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GAS INSULATED TRANSMISSION LINE (GIL)

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Abstract - *Considering the current electrical energy scenario, transmission plays a very important role. The generating factors comprehensively are of no use if transmission does not take place. Wherein the generation is made at the most effective end it's a challenge before the engineers to transmit this generated supply with minimal losses. There are a number of losses taking place in the OH as well as the UG systems hence to overcome this we use a transmission system i.e. GIL (Gas Insulated transmission Line). Going through this paper we promptly understand the outstanding features of GIL system that is, its high transmission capacity, superior Electromagnetic compatibility (EMC) to any other transmission system and most importantly its high safety. The laying basically can be done above and below the ground without disturbing its layout. Since GIL provides good heat dissipation properties it can be used for high transmission system. In this GIL, tubular Aluminum conductor is used which is partly insulated by the composition of N_2 and SF_6 gas. Since SF_6 beholds adverse environmental effect its research is still in process.*

Key Words: Underground Cable, GIL, Installation Methods, Insulating gas (SF_6, N_2), EHVAC, HVDC.

1. INTRODUCTION

High voltage underground cables for power transmission have been in use for many years and number of different technologies has developed over this progressive years. Solid insulation cables have limits when it comes to the voltage that can be carried safely, and oil impregnated paper cable are also limited in the capacity. Gas insulated transmission lines (GIL) provide technical, environmental and operational features which make them a very good alternative wherever the transmission of extra high voltage (EHV) and extra high currents (EHC) is needed within restricted space.

The GIL was first introduced by the scholars of MASSACHUSETTS University in Germany in the late 1970's. Their high transmission capacity (up to 3,000 MVA through one GIL circuit) and multiple advantages for transmitting bulk electric power in such complex sites networks over short and long range distances in a safe and environmentally friendly way represents one of the major challenges of the coming decades. GIL provides an effective technological answer to the increasing energy needs of our urban society and to the extension and reinforcement of the present electricity Transmission and distribution; GIL is a key to solve this issue. The outstanding features of a GIL system are its high transmission capacity, superior electromagnetic compatibility (EMC) to any other transmission system, low losses, high safety (no fire hazard) and flexible installation options makes it more fit in the working environment. They hardly impact on the landscape, and their minimal electromagnetic radiation means they can also be used close to, or even within buildings. They are suitable for providing a continuation for overhead lines underground, connecting power stations to the power network, or as a space-saving way to connect major industrial plants to the public grid.

2. CONSTRUCTIONAL FEATURES

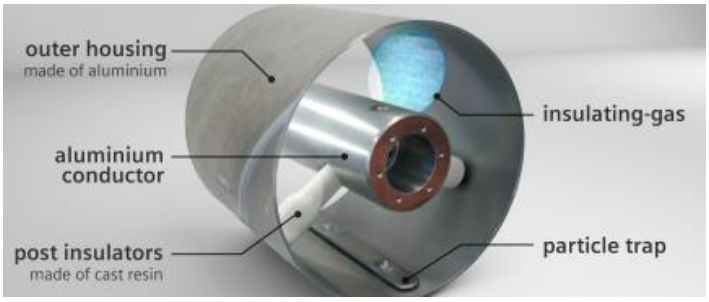

fig 1.Constructional Features

i **2 concentric Aluminium cylindrical tubes:**
- One is the inner core conductor (50cmthick) (180mm diameter) (C/S is 5400mm^2) variable with voltage. It is used to carry the current. The tubular portion enables the reduction in the skin effect. The voltage can be varied by varying the conductor size
- The other is for housing the conductor and the insulating gas. It is (18cm thick) (500mm in diameter).The outer conductor is earthed.

ii **Insulating Gas:** The composition of 20%SF6 (Sulphur HexaFluoride) and 80%N2 is used as the insulating gas. This gas helps in the quenching of the arc and prevent corrosion of the conductor and is filled at (7-8) bar

iii **Post insulators:** They are used to hold the conductors at the center of the housing tube. It is made up of Epoxy cast Resin.

iv **Particle Trap:** It is located at the bottom of the enclosure. This ensures if any particles resulting from the discharge or contained in the enclosure are trapped at the outer wall and do not affect insulating quality.

