

# FEATURES AND DESIGN CONCEPTS OF GAS INSULATED SWITCH GEAR

<sup>1</sup>Malvika Chauhan, <sup>2</sup>Upendra Joshi, <sup>3</sup>Divya Asija

<sup>1,2,3</sup>Department of EEE, ASET, AmityUniversity, Noida, (India)

## ABSTRACT

*This paper proposed the Gas insulated switch gear (GIS) features and how GIS is beneficial. GIS developed after the 1960's and it has been very popular in big cities, conventional substation requires compact size and protection against atmospheric pollution and moisture, noiseless operation, non-explosive, less maintenance, and reduced radio interference. Gas Insulated Switchgear is a kind of metal enclosed switchgear. Various components such as bus bars, circuit breakers, voltage transformer, current transformers, Isolators are in the form of metal enclosed, SF6 gas filled modules. SF6 gas is an excellent dielectric gas and high electronegative. It has some properties like as non-explosive, not-toxic, having good arc quenching. Site installation is faster and simpler. It is indoor and outdoor both.*

**Keywords:** Gas Insulated Switchgear, Circuit Breaker, Bus Bar, Isolators, Surge Arresters, Lighting Arresters, Voltage Transformer And Current Transformers.

## I INTRODUCTION

Switch gear is a mechanical device which is used for the protection of power systems. It also includes many devices which are associated with control, metering and regulating of electric power system. So all devices in a logical manner are called switch gear. Switchgear refers various equipment associated with switching of electrical plants and circuit during the Normal Operation and Abnormal Operation. Various types of switch gear depend upon the different level of voltages. There are three types of voltage difference level, such as-

- 1) Low voltage switchgear up to 1 KV.
- 2) Medium voltage switch gear the range is 3kv to 36 KV.
- 3) High voltage switch gear the range above the 36 KV.

### 1.1 Types of the high voltage Ac switchgear

- Metal-Enclosed Switchgear
- Outdoor open Terminal Switchgear (Switch Yard)
- Gas Insulated Switchgear (substation) (GIS).<sup>[6]</sup>

### 1.1.1 Metal Enclosed Switchgear

It is earthed enclosed. It is divided into 3 compartments. First or front compartment for the circuit breaker, top compartment for the bus bar assembly and back or rear compartment for current transformer and cable connection. It is also called metal clad switch gear. Clad switch gear is used for the low voltage AC (below 1000Vrms phase to phase) and medium Voltage AC (up to 33kv phase to phase), low voltage DC (up to 1000V DC). circuit breakers are used for the medium voltage DC because DC arcs cannot be easily quenched at higher voltages due to non-availability of current zeroes in DC.

### 1.1.2 Out-Door Open Terminal Switchgear (Switchyard)

For 33 KV or above from the 33 KV the size of the equipment becomes large and indoor metal and enclosed switchgear tends to be too large and costly. Bus bar, circuit breakers, Isolators surge arresters, earthing switches these are equipped are installed in outdoor yard. Each equipment is provided sufficient clearances (gap in the air between conducting parts) as follows,

- Phase to phase clearances in air
- Phase to ground clearances in air
- Lowest ground point to earth in air for safety of personal walking in switchyard.

### 1.1.3 Gas Insulated Switch Gear

Gas insulated switch gear or gas insulated substation is a worldwide technology, which are used for the protection of power system and network, it solves the problem and also associated with control, metering and regulating of electric power system. The Gas Insulated Switch Gear (GIS) is necessary for EHV (extra high voltage) and UHV (ultrahigh voltage) both. Due to their compactness and flexibility, increase the level of reliability and power availability possible. GIS substations can be located close to load centers, and increasing the capacity of demand. SF<sub>6</sub> are use of GIS due to highly electronegative and when the arcs produce in the system, then it absorbs the electron. so it has the good property of arc quenching. SF<sub>6</sub> gas have the many properties like as it does not harmful to ozone layer chemical stability, non-poisonous, colorless and heavier than the air, almost water insoluble and non-flammable.

