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PERFORMANCE OF A STING OF SUSPENSION INSULATOR AT 400 kV LINE DUE TO EFFECT OF POLLUTION

Sourabh kumar[*1] and Prof. Anil kumar kori[2]

[*1]Student, M.E., Department of Electrical Engineering, Jabalpur Engineering College, Jabalpur,(M.P.)

[2]Associate Professor, Department of Electrical Engineering, Jabalpur Engineering College, Jabalpur (M.P.)

ABSTRACT

Insulator is one of the important component of power transmission line. For giving support and providing insulation for over head line conductor against the highest voltage and worst condition insulator are used.Suspension insulator is generally used in transmission line because of less expensive price as well as capability to work at different voltage lavels.The main problem of this type of insulator I non –uniform voltage distribution on its units .Due to the presence of pollution on the insulator surface considerably modifies the voltage distribution &string efficiency. This paper discribes the sting efficiency of suspension insulator due to the effect of pollution.

Keywords: *400 kv line, Pollutions etc.*

1. INTRODUCTION

An electric power transmission can not be successful unless it is able to deliver unintrepeted power.continious operation of transmission line is dependens upon the effectiveness of the insulator which is employed. Insulator is a device made of non conducting material used to give support to electrical conductors and shield them from ground or other conductors.generally porcelain ,glass ,&polymer are used to design insulator .in this paper porcelain & polymer insulator are used.

TYPES OF INSULATORS

A. Pin Type Insulators;-This type is attached to a pin, which is secured to the crossarm on the pole or tower. It is generally used for 11 kv line and for extensiv use up to 33 kv .this is not economical beyond 33 kv.
B. Suspension Type Insulators;- Suspension insulator are consist of number of insulator unit or disc connected in series by metal ring in the form of string each unit is normally designed for a low voltage 11 kv.
C. Strain Type Insulators;-Strain type of insulator are used for dead end or sharp turns or where strain in transmission line is more.
D.Shacle Type Insulator;- These type of insulators are used for low voltage distribution line.
Advantage of suspension type insulator over pin type insulator.

1.Each insulator is designed for 11 kv and hence for any operating voltage a string of insulators can be used.
2.in case of failure of one of the units in the string only that particular unit needs replace ment rather than the whole string.
3.since the power conductor and string swing together in case of of wind pressure the meachanical stresses at that point of attachment are reduced as compared with the pin type of insulator where because of the rigid nature of the attachement faitigue and ultimate brittlness of the wire result.On the basis of voltage number of suspension string insulator s are dicided.

Number of insulators in suspension string.

Voltage(kV)	33	66	132	230	400	750
Number of units	3-4	5-7	9-11	14-20	18-21	30-35

2. VOLTAGE DISTRIBUTION

In a suspension insulator there are two types of capacitive effect is present.insulator capacitance is called self capacitance and capacitance present between metalic pin and tower strucutre is called self capacitance.If there is a self capacitance alone then voltage across each unit would have been same. But due to present of shunt capacitance voltage disti bution is not uniform.The disc nearest to the conductor has maximum voltage across it and as we move towards the cross arm the voltage across each disc goes on decreasing.The insulator disc are identical each disc is represented by its self capacitance c1. C2 is the shunt capacitance.shunt capacitance C2 =m c1 where m is the ratio of shunt capacitance to the self capacitance.

3. STING EFFICIENCY

The coefficient of shearing of voltage in string of insulator is called string efficiency. String efficiency = voltage across the string/n *(voltage across unit adjacent to the conductor).
The line unit is always under the maximum stress. To avoid possibility of puncture of line unit due to excessive stress, efforts are made to have uniform potential distribution. Hence some methods are used to get uniform distribution and higher string efficiency

A.Method of Improveming of String Eficiency & voltage distribution

1.Using larger cross arm ;- By the using of long cross arm shunt capacitance value can be reduced. Due to the limitations of mechanical strength and economical reason the value of k can be reduced to less than 0.1.
2. By grading of Capacitance ;-To create equal voltage distribution capacitance of different values are used since value of current increases while going towards line conductor capacitance value also increases in capacitance grading
3. By the use of guard ring;-This method is also called static shielding.in this method the voltage distribution and string efficiency can be improved by using aguard ring surrounding the bottom unit and connected to the line.