The modular length of GIL is (12-20) m and is assembled on the site by using orbital wielding. Angular sections of GIL is also available that makes it easy for vertical installations and also for taking sharp turns with a radius of about 400m.

3. INSULATING GASSES

i **SF_6 (Sulphur HexaFluoride):** It provides excellent insulation properties $SF_6$is used in power apparatus as an insulating and arc quenching medium because of its excellent. Insulating and arc extinguishing properties. However, its global warming potential has prompted discussion on replacing SF_6 in power equipment. It provides good thermal stability. Even the mixture having low percentages of SF_6 that is 20% of SF_6 provides 69% of dielectric strength and also reduces its amount by 71% compared with its pure quantity of equal dielectric strength. Since SF_6 is chemically inert it produces stable by-products. Hence for the sake of environmental aspect pure SF_6 is replaced by the combination of SF_6 and N_2.

ii **N_2 (Nitrogen)**: It is chemically inert. Use of nitrogen reduces the oxidation by absorbing the oxygen molecules and forming the nitrous byproducts. This in all reduces the corrosion of the conductor. Hence the overall life of the conductor increases.

4. INSTALLATION METHODS

i Above Ground

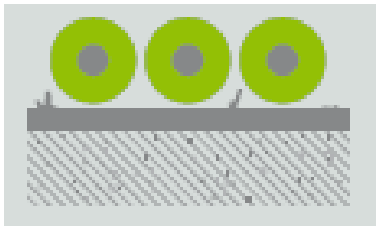

Fig 2. Above ground installation

GIL installation above ground is a trouble-free option, even for extreme environmental conditions. GIL systems can handle high ambient temperatures, intensive solar radiation, or atmospheric pollution such as dust or sand. Corrosion protection is not always necessary. Particularly high transmission power can be achieved with above-ground installation.

ii Direct Burial

These systems are coated with a continuous polyethylene layer to safeguard the corrosion-resistant aluminum alloy of the enclosure, providing protection for the buried system. As magnetic fields are marginal in the vicinity of all Siemens GIL applications, the land can be returned to public and agricultural use once the system is completed.

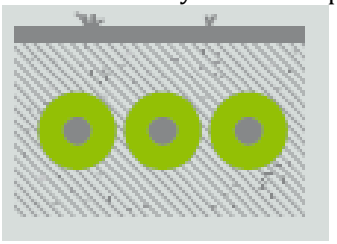

Fig 3. Direct Burial installation

iii Tunnel Installation

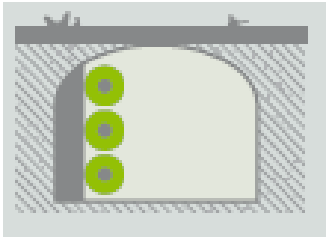

fig 4. Tunnel installation

Tunnels made up of prefabricated structural elements are another quick and easy method of GIL installation. The tunnel elements are assembled in a trench, which is then backfilled. Otherwise, tunnels can be created using a traditional boring method, to prevent any long-term disfiguring of the local landscape. The GIL is installed once the tunnel has been completed. With this method of installation the land above the tunnel can be fully restored to agricultural use. The system stays accessible for easy inspection and high transmission capacity is ensured.

iv Vertical Installation

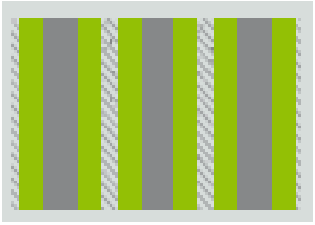

fig 5. vertical Installation

Gas-insulated lines can be installed without problem at any gradient. This makes them a top solution especially for cavern hydropower plants, where large amounts of energy have to be transmitted from the underground machine transformer to the switchgear

and overhead line on the surface. As GIL systems pose no fire risk, they can be installed in a tunnel or shaft that can also be used for access and ventilation

5. TRANSFER OF ENERGY

GIL is currently used only for HV AC transmission, but development of the system for use with HVDC is currently under way. A particular application which is being considered is that of offshore wind sites. With the increasing number of renewable energy installations which need to be connected to the grid, GIL HVDC may become a viable technology in the development of networks to cater for the high transmission loads resulting from renewable energy.