## II LITERATURE REVIEW

1970s-1990s: gas filled (SF<sub>6</sub>) switchgear are used for the short length, Many lab models Also use of SF<sub>6</sub>/N<sub>2</sub> for the high voltage and three phase design in a single duct. Superconductors are designed bearing the temperature capacity. But there are not working for high voltage rating<sup>[7]</sup>. Gas insulated switch gear is a necessary for the protection of a power system and it required to establish a substation at load centers. It reduces the length of the feeder and if the length of feeder reduces, then the voltage regulation will be increased. Establish the substations a very hardly problem created of space.

GIS (gas insulated switch gear) technology can solve this problem because all the component of switchgear is assembled in a limited space. GIS is a kind of metal enclosed switch gear. In this all the equipment of GIS is enclosed by gas tight metal and SF6 gas. The range of GIS up to 12 KV to 800KV. GIS has the important role in industries now days and it is widely used.

### III PROBLEM STATEMENT

- 1) From the 30 years, compressed gas, cable technology has matured, but for transport the bulk power potential is yet to be exploited and developed.
- 2) High temperature superconductor technology is not commercial for bulk power transport.
- 3) No longer line acceptable near to urban centers because of environmental and aesthetic.

### A SEE THROUGH OF TECHNOLOGY

Three choices in technology

- 1) Conventional underground power cables.
- 2) Compressed gas cables (SF6 – Sulphur Hexa-fluoride).
- 3) Superconducting cables.

### IV DEVELOPMENT

High voltage switchgear (1kv to up to 800 KV) and equipment are subjected to the high reliability and availability. For future transmission, distribution should be Reliable and economical. Gas insulated switchgear (GIS) is used for fulfil high-energy demands in industrial areas and it also space saving design due to compactness, cost also will be minimized. It introduced in 1968 with the modern technology, use of SF6 the modern technology, In Canada a 550kV substation with 100kA with high breaking capacity ever achieved in one of the steps of development since then. GIS technology is filled with a minimum of SF6, which have a good arc quenching properties and it has typically of modular design. It has low cost and can be used for indoor and outdoor application.

**Table 1: GIS growth before 1985 January to after 1985.**

	Before 1985 January		After 1985 January	
VOLTAGE	GIS	CB-Bay- Years	GIS	CB-Bay-Years
1	230	28669	731	28215
2	227	21252	382	12808
3	123	10362	147	5678
4	45	3870	65	2904
5	26	3252	37	1273

6	-	-	2	200
<b>TOTAL</b>	751	67405	1365	51078

### **WHERE AND WHY USE OF GIS**

Gas Insulated Substations are used in large cities and towns where space is provided. In normal substation the clearances between the phase to phase and phase to ground is a very large space required, such as in Air Insulated Switchgear (AIS). The overall size of each equipment reduced to about 10% of the conventional air insulated substation. SF<sub>6</sub> gas has the high dielectric strength compare to air.

Gas Insulated Substation is located:

- Underground stations
- Large cities and towns
- Indoor and outdoor both places.
- Located in offshore regions
- Mountains and valley regions

### **V FEATURES**

#### **5.1 Pre-Assembled and Tested units**

In the factory all components of a GIS are placed in well controlled conditions and very cleanly and tested as a unit also under well controlled conditions. For the Testing of GIS bay unit for voltage level up to 245 kV and gas tight section which has a small or a transportable size are sent to the site for assembly.

#### **5.2 Corrosion Resistance**

Aluminium alloy, usually against the corrosion and GIS is made of aluminium alloys today's which resistance against corrosion. GIS is painted with color and the aluminium enclosure use for the protection itself against corrosion with a layer of oxide.