4. EFFECT OF POLLUTION

On of the main problem under which the distribution network is exposed in the environment pollution of its electrical insulation. The particle placed in the insulations are not dangerous in dry weather but the problem arises when the environmental wether is humid rains there is drew fog ,then layer can become conductor. To calculate effect on insulator considering superficial resistance reduction by pollution a parallel resistance is considered between each insulator.this effect showed in this paper by parallel connection of resistance to each capacitor unit

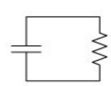

Fig. 1: Polluted insulator equivalent circuit

5. SIMULATION MODEL

MATLAB / SIMULINK software is being used for the modelling of this model. Simulink is one of its designing tools which is being used for modelling and simulation of electrical systems in MATLAB software. The complete precise modelling of the circuit along with their mechanism is explained in detail as follows below. Fig.1 shows basic equivalent circuit for string of Porcelain & Polymer suspension -type insulators. The portion which is a between the two metal fittings. Thus it forms a capacitor. This is called self capacitance that is denoted as C1.Fig.1 will consists of 18 self capacitors in series. If only such self capacitors exist alone in series, the voltage across them would have been equal and series charging current through them would have been same. But in addition to the self capacitance, there will be capacitance between each metal fitting and the earth i.e. tower. The air acts as a dielectric, such a capacitance is called ,"shunt capacitance" that is denoted as C2.due tue shunt capacitance unequal voltage distribution occurs, as shown in circuit 1 Porcelain & Polymer suspension –type insulators

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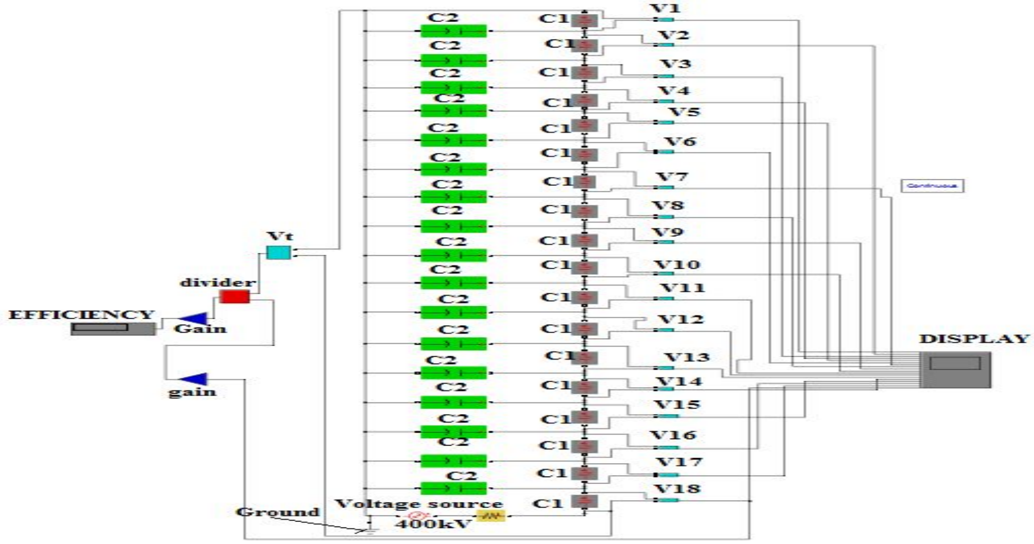


Fig1;-Equvilent circuit of Porcelain & Polymer suspension-type insulator without guard ring

As we know that by the use of guard ring string efficiency can be improved. The circuit 2 is designed by Porcelain & Polymer suspension -type insulators with guard ring. Fig.2 will consists of 18 self capacitors in series. If only such self capacitors exist alone in series, the voltage across them would have been equal and series charging current through them would have been same. But in addition to the self capacitance, there will be capacitance between each metal fitting and the earth i.e. tower. The air acts as a dielectric, such a capacitance is called ,"shunt capacitance" that is denoted as C2, as shown in fig.due toC2,voltage distribution is not uniform and string efficiency is less.bythe use of guard ring voltage distribution and string efficiency can be improved. guard ring is used in this circuit2.

