A SIMPLE COMPARISION BETWEEN ***AIR INSULATED SUBSTATION*** (AIS)AND ***GAS INSULATED SUBSTATION*** (GIS)

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Introduction,

Gas Insulated Substation uses sulfur hexafluoride (SF_6) gas which has a superior dielectric properties used at moderate pressure for phase to phase and phase to ground insulation. In Gas Insulated Substation the high voltage conductors, circuit breaker interrupters, switches, current transformers, voltage transformers and lightning arresters are encapsulated in SF_6 gas inside grounded metal enclosures.

Disadvantages of Air Insulated Substation (AIS):

١/More space is required for outdoor substation (picture ١,٢,٣and٤) when compared to indoor gas insulated substation (GIS).

٢/Outdoor switch yards are more vulnerable to faults as it is located in outside atmosphere which has some influence from pollution, saline environment and other environmental factors .Deposition of saline particles on insulators can cause insulator failures. They are also vulnerable to direct lightning strikes and other external events such as heavy winds, rains and cyclones. Therefore reliability wise air insulated substation or outdoor substations are relatively low compared to indoor substation.

٣/ Regular maintenance is required compared to indoor substations (Maintenance for Gas Insulated Substation is very minimal and reliability is very high) as they are exposed to outside environment .


Picture No.1


Picture No.2


Picture No.3


Picture No.4

Explaination:

The SF٦ Gas Insulated Substation (GIS) contains the same compartments as in the conventional outdoor substations. All the live parts are enclosed in metal housings filled with SF٦ gas. The live parts cast resin insulators. Some of insulators are designed as barriers between neighboring modules such that the gas does not pass through them. The entire installation is sub divided into compartments which are gas tight with respect to each other. Thereby the gas monitoring system of each compartment can be independent and simpler.

The enclosures are of non magnetic materials such as aluminum or stainless steel and are earthed. The gas tightness is provided with static ' O ' seals placed between the machined flanges. The ' O ' – rings are placed in the grooves such that after assembly , the ' O ' – rings are get squeezed by about ٢٠٪. Quality of the materials, dimension of grooves and ' O ' – seals are important to ensure gas tight performance of Gas Insulated Substation.

Gas Insulated Substation has gas monitoring system. Gas inside each compartment should have a pressure of about

۴kg/cm^{۲}. The gas density in each compartment is monitored. If the pressure drops slightly, the gas automatically trapped up. With further gas leakage, the low pressure alarm is sounded or automatic tripping or lock – out occurs.

Sulphur Hexafluorid Gas (SF٦) :

SF٦ or sulphur hexafluoride gas molecules are combined by one sulfur and six fluoride atoms . In the middle of ٢٠th century ,popularity of using sulphur hexafluoride gas as insulating material in electrical system was rising very rapidly.

Allied chemical Corporation and Pennsalt were the first Americsn industries, who began to produse this gas commercially in ١٩٤٨. During ١٩٦٠ , using of sulphur hexafluoride gas in high voltage switchgear became popular . As the demand of this gas was increasing many manufactures in Europe and America started producing SF٦gas in large scale, during that time .

At the beginning sulphur hexafluoride gas only used for insulating purpose in the electrical system . But soon it was realized that this gas has tremendous arc quenching property .Hence , this gas also began to be used in circuit breaker as arc quenching medium .Sulphur hexafluoride medium