#### **5.3 Need of Minimal Cleaning**

GIS is completely closed and filled with SF<sub>6</sub> gas, which is cleaned and dry gas, thus the complete GIS is protected against all ambient disturbances and environmental disturbance also. GIS doesn't have the direct contact with ice humidity, dust, sun radiation storm and salt. Only some part in Gas insulated substation such as the transformer and the Air bushing at the connection point to an overhead line needs to be cleaned according to the environmental impact.

#### **5.4 Low Fault Probability**

In Air insulated substations, the fault probability is more than Gas insulated switchgear or Gas insulated substation due to ambient impact and the environmental impact can be excluded for the high voltage and availability will be higher of Gas insulated switchgear.

### **5.5 Operating Life Period**

Since 1960s describe that according to the practical experience, no ageing on the high voltage equipment part. The high voltage parts in GIS are tightly enclosed inside the dry gas due to this reason arise the stability and prevention from environmental and ambient conditions. In first major inspection Under normal operating condition, not needed before 25 years. In GIS the requirement of maintenance is needed for the moving elements and Switching elements only. Today's according to the experience shows the operating life more than 50 years of GIS.

### **5.6 Less Space Requirement Compare to AIS**

20% less space require for the GIS installation compare to AIS, That means less than 20 % of the space of AIS and the using of GIS the ratio will be 1:5. Today in the all over world 2000 substation have the more than 20000 bays, in any type of environmental condition.

## **VI MAIN COMPONENTS OF GIS**

Here describe the main component of Gas Insulated Substation. Circuit breaker, current transformer voltage transformer, bus bars, surge arresters, disconnectors and earthing switches.

### **6.1 Circuit Breakers**

The circuit breaker is an automatic and manual switching device. It is used for the controlling and protection of the power system, when the large amount of current flow in the circuit then the arc will be produce between the contacts of the circuit breaker. Thus circuit quench of this arc in safe manner with the help SF<sub>6</sub> gas.

### **6.2 Bus Bar**

Bus bar has the 3 phase encapsulation. Bus bars modules of adjacent bays are connected with expansion point with absorbing the constructional tolerance the temperature, movement is into 2 directions one is longitudinal as well as in the transverse direction to the bus bar. Axially the temperature compensates between the conductors contact and expanded according to the conductor's length. So, the availability increase of switchgear increase without fitted any additional measures.

### **6.3 Voltage Transformer**

Voltage transformer encapsulated its own housing which forms a separate gas tight module. The main component of voltage transformer-

- Primary winding
- Secondary winding
- An iron core

The pressurized gas inside the enclosure with the insulating film. The insulating film provides the protection against the over voltage. The connection of the high voltage is directly connected to the switchgear. The primary and secondary connections are connected from gas tight bushing plate to terminal.

#### **6.4 Current Transformer**

The current transformer the primary is connected to the power line in the series. so the primary is nothing it is only the current which flow through the power line and it does not depend on the load. Gas compartment reduces the access of moisture and to suppress gas tight bushing for secondary connections.

#### **6.5 Earthing Switches**

An Earthing switch is used for the protection and it has the slowest operation. These switches are to be vertically broken switches. The earthing arm interlocked with main isolator moving contact. When the main contact of isolator will be close, then it will be open. Similarly the main contact of isolator will be open when earthing arms will be in close position. It operated only when it is a High voltage system is not energized.