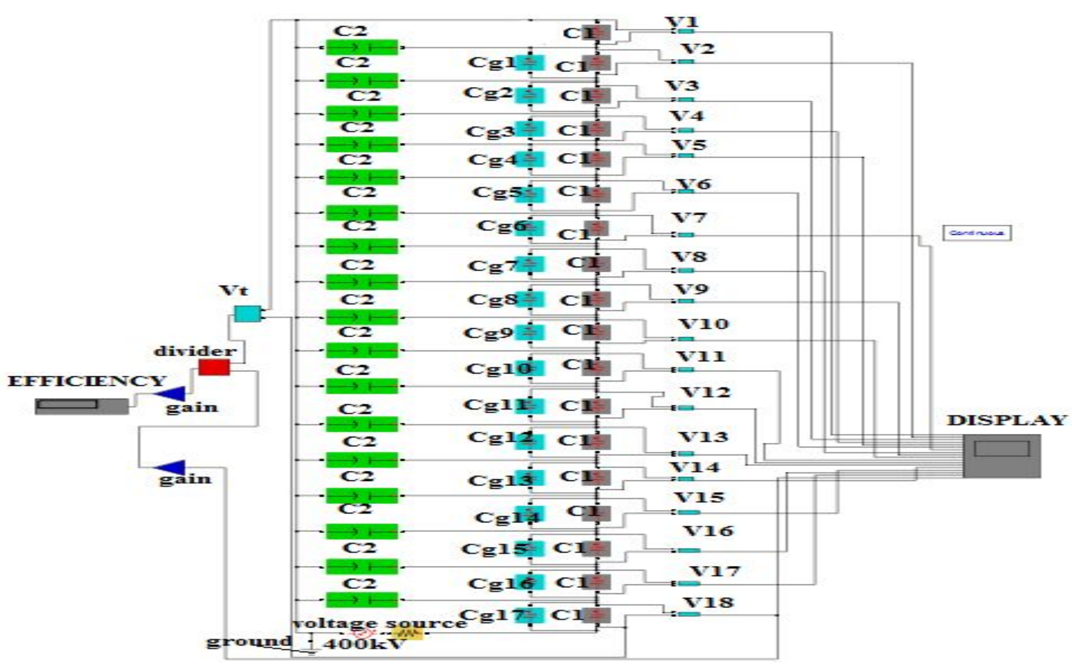
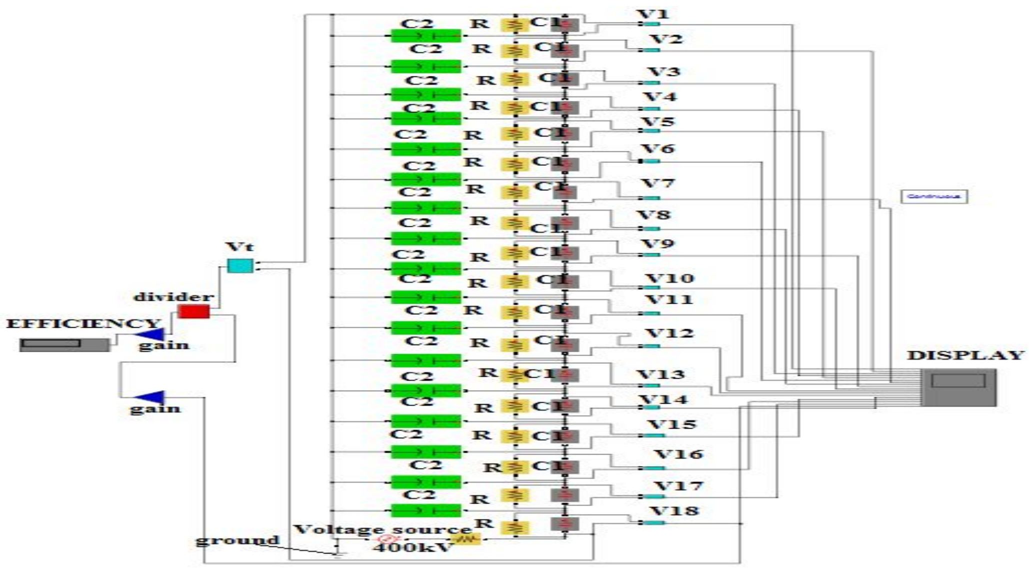


