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STUDY THE EFFECT OF METALLIC PARTICLE ON DIFFERENT SPACER IN A CO-AXIAL DUCT AT DIFFERENT PLACES

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Abstract: *Particle accelerators can be placed in two general classes, those which operate by direct time varying electric or magnetic fields. The following discussion will relate primarily to the direct acceleration machine where the maximum particle energy is determined by the voltage which can be insulated. In this work, it is proposed the breakdown of air gaps in a co-axial geometry, due to the presence of metallic particle has been studied. Bare copper wire particles of different lengths have been introduced in to a co-axial geometry and breakdown strength of air gap has been estimated. The testing high ac voltage, positive dc voltage and negative dc voltage is carried out. The study repeated with dielectric covering to the control conductor. When a sufficiently high electric field is applied to a gas, avalanche ionization (TOWNSEND PROCESS) occurs which will lead to breakdown. Gas insulated systems are extensively used in air insulated system due to advantages of weight and volume reduction, limited overall space requirements and easy maintenance. Even though case wise, GIS is very expensive has compared to AIS, it is preferred because of better service, more reliable performance and facility of higher operating stresses. In recent years, SF6 has been considered to green house gas and hence, all round efforts are made to reduce emission of SF6 gas in to the atmosphere. This was successfully used in GITL (gas insulated transmission lines) and experimental lines of few kilometers lengths are available.*

I. Introduction:

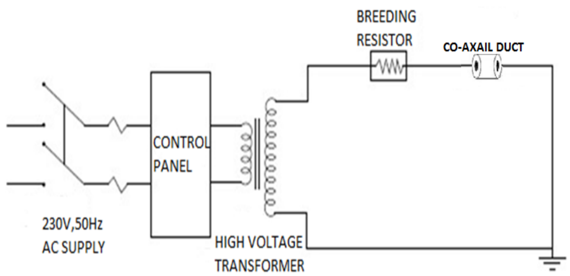
The most extensively and comprehensively studied molecular gases to date is Sulphur Hexa Fluoride (SF_6) gas. SF_6 gas is used widely as the insulating medium in gas insulated apparatus such as Gas Insulated Sub stations, owing to its favorable characteristics. SF_6 gas is a strong electronegative gas both at room temperature and at temperatures well above ambient, which principally accounts for its relatively high dielectric strength. The breakdown voltage of SF_6 gas is nearly three times higher than air at atmospheric pressure [1]. SF_6 gas has a much higher insulating capacity and allows to put all three phases of the system close together in one common enclosure. A study of CIGRE group suggests that 20% of failures in gas insulated substations (GIS) are due to the existence of various metallic particles. The presence of contamination can therefore be a problem with gas-insulated substations operating at high fields [2]. Gas insulated systems have been widely used all over the world for their advantages of
reduced weight, size volume and higher operating stresses. Even though the transition from conventional insulation system to GIS was smooth, there are still some technological problems relating to maintenance and long term performance of GIS. In recent years, the environmental impact of SF_6 gas leakage into the atmosphere has been the focal point of worldwide research. The Power Engineers all over the world are proceeding with caution and efforts are on to find possible replacement to SF_6 gas. SF_6 gas has a high global warming potential, 23,900 times that of CO_2 and was designated a regulated gas at the 3rd session of the Conference of the Parties to United Nations Framework Convention on Climate Change held in Kyoto. It is essential to reduce the use of SF_6, and to develop recovery technology for it and intense study is being carried out on various mixtures of gases that include small amount of SF_6, such as SF_6/N_2 gases with a smaller global warming potential than SF_6 [3,5].

II. Experimental Details:

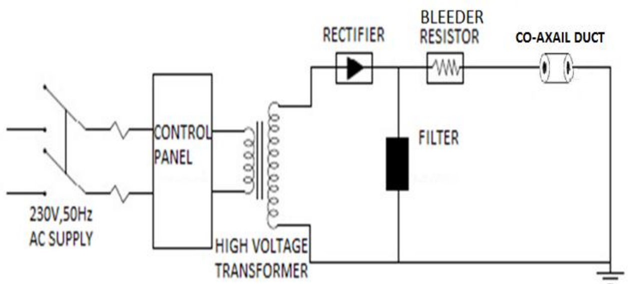
A. Experimental Set-up

The test equipment consists of breakdown voltage Measuring instrument with AC and DC system.