#### **6.6 Surge Arrester And Lighting Arrester**

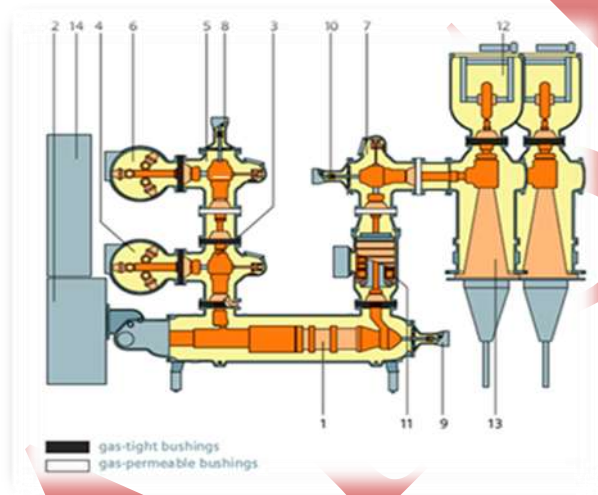
Surge arrester can be connected directly if it is required. The function of its limit to over voltages. Their active part consists of metal oxide resistors with a strongly nonlinear voltage current characteristic. Surge arresters are flange joint to the switch gear through a gas tight bushing. In a tank of arrester module, it has an inspection hole in which a conductor inspected and at the bottom there are the connection for monitoring, arrester testing and operation counter.

### **VII DESIGN**

3 phase enclosures are used for the distribution voltage level. The aim of developing SF6 insulated switch gear was to reduce the cost and use of materials and increase the high reliability.

1. Circuit Breaker Interrupter Unit
2. Spring stored energy mechanism with circuit breaker control unit
3. Bus bar disconnected I
4. Bus bar I
5. Bus bar disconnected II
6. Bus bars II

7. Outgoing Feeder disconnected
8. Work in progress earthing switch
9. Work in progress earthing switch
10. Make proof earthing switch (high speed)
11. Current transformer
12. Voltage transformer
13. Cable
14. Integrated local control cubicle



**Fig 1: Design of GIS<sup>[1]</sup>**

### VIII SOME DEVELOPMENT STEPS

- Improve the Circuit-breaker technology, which reduce the number of interrupter units despite the increasing braking capability.
- Progress of machining technology of aluminium cast parts uses for the minimized shapes and volumes
- Use of computerized production of high quality standards and testing equipment.
- Integrated components Design which has the several functions such as grounding switch, dis-connectors within one gas compartment.
- To avoid the unnecessary tasks and maintaining the activities for use of intelligent monitoring and diagnostic tools.

### IX RESULTS

- VOLUME reduces of SF6 = Up to 75%
- SPACE reduce in GIS compare to AIS =Up to 98%

- TESTED BAY unit and Delivery of completely sealed =Up to 245 KV
- Leakage rates down to less than 0.5% per compartment.

## X RECENT DEVELOPMENT

- Leakage of SF<sub>6</sub> <0.5% / year
- Refurbishing of old GIS
- Replacement of Air Insulated Switchgear in Urban areas
- Mechanical design to allow for SF<sub>6</sub>/N<sub>2</sub> Mixtures.
- Combined VT/CT

## XI CONCLUSION

GIS or gas insulated switchgear system available for the high voltage, only SF<sub>6</sub> (sulphur hexafluoride) is used both for interruption medium and insulation because dielectric strength is so excellent of SF<sub>6</sub>. In some areas to be studied include more conservative designs, better particle control & improved gas handling & decomposition product management techniques Achieving & maintaining high levels of availability requires a more integrated approach to quality control by both users and manufactures. In the future we can see the gas insulated current transformer work in this substation and the compact size will be less and it will be more economical

## REFERENCES

- [1]. [Gas-Insulated Switchgear Type 8DN8, 25november 2009]<http://www.csanyigroup.com/gas-insulated-switchgear-type-8dn8>.
- [2]. Gas-insulated switchgear from 72.5 to 800 kV Excellent systems,ABB Colour Emerge Schaltanlagen AG
- [3]. GIS and AIS systems for urban supply networks
- [4]. Indoor and Outdoor Medium Voltage Metal-Clad Switchgear Outdoor PowerControl Enclosure Installation Instructions, January 2013.
- [5]. Switchgear and substation, Siemens energy sector, edition 7
- [6]. Badri Ram Vishwakarma "Power System Protection and Switch gear protection."
- [7]. Dr. S. L. Uppal,Prof S. Rao "Electrical Power systems power".
- [8]. Dr.K. D. Srivastava" Gas Insulated Substations" IIT (BHU) December 2012.