Fig2;-Equvilent circuit of Porcelain & Polymer suspension-type insulator with guard ring

Circuit3. Shows atmospheric model for Glass suspension insulators without guard ring for 400kV. Fig.3 shows simulation model of 400k. Glass suspension-type insulator under dust condition (R). To calculate pollution effect on insulation considering resistance reduction by pollution, a parallel resistance is considered between each insulator [7]. R represents values of resistance 5e10, 10e10, 20e10, 40e10 for insulator under dust condition. The values of voltage distribution and efficiency for different value of R(showing amount of dust on Porcelain & Polymer suspension –type insulators)



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Circuit3. shows atmospheric model for Porcelain & Polymer suspension insulators without guard ring for 400kV.

Fig.4 shows simulation model of 400k. Porcelain & Polymer suspension-type insulator under dust condition (R). Tocalculate pollution effect on insulation considering resistance reduction by pollution, a parallel resistance is considered between each insulator [7]. R represents values of resistance 5e10, 10e10, 20e10, 40e10 for insulator under dust condition. The values of voltage distribution and efficiency for different values of R (showing amount of dust on Porcelain & Polymer suspension –type insulators)

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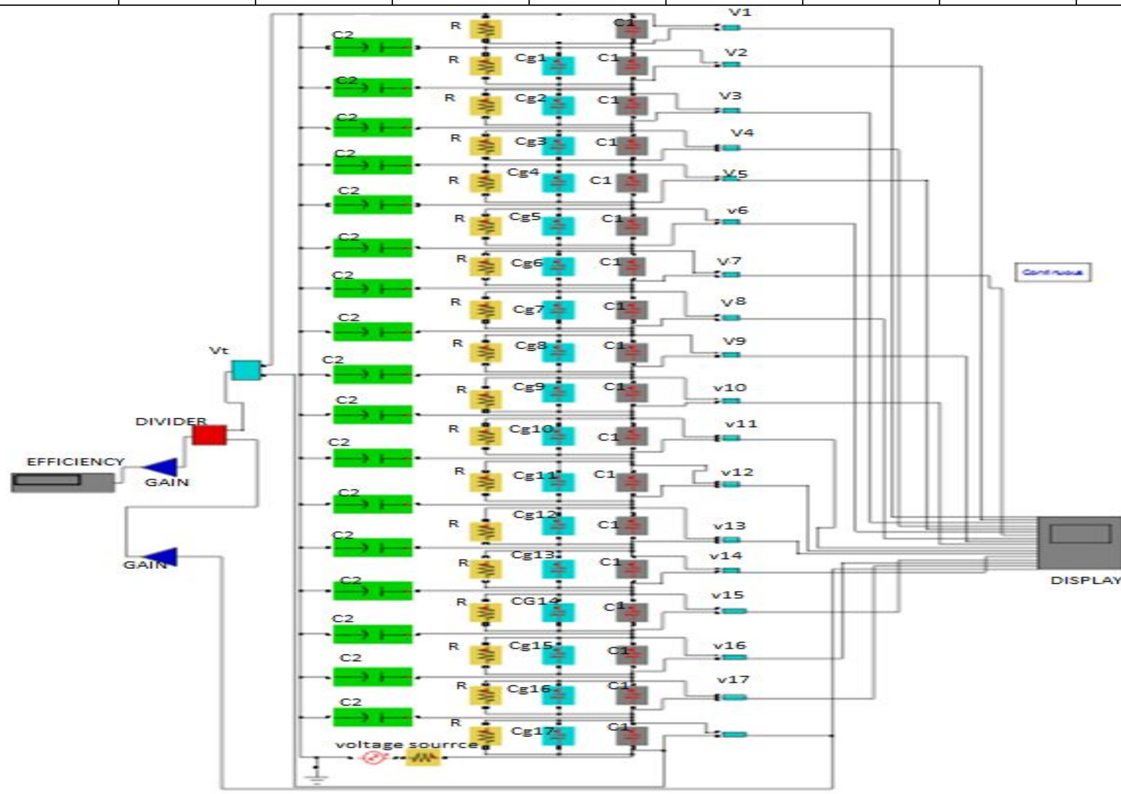
V1(kV)	V2(kV)	V3(kV)	V4(kV)	V5(kV)	V6(kV)	V7(kV)	V8(kV)	V9(kV)	η(%)
4.40	4.65	4.96	5.60	6.25	7.25	8.50	10.00	12.00	
V10(kV)	V11(kV)	V12(kV)	V13(kV)	V14(kV)	V15(kV)	V16(kV)	V17(kV)	V18(kV)	44.05
14.50	18.20	22.00	27.00	31.00	34.00	37.00	39.00	42.00	



