Substation Engineering

Gas Insulated Substations (GIS) & Hybrid GIS Substations (Part 4)

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- Gas Insulated Substations (GIS) & Hybrid GIS Substations
- Part 4 of 4: Hybrid GIS Configurations
- Course: Substation Engineering (DI04009011)

Agenda

- Introduction to Hybrid GIS (HGIS)
- Components of HGIS
- Comparison: AIS, GIS, and HGIS
- Space Optimization with HGIS
- HGIS Configurations (PASS and MTS)
- Reliability and Maintenance
- Case Studies and Applications
- Summary and Q&A

What is Hybrid GIS (HGIS)?

- A hybrid approach combining Air Insulated Substation (AIS) and Gas Insulated Substation (GIS) technologies.
- Utilizes SF6 or alternative gas-insulated switchgear for a compact footprint.
- Busbars are often air-insulated, while circuit breakers, disconnectors, and earth switches are gas-insulated.
- Provides a balance between the high cost of full GIS and the large footprint of full AIS.

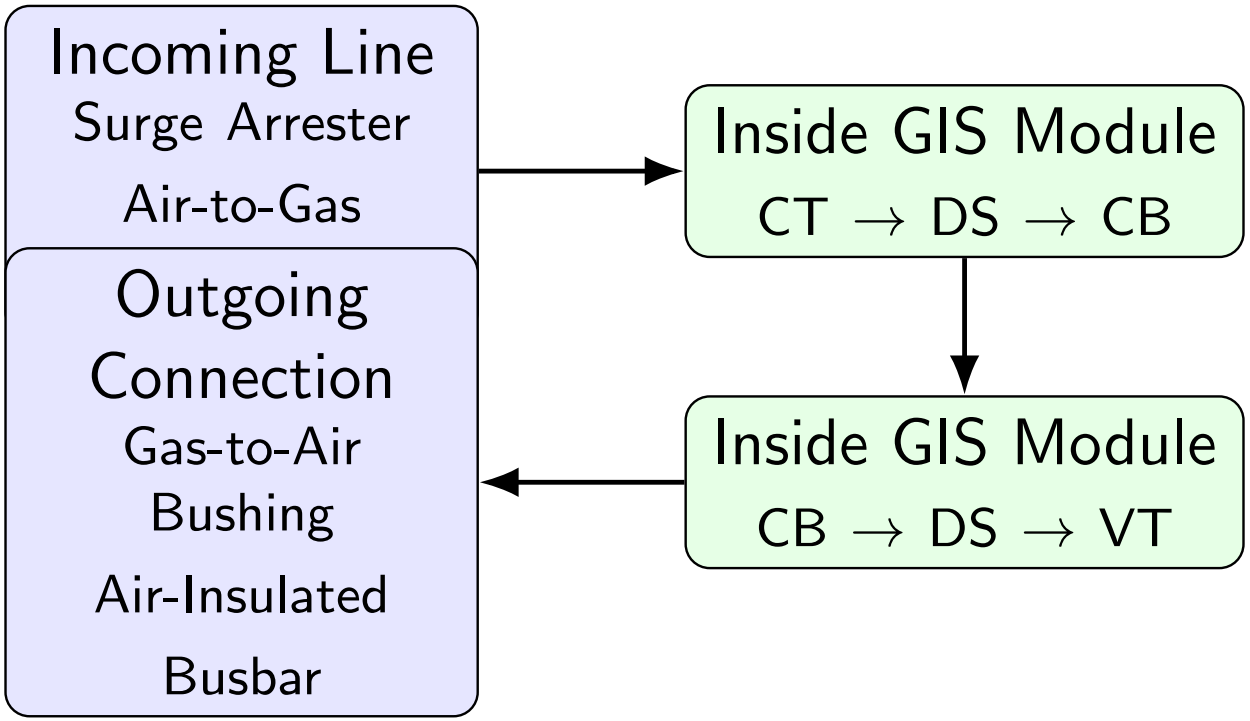
Why Choose Hybrid GIS?

