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Van De graaff Generator for High Voltage DC Source and it's Applications

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ABSTRACT:This paper proposes a design and operation of high voltage van de graaff DC generator whose output is 81.506KV so we can see the corona discharge with input voltage 10 volt. A Van de Graaff generator that we design and built and that is intended to be used in college project work for demonstrating basic principles of electrostatics and use of high voltage in Electrostatic pracipitator , Radiotherapy as well as a number of other applications.

KEYWORDS: Electrostatic machine, van de graaff generator, Triboelectric series and Electrostatic precipitator.

I.INTRODUCTION

Electrostatics was first noticed sometime in 600 B.C. when the Greek philosopher Thales discovered that amber attracted light objects when rubbed. The phenomenon demonstrated a fundamental concept of electrostatics. It is an elementary physical fact that extremely high voltages can be generated by friction. This fact is the base concept of functioning of Van de Graff generators.The Van de Graff generator is named after Dr. Robert J. Van de Graaff who patented his electrostatic generator in 1935. He developed this generator for studying the acceleration of charged particles to explore the atom.The Van de Graaff generator is an impressive electrostatic generator that is capable of producing enormously large static electric potentials.More modest "class room" sized Van de Graaff generators typically produce 100,000 V to 500,000 V. The output of this device was applied in several fields of physics, astrophysics, medical and industry.In the same way is very useful inteaching corona discharge and electrostatics phenomenon.

The Van de Graaff generator, which was developed from the end of the 1920, derivesfrom a series 18th century electrostatic machines.In our project we use single phase ceiling fan that can run our nylon belt which is held by two pully.The material use for our dome is Steel also the discharge dome is made up of steel.We give the input voltage of 10 volt Dc source and we get 80KV which can be use for air purification and in cable testing. For calculating such a large high DC voltage we use Sphere gap method . In this method we take two reading that is of temperature and pressure of our working area. For showing the application of van de graaff generator as Electrostatic precipitator we create a smoke in between two dome that is main dome and discharge dome and get surprising result that the amount of smoke is reduced after passing through that gap.

II.HISTORY

Otto von Guericke, using a sulphur globe frictioned by hand, builds the first electrostatic generator in 1660. The globe could be removed and used as source on electricity experiments but this source can not generate the high voltage for studying the acceleration of charged particle to explore the atom.

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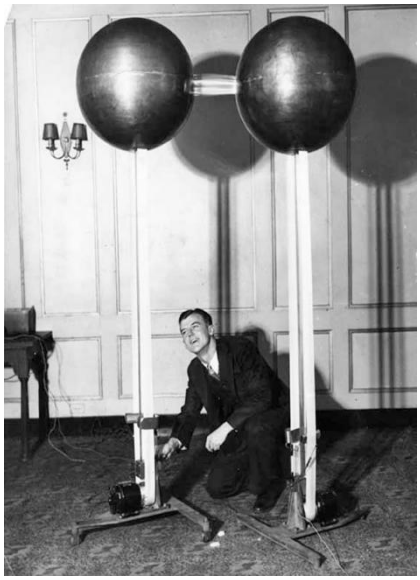
In 1917 sir robert van de graaff developed the first generator which can generator about 5 million volt. The Van de Graaff generator is an impressive electrostatic generator that is capable of producing enormously large static electric potentials.



III.HOW IT WORK

To understand the bases of a Van de Graaff generator it is important to understand static electricity. Static electricity is an imbalance in the amounts of positive and negative charges in the surface of an object.Some atoms hold on to their electrons more tightly than others do. How strongly matter holds on to its electrons determines its place in the tribo-electric series. A material is more positive in this series if is more apt to give up electrons and more negative if is more apt to capture electrons when in contact with other materials. Another important factor in electrostatics is humidity. If it is very humid, the charge imbalance will not remain for a useful amount of time. Humidity is the measure of moisture in the air. If the humidity is high, the moisture coats the surface of the material, providing a low-resistance path for electron flow.This path allows the charges to "recombine" and thus neutralize the charge imbalance. Likewise, if it is very dry, a charge can build up to extraordinary levels, up to tens of thousands of volts.