Circuit connections for breakdown measurements for AC system



Circuit connections for breakdown measurements for DC system



Figures: Circuit Connections for breakdown measurements for AC and DC system.

B. Test Specimen

The duct is made of non magnetic stainless steel and has an internal diameter of 4.6cm and external of 5cm. It has flange at both the ends and the surfaces are well polished. The spacer with the inner High Voltage (HV) conductor is terminated by spheres of 25mm diameter to avoid corona.

The discharge characteristics of a coaxial dielectric barrier discharge are investigated by using a differential equation based on the Townsend discharge model. An analytical expression for the saturated voltage in the gap between the dielectric materials is obtained in terms of the physical parameters of the dielectric barrier coaxial cylinders, the rising rate of the alternating applied voltage, and the gas pressure. The rising rate of the front edge of alternating applied voltage, rather than its amplitude or frequency, is shown to play decisive role in the dielectric-barrier discharge. The influence of the dielectric surface charge on dielectric-barrier discharge becomes appreciable at low pressure, where it accumulates an excessive dielectric surface charge, reducing the electric field between the dielectric materials and resulting in extinction of the electric discharge due to the rising rate of the applied voltage. Dielectric barrier-discharge (DBD), Also known as silent discharges or partial discharges, are widely used in industry for ozone synthesis.

C. Experimental Procedure:

Connections are made as shown in the circuit diagram. Output terminal of the high voltage transformer is connected to the rod gap equipment through water resister as shown in fig.

The central conductor and the bus duct were cleaned to minimize surface deposition and oxide depositions. The central conductor was connected to ac supply and outer duct grounded. The experiments were carried without particle and also with particle. The particle of bare copper of diameter =0.6mm and 20mm length were placed at different positions. It was observed that the presence of conducting particle strongly disturbed the field bringing variation of breakdown voltage. Now the main supply is switch on from the control panel. The voltage is increased using increase button from the control panel till the spark is produced, the voltage is noted in tabular column which is the voltage. Before placing the next conductor inside the co-axial cylinder proper discharging is done through grounding rod the next set of readings is noted down.

III. Results and Discussions:

EXPERIMENTAL TABULAR COLOUMN

Table 5.1 BREAKDOWN VOLTAGE OF DIFFERENT SPACER MATERIALS IN A.C

Materials used	Position of particle	Breakdown voltage in kv			Mean in kv
Polypropylene	1.Clean air 2.horizontal 3.Vertical	17.5 14.5 6	16.5 15 6	16.5 15 6.8	16.83 14.83 6.26
Nylon	1.Clean air 2.horizontal 3.Vertical	15 12.5 4	16 13 4.5	15.5 12 5	15.5 12.33 13.5
Acrylic	1.Clean air 2.horizontal 3.Vertical	12 11.5 6	12.5 11.5 5.5	12.5 12 6	12.33 11.66 5.83
Teflon	1.Clean air 2.horizontal 3.Vertical	18 17 6	18.5 17 6	18 17 6	18.17 17 6