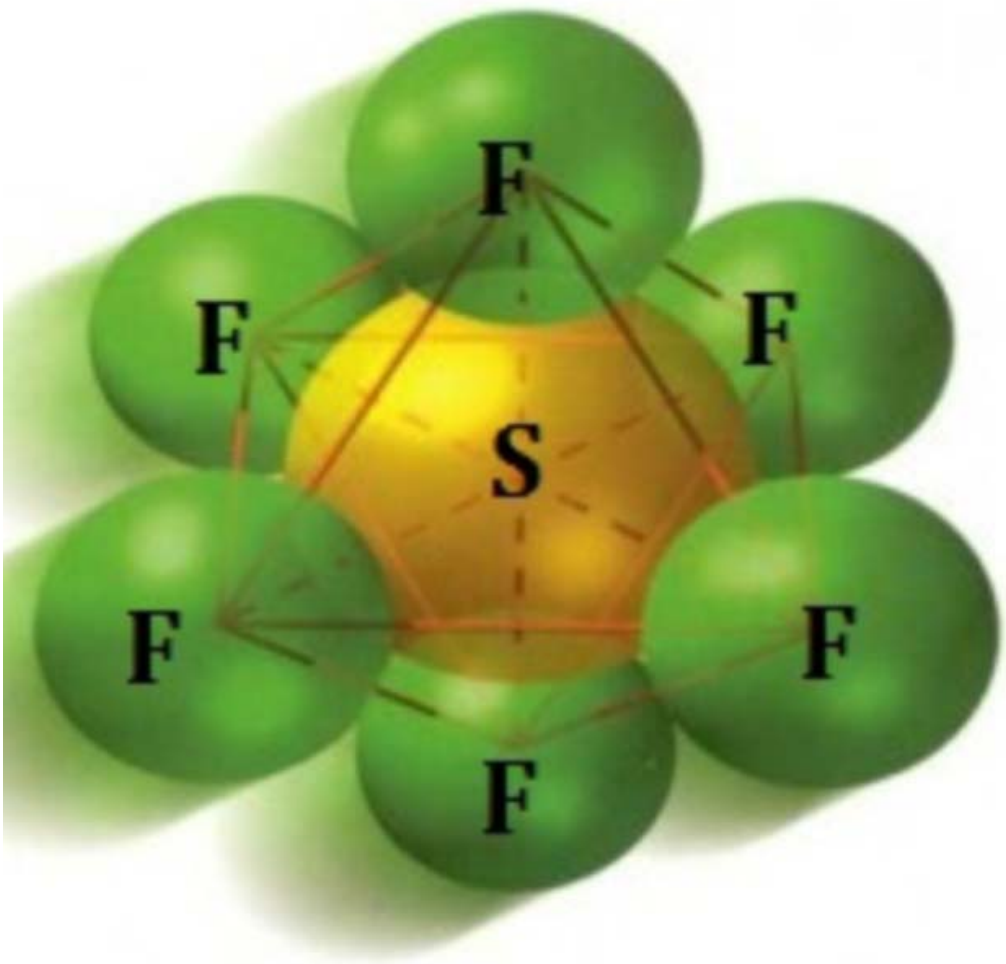
voltage circuit breakers launched into market from ١٩٧١.

The $SF_٦$ gas is one of the heaviest gases .Density of this gas at ٢٠°C an one atmospheric pressure , is about ٦,١٣٩kg/$m^٣$ wich is about ٥ times higher than air at same conditions . Molecular weight of this gas is ١٤٦,٠٦ .

The variation of pressure with temperature is linear for sulfur hexafluoride and it is small within the service temperature, i.e.

The volumetric specific heat of this gas is also high. It is around ٣,٧ times more than that of air and that is why this gas has also tremendous cooling effect in electrical equipment. The thermal conductivity of this gas is not very high it is even lower than air . Still it is quite suitable for cooling effect in ciruit breaker . It is because ,during dissociation of sulphur hexafluoride molecules absorb high amount of heat . Thus heat is then released when the molecules reform at the periphery of the arc . This process helps to transfer

heat from hot season to cool season very rapidly. That is why, this gas has excellent cooling effect at high temperature although the thermal conductivity of SF_6 is not very high .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Where and Why Gas Insulated Substation are Used:

Gas Insulated Substation are used where there is space for providing the substation is expensive in large cities and towns. In normal substation the clearances between the phase to phase and phase to ground is very large. Due to this, large space is required for the normal or Air Insulated Substatio (AIS). But the dielectric strength of SF٦ gas is higher compared to the air, the clearances required for phase to phase and phase to ground for all equipments are quite lower. Hence, the overall size of each equipment and the complete substation is reduced to about ١٠٪ of the conventional air insulated substation (picture ٥,٦,٧ and ٨) .


Picture No.5


Picture No.6


Picture No.7


Picture No.8

Merits(Advantages) of SF٦ Gas Insulated Substation:

Safe:

Gas Insulated Substation are very safe and operating personnel are protected by the earthed metal enclosures. While the substation in operating condition the operating personnel can touch the compartment.

Reliable:

The complete enclosure of all live parts guards against any impairment of the insulation system.

Space Saving:

SF٦ switchgear installations take up only ١٠٪ of the space required for the conventional installation.

Economical:

Initial high investment is required for installation but the cost can be comparable for the less

maintenance, reliable, safe operation against conventional substation.

Maintenance Free:

An extremely careful selection of materials, an expedient design and a high standard of manufacturing quality assure long service life with practically no maintenance requirement.

Low Weight:

Low weight due to aluminum enclosure, corresponds to low cost foundations and buildings.

Shop assembled:

Quick site assembly ensured by extensive pre assembly and testing of complete feeders or large units in the factory.

Demerits(Disadvantages) Of Gas Insulated Substation*:*

١/ Cost is higher compared to Air Insulated Substation or conventional substation.

٢/ Procurement of SF٦ gas and supply of gas to the site is problematic.

٣/ Normally this type of substation are indoor type and requires separate building.

٤/ Maintaining Cleanliness is very important. Dust or moisture inside the compartment causes the flash overs .

٥/ When fault occurs internally, the outage period will be very long. The damage effect will also be severe.