Circuit4. shows atmospheric model for Porcelain & Polymer suspension insulators with guard ring for 400kV.

6. RESULTS AND DISCUSSION

TABLE1:NORMAL ATMOSPHERIC CONDITION FOR PORCELAIN SUSPENSION-TYPE INSULATOR WITHOUT GUARD RING

TABLE 2: NORMAL ATMOSPHERIC CONDITION FOR POLYMER SUSPENSION-TYPE INSULATOR WITHOUT GUARD RING

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TABLE3: NORMAL ATMOSPHERIC CONDITION FOR PORCELAIN SUSPENSION-TYPE INSULATOR WITH GUARD RING

V1(kV)	V2(kV)	V3(kV)	V4(kV)	V5(kV)	V6(kV)	V7(kV)	V8(kV)	V9(kV)	η(%)
6.40	6.60	7.00	8.00	8.70	10.10	11.50	13.80	16.00	75.99
V10(kV)	V11(kV)	V12(kV)	V13(kV)	V14(kV)	V15(kV)	V16(kV)	V17(kV)	V18(kV)	
18.00	21.00	25.00	27.50	30.10	32.50	34.00	30.00	22.70	

TABLE 4: NORMAL ATMOSPHERIC CONDITION FOR POLYMER SUSPENSION-TYPE INSULATOR WITH GUARD RING

V1(kV)	V2(kV)	V3(kV)	V4(kV)	V5(kV)	V6(kV)	V7(kV)	V8(kV)	V9(kV)	η(%)
6.65	6.70	7.05	7.57	8.28	9.20	10.50	12.00	13.50	51.37
V10(kV)	V11(kV)	V12(kV)	V13(kV)	V14(kV)	V15(kV)	V16(kV)	V17(kV)	V18(kV)	
15.60	17.90	20.10	23.00	27.50	30.80	34.60	36.50	38.20	

