

A PROPOSED DESIGN OF SEMI AUTOMATIC CLEANING SYSTEM FOR HIGH POWER TRANSMISSION LINE

Vishwas C. Patel¹

¹Student, M.Tech Advanced Manufacturing System, U. V. Patel College of Engineering, GANPAT University, Gujarat, India.

ABSTRACT - The cleaning of cup and pin type of insulators of power transmission system (in lines or substation) is essential due to some atmospheric condition reasons. Known over the years various system have been in use. However due to a number of limitation it is required to develop new system overcoming the existing design limitation here a semiautomatic system is proposed and detailed design is presented. It adopts concept of dry cleaning by using three rotational microfiber roller with guided lead screw.

Keywords: Insulator cleaning system, Insulator maintains, Dry cleaning methods, Insulator.



Fig.2 Flashover [7]

1 INTRODUCTION

Insulator is one of the most important component which used in the power transmission and distribution network system to utility poles and transmission tower - Electrical Insulator. It absorbs the electrical energy and isolates from the earth. In short Insulator is the resistor - Hypothetically with infinity value of resistance which prevent the flow of current from tower to ground [1]. The Ideal insulator does not exist. Insulators carry few amount of current because it contain small numbers of mobile charges and made up of highly resistive material.

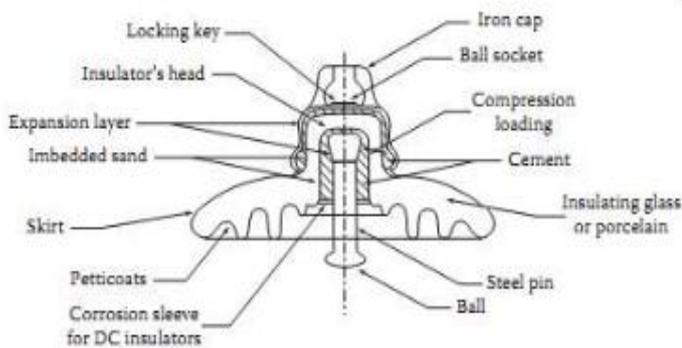


Fig.1 Cross section of cup and pin type insulator

2 INSULATOR TYPES AND MATERIAL

- 2.1 Porcelain insulators are made up of alumina or quartz, clay, and feldspar – covered with a smooth glaze having high mechanical and dielectric strength i.e. 4 to 10 kv/mm.
- 2.2 Glass insulators are made up of annealed tough glass used as insulating purpose. It has high dielectric strength compared to porcelain. Its resistivity is also high and low thermal expansion coefficient. It has high tensile strength 35000 kg/cm² [1]. Impurities and air bubbles are easily detected due to glass transparency. Disadvantage in glass insulator is that moisture condenses on glass surface hence dust is deposited on it. For high voltage casting of insulator is difficult.
- 2.3 Polymer insulator has two parts, one is glass fiber reinforced epoxy resin rod shaped core and the other is silicone rubber or EPDM (ethylene propylene diene monomer) made weather sheds. Weather sheds protect the insulator core from outside environment. It is made of two parts so called composite insulator too. It is very light weight compared to porcelain and glass insulators. It is flexible so chance of breakage is minimum. It has higher tensile strength compared to other insulators. Its performance is better particularly in polluted areas, less cleaning is required due to hydrophobic nature of insulator [1]. Disadvantage of this insulator is that if moisture may enter in the core causes electric failure of insulator. Over crimping in end may cause crack in the core.

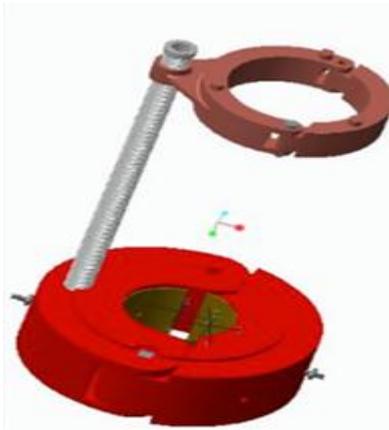


Fig.3 Propose Design

3 METHOD OF CLEANING

There are basically two types of cleaning system is there for washing of insulator one is dry cleaning and other is wet/hot cleaning.