6. GENERATIONS IN GIL

The first generation of GIL consisted of pure SF_6 insulating gas, Aluminium pipes with straight beads, the transportation units were a bit short i.e. 9m and were hand wielded. It was used for disc spacers. This all was overcome by the second generation of GIL that consists of the combination of two inert gases (SF_6 and N_2) that in all safeguarded the environmental aspect, spiral wielded Aluminium pipes, transportation units between 11.5m and 13.5m. Due to the automated orbital wielding it is possible to bend the whole tube into the radii greater than 400m.

7. STANDARD SPECIFICATIONS OF GIL

(Manufactured by Siemens)

SR NO	PARAMETERS	SPECIFICATIONS
1	Rated voltage	245-550 KV
2	Rated Current	Upto 4500 A
3	Rated Short Circuit Current	63 KA/3sec
4	Insulating gas	N_2 and SF_6
5	Impulse withstand Voltage	1050-1675 KV
6	Capacitance	55nF/km
7	Resistance	10mΩ/km
8	Inductance	220nH/m
9	Electro Magnetic field strength	1μT
10	Weight per Phase	50kg/m
11	Outer Diameter	375-512 mm
12	Aging Factor	Upto 50 years
13	Radius	400mtrs

Table no 1. Specifications of GIL

8. PROPERTIES OF GIL

- The major properties include are of installations : Straight vertical distances of more than 200m , steeply inclined slopes, passing around building both above and below ground , angles are possible.
- Creates physical similarities to overhead line
- Smooth curves can be obtained with an average radius of 400m. Sharp curves are possible with elbows.
- Small pieces called SEAM are wielded together by orbital wielding. Wielding done is gas tight that prevents the leakage of gas.
- High power transmission is possible.

9. FEATURES

9.1 ADVANTAGES

- Enables high power transmission
- Low space requirement
- Minimal Electro Magnetic impact
- Superior Electromagnetic Compatibility
- Suitable for gas fired station
- Good heat dissipation
- Flexible Installation
- High safety parameters
- Free from Radiations
- No fire risk
- High reliability
- Losses are reduced
- As there is no virtual electrical or magnetic field there is no disturbance to telecommunication network or air traffic control system

9.2 DIS-ADVANTAGES

- Four times more costly than their free standing counter parts hence mainly used for high voltage
- The leakage of the insulating gas may result in the ad versified effects on the environment.
- Skilled laborers are required for the implementation of GIL.
- Excessive damage in case of internal fault
- Fault verification is difficult.
- SF_6 gas must be monitored in each compartment.
- Reduction in the pressure of the SF_6 gas in any module results in flashover or fault.
- SF_6 cause ozone depletion and global warming.

10. SUCCESS STORIES:

- New Paulaner Brewery to power network. Its transmission capacity is 420KV GIL system and its distance is 500m and its max apparent power is 2*2300MVA.
- China (3 Gorges corporation to xiluodu) vertical installations was done with a phase length of 12,750m and its transmission capacity was 7*4280MVA
- Frankfurt Airport (Germany) where the lines are laid directly having a phase length of 5400m and transmission capacity of 2*2000MVA
- Wehr, Hydro power project

- GIL in Thailand of 550KV bearing a current of 4000A was built in the year 2002.

11. CONCLUSION

Second-generation gas-insulated lines for high power transmission are the best option where environmental or structural considerations rule out the use of overhead transmission lines. The outstanding features of a GIL system are its high transmission capacity, superior electromagnetic compatibility (EMC) to any other transmission system, low losses, high safety (no fire hazard) and flexible installation options. GIL can be laid aboveground, installed in tunnels or buried directly in the soil, depending on individual requirements. GIL will undoubtedly prove as the backbone of the demanding transmission projects of the future – whether for the underground transmission of large power volumes for e.g.: connecting key power stations to transmission lines with maximum reliability. Compact, space-saving (underground) transmission in the mega-cities for the future, for a continually improving quality of life for mankind. The land can be utilized even after the installation of this well-equipped transmission line. GIL is not partly installed in India may be due to lagging knowledge of the subject or may be due to any other technical reasons that is not specified as such.

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