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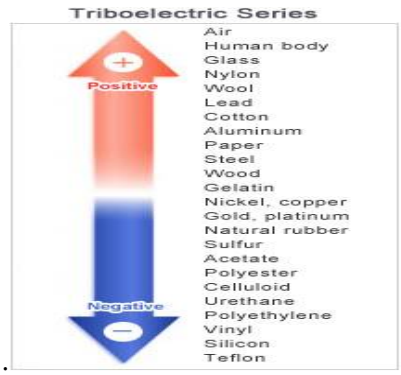

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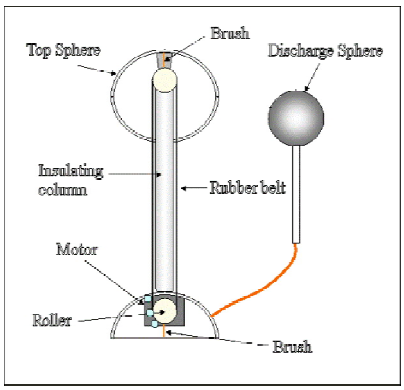
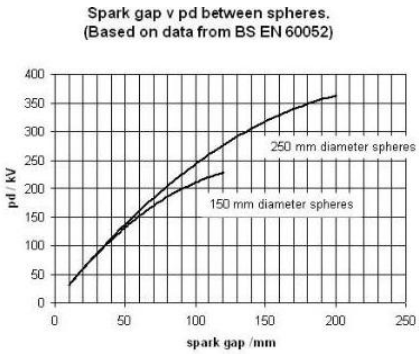
When single phase motor run the bottom brush rubbed by nylon belt , then there is the generation of imbalance positive and negative charges that is carried by belt and collected by top brush so that the entire dome is get positive charge and if we take the discharge dome nearer to main dome then we see the spark with cracking sound.



IV.COMPONENTS

Based on the data from BSEN 60052 that if the size of the dome increases then output voltage and the spark gap also increases this can be shown in below figure,



In our project we use single phase capacitor start motor for running the belt which is made up of nylon, the bottom pully coverd by teflon layer and the top pully coverd by Aluminium foil , the top collector and discharge brushes are made up of Aluminium foil.

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COMPONENTS	RATING / SIZES
SINGEL PHASE MOTOR	220 V , AC 50 Hz 330 RPM
MAIN DOME	25 cm in diameter
DISCHARGE DOME	10 cm in diameter
PVC PIPE	65 cm in hight

OUTPUT: We get a spark at 3 cm , with cracking sound. The output voltage of van de graaff generator can easly determine by sphere gaps method,

$$V = \frac{2dE}{\frac{d}{R} + \sqrt{\left(\frac{d}{R}\right)^2 + 4}}$$

where d = 3cm , R = 13cm and E can be calculated as,

$$E = 27.2\delta\left(1 + \frac{0.54}{\sqrt{\delta R}}\right)$$

Where δ is the correction factor which is depend upon the temperature and pressure.

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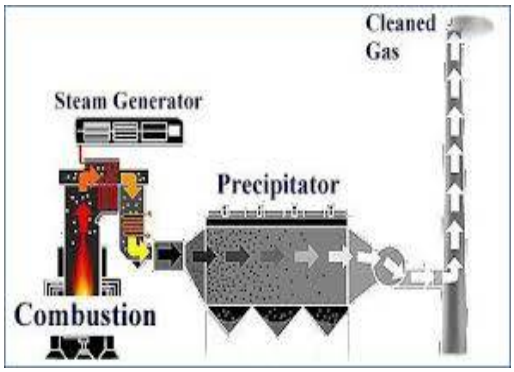
$$\delta = \frac{293p}{760(T+273)}$$

By putting the value of T and p as T = 28 degree and p = 760 torr.

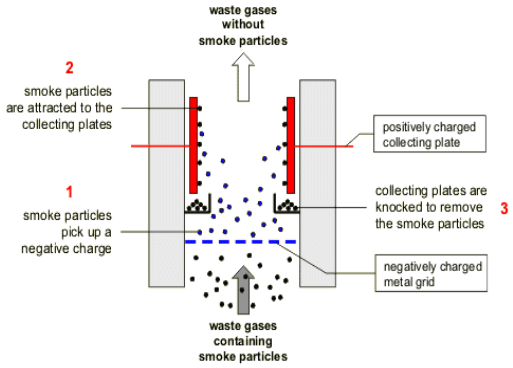
δ = 0.973 also E =30.484 and the output voltage V = 81.506 KV

V.APPLICATION

As we know the steam generator, generate a large amount of waste gases that must be eliminated before injected to atmosphere, so we use electrostatic precipitator.



Electrostatic precipitator is nothing but the made up of two electrodes which is connected to high voltage positive dc supply. The waste gases is passed through the negatively charged metal grid so that the smoke particles are pick up a negative charge and then these smoke particles are attracted to positive plate so we get a clean gases which can be injected to atmosphere .



VI. CONCLUSION

The van de graaff generator is used for studying the acceleration of charged particles to explore the atom.The output of van de graaff generator is used in air purification technique and in cancer treatment ,Also using van de graaff generator we can see the corona discharge which is occure about 30 kilo volt.Person with cardiac pacemakers should

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never operate the van de graaff generator.Do not run the device near operating computer or electronic equipment .Do not operate in wet or damp location or outdoors(to avoid shocks).

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