Fig.2b Dry Cleaning of insulator [10]

2.4 Causes of insulator dirtiness in the country transmission lines traverse areas having different environment condition and different pollution level. Day by day increasing in pollution level has become global phenomenon. Existing old transmission lines are under serious treat due to industrial pollution as well as other related activities like increase in number of brick kilns, cement industries etc. Due to change of atmospheric condition and climatic condition some dust particle, moisture, bird dropping and other contaminants form layer on the surface of insulator. Moreover, because of irregular rains and short monsoon seasons, cleaning of insulator by natural process is not effective resulting in increasing in deposit of pollution over insulator.

2.5 Justification for cleaning Pollution and oxidation due to contaminants create degradation of material properties, mostly if we talk about power transmission line then the insulation properties of the insulator is degraded .The environment pollution mostly affect dielectric capacity of insulator and reduced performance of the insulators - increases the "flashover" discharges and reducing mechanical resistance of insulator. The major problem with insulator by pollution which reduced the flashover voltage under rated voltage [3, 8]. Contamination and wetting causes form conductive layer path leading to increase in surface leakage current, formation of dry band and flashover. So current flowing from hot conductor to ground over the outside surface of insulator is called leakage current and due to contaminant lead to current flow through conductive path over the insulator generate flashover. To ensure the continuity of the electric system maintenance companies use different equipment and different systems for washing of insulator vary frequently to get better performance of the insulator and increases the life span of the insulators.

3.1 Method of dry washing:

3.1.1 Manual: The insulator are cleaned by clothes by manual in which as a cleaning medium dehydrate pulverized limestone or corncob is used. Once they spray the medium, clean the insulator by hand with using some clothes.

3.1.2 Compressor: The compressor air used in cleaning has approximate 12 bar pressure. The flow of air from the compressor is very low and it does not have a reservoir of air. The average level of pressure reached was around 10 bar. The tests have shown that the air has capacity to drag the pollution of the insulator, but with these conditions of the compressor the cleanness is not very efficient. In function of the difficulty of providing high-pressure compressors, plus the high cost, a change in the method of dry washing was proposed. The proposal was the use of pressurized nitrogen gas.

3.1.3 Cylinder of nitrogen gas: Exists in the local market the trade of industrial gases - nitrogen that are distributed in cylinders of 10 m³ and with a pressure of 200 bar more which much more than 12 bar pressure of compressed air. A system supplied by nitrogen was mounted through six cylinders in series to perform the tests. This avoids the purchase of a compressor for task. The structures used such as pipes and supports have high mechanical strength to withstand the operating conditions at high pressure. But the insulator must be in the vertical position.

3.2 Method of hot/wet washing:

Hot washing consist de-mineralize water for cleaning of insulator. Demineralized water used as cleaning purpose with specific reason is that it has high resistance toward conduction electricity. Demineralize water having high resistivity which is approximately 50,000 ohm cm. By using pressurized de-mineralize water and sprayed in jets from special cleaning machines. These cleaning machines are stationed on the ground but in some cases machine can be fixed on helicopters which over near the lines and clean the insulators. The Hot washing is usually carried out from the bottom of the insulator. The bottom of the insulator is washed and then the washing proceeds to the middle sections and the then to the top of the insulator. Because water spray for cleaning should be fall from one insulator to another may generate flashover. By using hot cleaning cost of necessary equipment and helicopter for six months on experimental basis 8.13cr, which is most costly and trained manpower is required. Both hot and dry cleaning method are time consuming, according to our inside source working at GETCO (Gujarat energy transmission corporation) Nadiad, Gujarat, India substation 66kv , team of 50 people , working for 4-5 days for 7-8 hours per day, at rate of 600-700 per person per day. Apart of this labour cost, company has loss of electricity during cleaning because A.C power can't be stored. So rather than using such costly and difficult method of cleaning one should adopt proposed semiautomatic system design to make this work much easier and efficient.