Table 5.2 BREAKDOWN VOLTAGE OF DIFFERENT SPACER MATERIALS IN +VE D.C

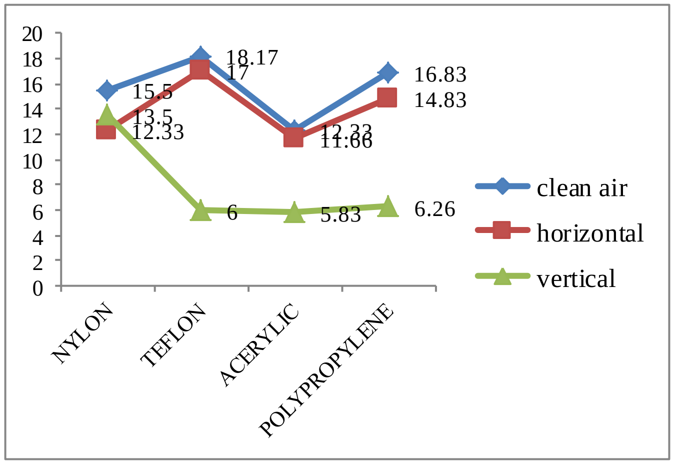
Materials used	Position of particle	Breakdown voltage in kv			Mean in kv
Polypropylene	1.Clean air 2.horizontal 3.Vertical	25.5 23 16	26 23 16	26.5 23 16	26 23 16
Nylon	1.Clean air 2.horizontal 3.Vertical	24 20 7	24 20.5 7.5	24.5 20.6 7.6	24.16 20.36 7.36
Acrylic	1.Clean air 2.horizontal 3.Vertical	13 14 15	13 14.5 16	13.5 14 15.5	13.16 14.16 15.5
Teflon	1.Clean air 2.horizontal 3.Vertical	24 23 14	24 23 14.5	24 23 16	24 23 14.83

Table 5.3 BREAKDOWN VOLTAGE OF DIFFERENT SPACER MATERIALS IN -VE D.C

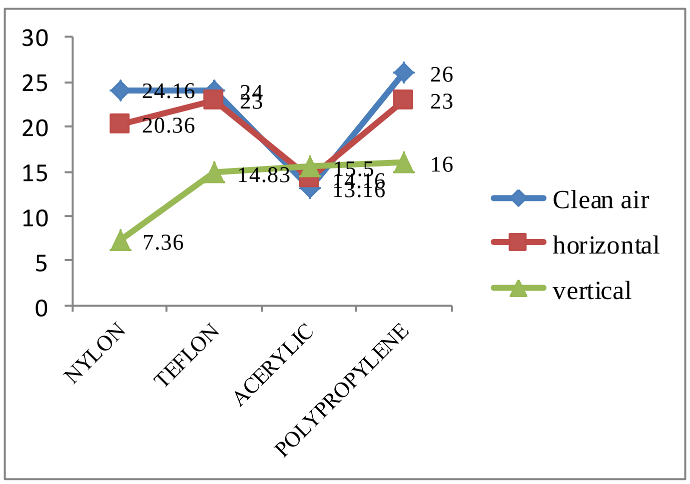
Materials used	Position of particle	Breakdown voltage in kv			Mean in kv
Polypropylene	1.Clean air 2.horizontal 3.Vertical	28 24 8.5	28 24 8	25 23 9	27 23.66 8.5
Nylon	1.Clean air 2.horizontal 3.Vertical	25 18 5	25.5 18.5 5.5	26 18.6 5.6	25.5 18.36 5.3
Acrylic	1.Clean air 2.horizontal 3.Vertical	14 12 8	14.5 12.5 7.5	14 12 7.5	14.16 12.16 7.66
Teflon	1.Clean air 2.horizontal 3.Vertical	26 22 8	26 22 9	25 22 9	25.6 22 8.6