- Cost-effective alternative to full GIS for substation upgrades.
- Reduces space requirements by up to 50% compared to conventional AIS.
- Higher reliability and lower maintenance than standard AIS.
- Faster installation and commissioning due to modular design.
- Suitable for heavily polluted or seismically active areas.

Key Components of HGIS

- Gas-Insulated Switchgear Module: Houses the circuit breaker, disconnector, and earthing switch.
- Air-Insulated Busbars: Connect the GIS modules to the rest of the network.
- Outdoor Bushings: Interface between the gas-insulated components and the air-insulated busbars.
- Current and Voltage Transformers: Often integrated into the gas-insulated module to save space.
- Local Control Cabinet (LCC): Provides control, monitoring, and interlocking functions.

HGIS Module Architecture



Comparison: AIS vs GIS vs HGIS

Feature	**AIS**	**HGIS**	**GIS**
Footprint	Large (100%)	Medium (50%)	Small (10-20%)
Capital Cost	Low	Medium	High
Maintenance	High	Low	Very Low
Environmental Vulnerability	High	Medium	Low
Installation Time	Long	Medium	Short

Space Optimization Strategies

- Brownfield Extensions: Adding bays to an existing AIS without acquiring new land.
- Urban Substations: Fitting higher capacity into limited city plots.
- Integration of multiple functions (CB, DS, ES, CT) into a single compact module.
- Flexible busbar routing to avoid existing obstacles in upgraded substations.

HGIS Configurations: PASS

- PASS (Plug and Switch System) is a popular HGIS configuration.
- Pre-assembled and pre-tested at the factory.
- Reduces on-site installation time from weeks to days.
- Features a rotating bushing design for flexible connection to different busbar layouts.
- Available in various voltage levels up to 420 kV.

HGIS Configurations: MTS

- MTS (Mixed Technology Switchgear) is another common term for HGIS.
- Highly customizable based on the specific substation layout.
- Can be configured as a single busbar, double busbar, or breaker-and-a-half arrangement.
- Often utilizes standard GIS components for the enclosed sections to ensure reliability and spare parts availability.

Reliability and Maintenance of HGIS

- Reduced Maintenance: Critical moving parts are protected in SF6 gas, minimizing wear and corrosion.
- Extended Lifespan: Lower exposure to environmental factors extends the life of the switchgear.
- Condition Monitoring: HGIS modules are often equipped with sensors for SF6 density, partial discharge, and circuit breaker wear.
- Visual Inspection: Unlike full GIS, the air-insulated busbars allow for easy visual inspection of connections.

Environmental Considerations

- SF6 Usage: HGIS uses significantly less SF6 gas than full GIS.
- Leakage Rates: Modern HGIS modules have extremely low guaranteed leakage rates (under 0.1% per year).
- Visual Impact: Lower profile than AIS, making it easier to integrate into sensitive landscapes.
- Noise Reduction: Enclosed circuit breakers produce less noise during operation than open-air AIS breakers.

Case Study: Urban Substation Upgrade

- Scenario: 132 kV AIS substation in a growing city needed expansion from 4 to 6 bays.
- Challenge: No adjacent land available for expansion; high pollution levels.
- Solution: Replaced two existing AIS bays with HGIS modules, freeing up space for two additional bays.
- Result: 50% capacity increase achieved within the existing fence line; improved reliability against pollution.

Summary of Gas Insulated Technologies

- GIS provides ultimate compactness and reliability for severe space or environmental constraints.
- HGIS offers a balanced approach, ideal for brownfield expansions and cost-sensitive projects.
- Both technologies rely on the superior insulating properties of SF6 (or modern alternatives).
- Proper gas handling and condition monitoring are critical for the lifecycle of both GIS and HGIS.

Next Lecture Preview

- Introduction to High Voltage Direct Current (HVDC) Substations.
- Why HVDC? Advantages over HVAC for long-distance transmission.
- Basic components of an HVDC converter station.
- Types of HVDC links (monopolar, bipolar, back-to-back).