex Paper in the presence of voids under ac and dc conditions using fuzzy logic techniques. International Journal on Electric Power and Energy Systems Elsevier, 2010: 518–523.
35. Cross JA. Electrostatics Principles, Problems and Applications, Adam Hilger, Bristol 1987.
36. Hauschild W, Mosch W. Statistical techniques for high-voltage engineering. IET 1992.

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