GRAPHS

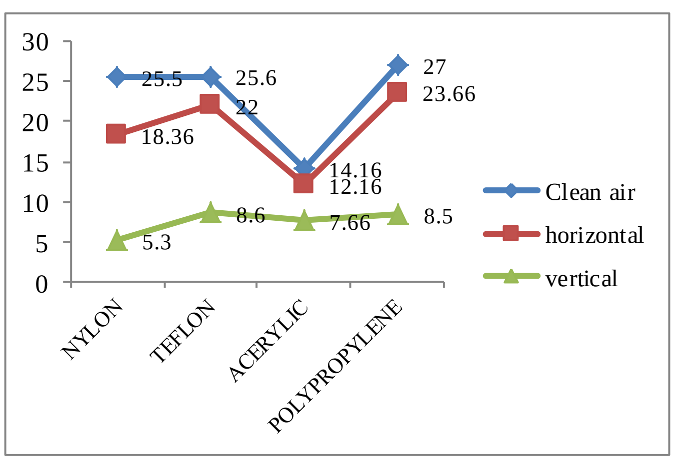
AC



+VE DC



-VE DC



VARIATION OF BREAKDOWN VOLTAGE ON SPACER MATERIAL (with particle) IN A.C

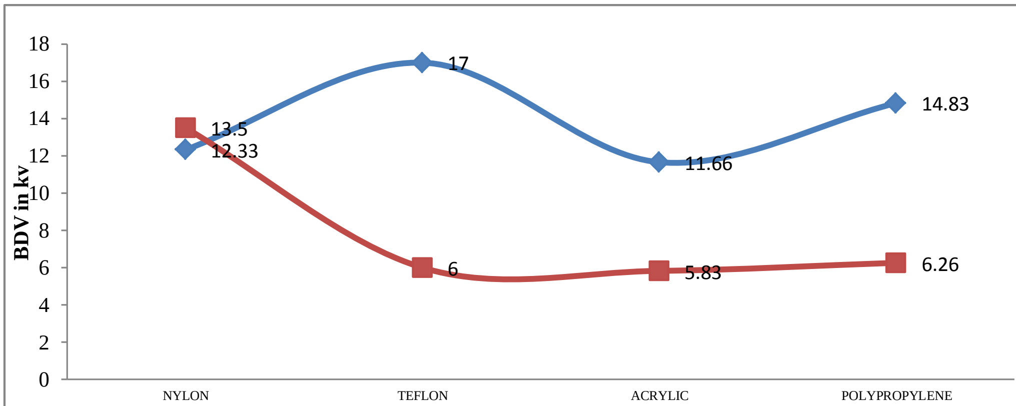


Fig: 5.4
Different spacer materials
When particle placed horizontally

VARIATION OF BREAKDOWN VOLTAGE ON SPACER MATERIAL (with particle) IN +VE D.C

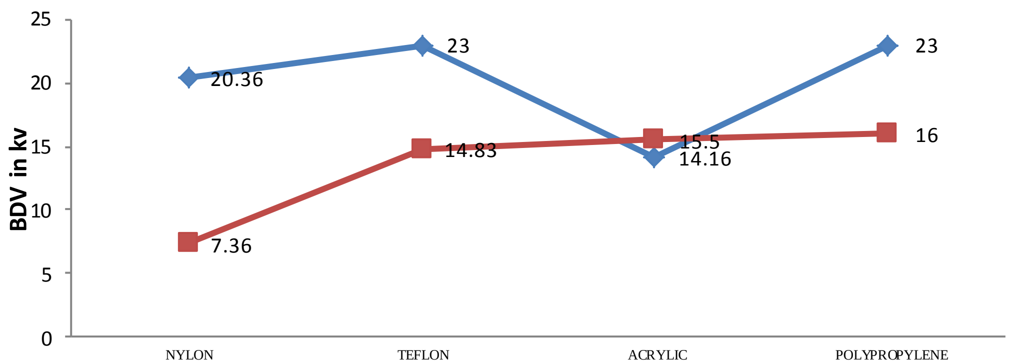


Fig: 5.5
Different spacer materials
When particle placed horizontally

VARIATION OF BREAKDOWN VOLTAGE ON SPACER MATERIAL (with particle) IN -VE D.C

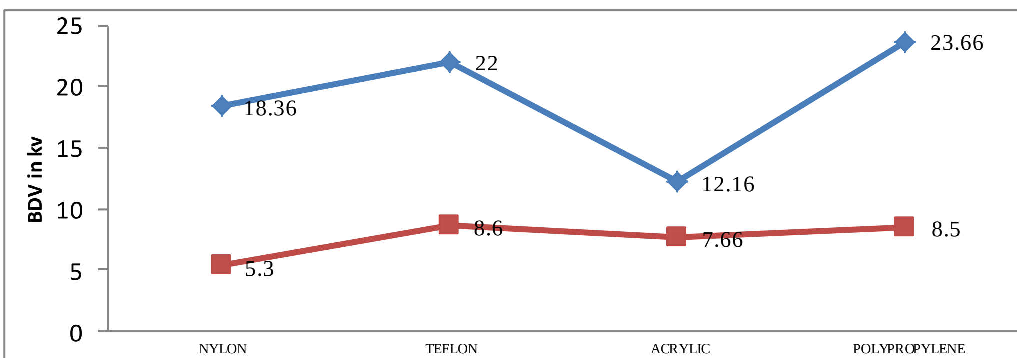


Fig: 5.6
Different spacer materials
When particle placed horizontally

RESULTS AND OBSERVATION:

In AC, it was observed that breakdown strength of **TEFLON** is maximum, when metallic particle is not placed on the spacer. When particle is placed horizontally and vertically on spacer, **TEFLON** is having the maximum breakdown strength. Thus, based on the result we can conclude that **TEFLON** and **POLYPROPYLENE** can be the best material in case of AC.

In case of (+ve) DC, **POLYPROPYLENE** proves to be a dominating spacer material. When the particle is placed in different positions on spacer materials, **POLPROPYLENE** and **TEFLON** has the maximum breakdown strength.

In case of (-ve) DC, when metallic particle is not placed on the spacer breakdown strength of **POLYPROPYLENE** and **TEFLON** is maximum. When metallic particle is placed horizontally and vertically on spacer breakdown strength of **TEFLON** and **POLYPROPYLENE** is maximum. **ACRYLIC** is least value of breakdown voltage as compared to other.

CONCLUSIONS

From the study, it is very clear that use of different supply voltage as AC, positive DC and negative DC, variation in the position of the conductor and width of the insulator play a vital role in determining the breakdown voltage in co-axial geometry. The study of the graphs done shows the effect of these factors on break down voltage.

Hence after undergoing through study of the graph and the reading obtained after conducting the experiment, it can be observed that the number of conductor, insulators and conducting particles with their respective position affect the BREAKDOWN VOLTAGE. Generally if the conductor is placed near the extreme end and vertically the spark over occur for less values of breakdown voltage. If they are placed horizontally near the extreme end the values of breakdown voltage are more.

FUTURE ASPECTS

In the upcoming era the studies and inventions, we can attain perfection by doing more experiments and advance studies on HV. While conducting the experiment it was observed that the same experiment when conducted without the use of insulator and using copper conductor and with different position there was slight change in break down voltage.

Moreover **polyester** can also be used as an insulator to see what changes may happen on break down voltage. Hence **HV** being very vast in nature it is unpredictable when different conductors and insulators of different lengths and widths respectively are used. Even two spacer material that from a hybrid can be used in future that will determine the breakdown voltage. **Many more experiments and observations are yet to be done in the field of HV for the better and advanced knowledge about the effect of breakdown voltage on the co-axial geometry.**

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References:

[1]A.H.Cookson,O.Farish,andG.M.L.Sommerson: ‘Effect of conducting particles on A.C. Corona and Breakdown in Compreesed SF_6, IEEE Tras. PAS, Vol 91, pp.1329-1338, 1972.

[2] Nagesh Kumar G.V, Singh B.P, Amaranath J, Srivastava K.D. “Electric field effect on metallic particle contamination in a common enclosure gas insulated busduct” Dielectrcs and Electrical Insulations, IEEE trans Vol. 14, Issue 2, April 2007, pp 334-340.

[3] H. Hama, M.Yoshimura, K.Inami, and S. Hamano, “Application problems of SF6/N2 Mixtures to Gas Insulated Bus”, Gaseous Dielectrics VIII, pp.353-359,1998.

[4]H.Saitoh, K.Morita, T.Kikkawa, N.Hayakawa and H.Okubo, “Impulse Partial Discharge and Breakdown Characteristics of Rod-plane Gaps in N2/SF6 gas Mixtures”, IEEE Trans.Dielectr.Electr. Insul., Vol.9, pp.544-550, 2002.

[5]S. Okabe, S. Yuasa and H. Suzuki,”Dielectric Properties of Gas Mixtures with Carbon Fluoride Gsaes and N2/CO2”, Gaseous Di-electrics IX, pp.345-350, 2001.

Biographies

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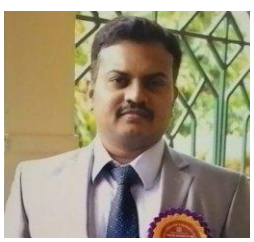

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