4 PROPOSED DESIGN

Our system contains four major parts, Base Gripper, Lead Screw, Washer Base, and Microfiber Roller. We designed base gripper that will grip the bottom of the insulator. Base gripper itself Contain 5 parts , Spring Plate, Spring , Spring Plate tightening nut & bolt, Stepper motor, DC geared motor, Embedded system shown in fig.4, with it's bill of material in fig.6 Spring plate with combined use of spring and tightening nut and bolt as shown in fig.5, is used to gripe the insulator's base of various diameters. As the stepper motor rotates around the base of insulators the spring will compressed if the diameter of insulator is more than the its inner gap and if base diameter of insulator is less the spring will decompress And force the spring plate to grip the base. Assembly of base gripper is shown below. Dc motor in the base gripper will rotor the lead screw mounted on the base gripper fitted with collars. Due to rotation of the lead screw washer assembly will move up and down, this one is like simple nut and bolt type mechanisms.

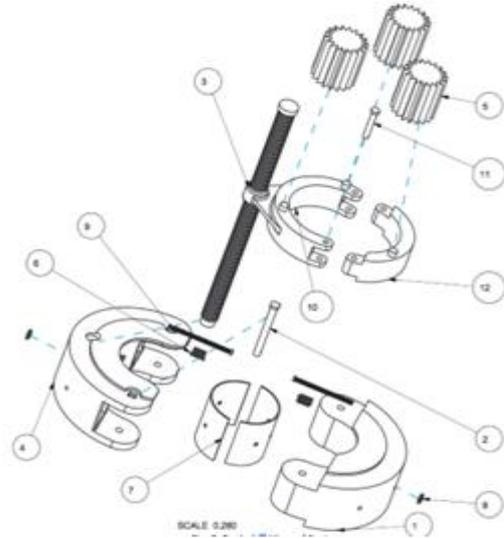


Fig.4 Proposed design of system

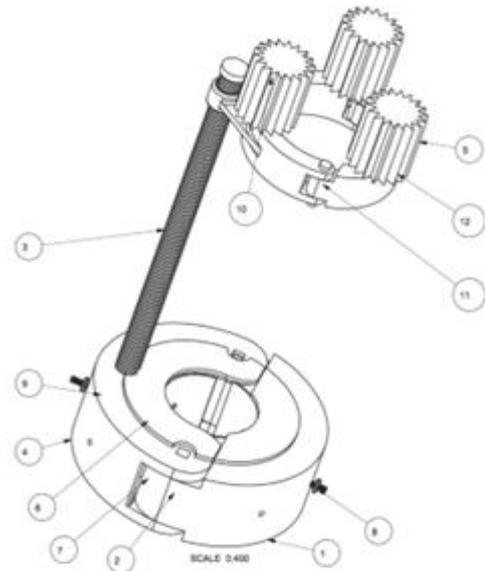


Fig.5 Exploded view of system

| Sr No. | Part Name | Material | Qty |
|--------|------------------|----------|-----|
| 1 | BASE2 | PVC | 1 |
| 2 | BASEBOLT | PVC | 1 |
| 3 | MAINSCREW1 | PVC | 1 |
| 4 | PART1BASE | PVC | 1 |
| 5 | ROLLER | EPOXY | 3 |
| 6 | SPRING | FE20 | 2 |
| 7 | SPRINGPLAT2 | PVC | 2 |
| 8 | SPRINGPLATEBOLT | NYLON | 2 |
| 9 | SPRINGPLATESCREW | PVC | 2 |
| 10 | WASHERBASE | PVC | 1 |
| 11 | WASHERPIN | PVC | 1 |
| 12 | WHASERBASE2 | PVC | 1 |

Fig.6 BOM table

4.1 WORKING PRINCIPLE

Base griper contains simple rod attachment at base as shown in figure 7 ,so one can easily lift the whole system at desired level (less that 20m) and grab the base of insulator by closing the base griper part 2 and washer base part 2 with the help of stepper motor and then starts one. DC motor than will rotates the lead screw. As a result of this washer base will moves up and down, which contains three microfiber rollers that rotated by three separate brushless D.C. motor. Once washing is done, system is pulled out from on insulator by doing exactly opposite operations that we have done during mounting. Repeat the same procedure to all the insulator, which to be cleaned.