TABLE 5: POLLUTED ATMOSPHERIC CONDITION FOR PORCELAIN SUSPENSION-TYPE INSULATOR WITHOUT GUARD RING

RESISTANCE	5e10	10e10	20e10	40e10
η(%)	67.10	54.23	48.90	46.21

TABLE 6: POLLUTED ATMOSPHERIC CONDITION FOR POLYMER SUSPENSION-TYPE INSULATOR WITHOUT GUARD RING

RESISTANCE	5e10	10e10	20e10	40e10
η(%)	77.36	70.71	60.86	55.07

TABLE 7: POLLUTED ATMOSPHERIC CONDITION FOR POLYMER SUSPENSION-TYPE INSULATOR WITHOUT GUARD RING

RESISTANCE	5e10	10e10	20e10	40e10
η(%)	94.11	91.25	88.18	85.26

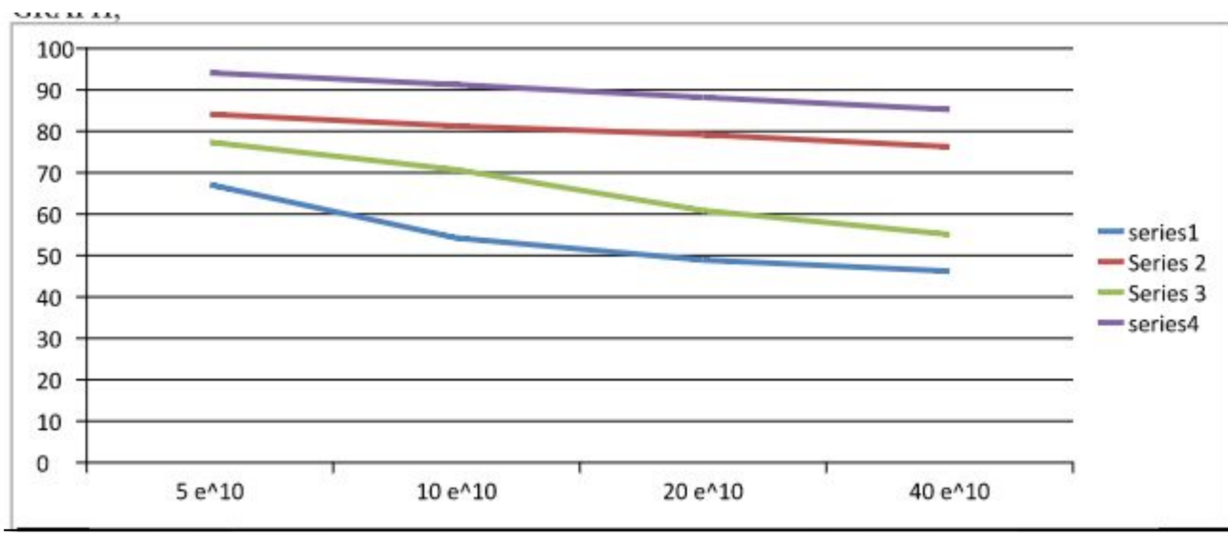
TABLE 8: POLLUTED ATMOSPHERIC CONDITION FOR PORCELAIN SUSPENSION-TYPE INSULATOR WITHOUT GUARD RING

RESISTANCE	5e10	10e10	20e10	40e10
η(%)	84.11	81.25	79.18	76.26

Graph

In graph X-axis shows resistance in ohm,and Y-axis shows efficiency in percentage series-1 belongs to polluted atmospheric condition for porcelain ssuspension type insulator without guard ring. Series-2 belongs to polluted atmospheric condition for porcelain ssuspension type insulator with guard ring.Series-3 and series-4 represents polluted atmospheric condition for polymer suspension type insulator without guard ring. polluted atmospheric condition for polymer suspension type insulator without guard ring respectively.

GRAPH



7. CONCLUSION
The voltage impressed on a string of suspension insulators does not distribute uniform it self presence of shunt capacitance. If there is a self-capacitance alone, then charging current would have been the same through all the discs and consequently voltage across each unit would have been the same. The disc nearest to the conductor has maximum voltage across it.Due to this reason poncutre of insulator may result.by the use of guard ring voltage distribution can be improved. On of the main problem under which the distribution network is exposed in the environment pollution of its electrical Insulation. The particle Placed in the insulations are not dangerous in dry weather but the problem arises when the environmental wether is humid rains there is drew fog ,then layer can become conductor. This effect showed in this paper by parallel connection of resistance to each capacitor unit.As the value of resistance increases η(%)will be be decreses.uniformly across the individual discs due to the . effect of pollution.in this paper porcelain &polymer suspension type of insulator are used.

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THOMSON REUTERS ENDNOTE
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