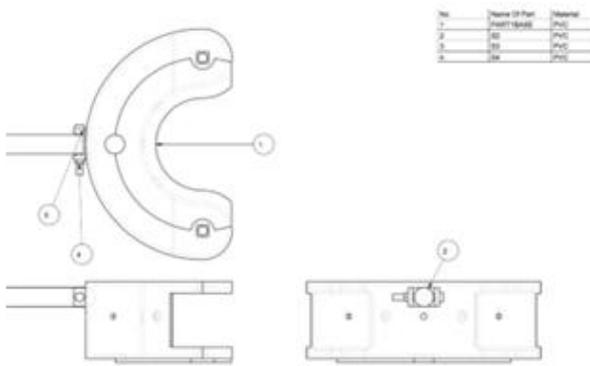


Fig.7 assembly of lifting rod and base gripper

4.2 CALCULATION

Calculation of mass and volume of each part of system is created in Creo Parametric 2.0 for material PVC[14] (Poly venial chloride). By default software generates weight in tone .(1 Tone = 1000 Kilogram).Weight of whole assembly is about 5kg ,as shown in fig.8.

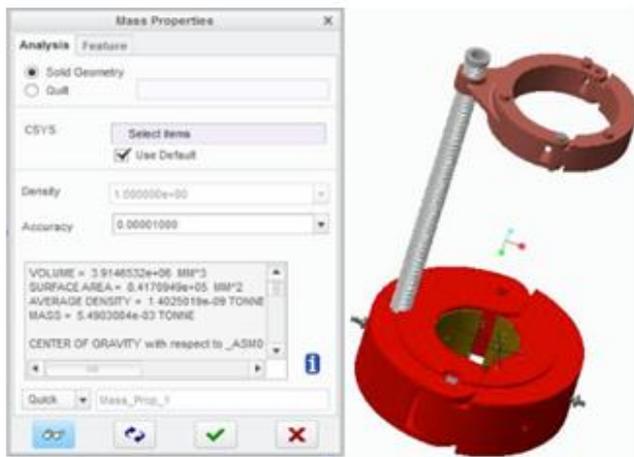


Fig.8 Mass Properties of Assembly Simulated in Creo Parametric 2.0

We have decided the dimension of each component, by selecting mode of load i.e. gravity, force/moment, pressure, centrifugal, preload etc. direction of force with its magnitude up to its safer limit in creo with our measured dimension i.e. height of insulator, base diameter of insulators. Some of the simulation is shown in fig.9.

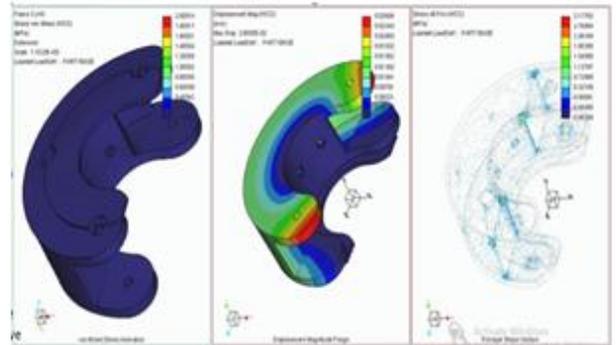


Fig.9a Simulation of Base Griper Under loading condition

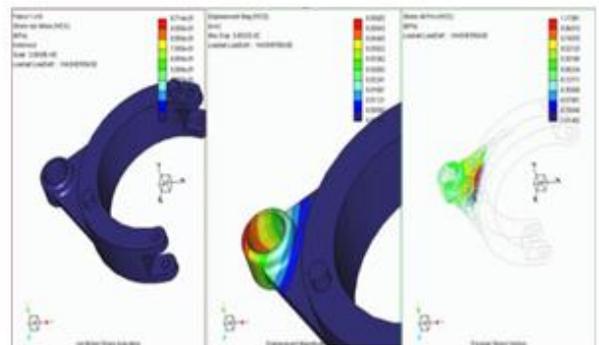


Fig.9b Simulation of Base Griper Under loading condition

5 LIMITATION OF OUR SYSTEM

Our system is only used to clean the cup and pin type insulator ,which are situated 20m from ground at max, best for 66Kv or 11Kv substation.

6 CONCLUSION

This paper introduced a new system for cleaning a cup and pin type insulators, which are situated less than 20m from the ground, to prevent a failure of insulator mostly caused by pollution. System is designed to adopt the dry cleaning method, instead of using jets of water or air, using a rotating three microfiber roller placed on the washer base, which moves up and down by the rotation of lead screw powered by separate D.C. motor located in the base griper.

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