Phase Segregated Type

SF$_6$ Gas Insulated Switchgear

Type SDA524 for 245 kV
The number of application for SF₆ gas insulated switchgear has been tremendously growing all over the world, because it has many advantageous features as below:

- Small space requirement
- High reliability
- Safety
- Good harmony with environment
- Long maintenance interval
- Short erection period at site

Fuji started the development of SF₆ gas insulated switchgear (GIS) in the 1960’s. The first 72.5 kV GIS, which was of the phase segregated type, was put into operation in 1970. Since then Fuji has also developed three phase encapsulated type GIS in addition to phase segregated one as our standard series of GIS. Based on these experiences with high and long term technology, Fuji has successfully developed as a standard series of phase segregated type GIS which realizes a quite compact and very reliable construction. The 72.5 kV and above GIS is being manufactured in our substation equipment factory located in Chiba prefecture, Japan. The substation equipment factory has been recognized to be in accordance with the requirements of the quality standards ISO 9001.

SDA524 245 kV 4,000 A 40 kA

Small overall dimensions make for minimum space requirements. Therefore, the costs of foundations and buildings can be minimized.

Phase isolated and individually encased in earthed metal housing construction realizes no possibility of phase-to-phase short-circuit fault completely.

The modular design principle applied realized the standardization of components and parts. This makes possible the large quantity production way which increases the reliability of components and parts with their easy stock control.

Unified SF₆ gas pressure throughout the switchgear makes simplified gas maintenance work.

**Small Space Requirement, High Reliability and Safety — 245 kV GIS, SDA524**

**Technical data**

<table>
<thead>
<tr>
<th>Parameter</th>
<th>Specification</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rated voltage</td>
<td>245 [kV]</td>
</tr>
<tr>
<td>Rated power frequency withstand voltage [kV]</td>
<td>Phase-to-earth 395/460</td>
</tr>
<tr>
<td></td>
<td>Across open switching device 395/460</td>
</tr>
<tr>
<td></td>
<td>Across isolating distance 460/530</td>
</tr>
<tr>
<td>Rated lightning impulse withstand voltage [kV]</td>
<td>Phase-to-earth 950/1050</td>
</tr>
<tr>
<td></td>
<td>Across open switching device 950/1050</td>
</tr>
<tr>
<td></td>
<td>Across isolating distance 1050/1200</td>
</tr>
<tr>
<td>Rated normal current [A]</td>
<td>Busbar 2000, 3150/4000</td>
</tr>
<tr>
<td></td>
<td>Others 1250/1600/2000, 3150/4000</td>
</tr>
<tr>
<td>Rated short-circuit breaking current of circuit breaker [kA]</td>
<td>31.5/40</td>
</tr>
<tr>
<td>Rated short-time withstand current (3 s) [kA]</td>
<td>31.5/40</td>
</tr>
<tr>
<td>Rated peak withstand current [kA]</td>
<td>80/100(50 Hz), 82/104(60 Hz)</td>
</tr>
<tr>
<td>Rated SF₆ gas pressure, gauge at 20 °C [MPa]</td>
<td>Switchgear 0.6</td>
</tr>
<tr>
<td></td>
<td>Circuit breaker 0.6</td>
</tr>
<tr>
<td>Rated break time of circuit breaker [cycles]</td>
<td>3</td>
</tr>
<tr>
<td>Rated operating sequence of circuit breaker</td>
<td>O-0.3 s-CO-3 min.-CO, 0-3 min.-CO-3 min.-CO, CO-15 s-CO</td>
</tr>
</tbody>
</table>

Applicable standards: IEC
Circuit breaker

Thousands of Fuji SF₆ gas circuit breakers with hydraulic operating mechanism were delivered into all over the world and have been in satisfactory operation since 1973. The SF₆ switchgear is equipped with the single pressure puffer type gas circuit breaker with hydraulic operating mechanism which is used uniformly also for outdoor circuit breakers. Fuji SF₆ gas circuit breaker has the advantages:

- Low noise level during operation
- Excellent interruption performance
- Long maintenance intervals
- Individual energy supply, no air-compressor necessary

The earthed metal housing accommodates single pole interrupter fixed on insulating mount and support insulator for each phase. At the front of the circuit breaker, three pole common operating box is arranged, which accommodates hydraulic operating mechanisms and monitoring unit for the circuit breaker suitable for individual single pole operation. The moving section is composed of nozzle, moving contact and puffer cylinder connected to hydraulic operating mechanism through insulating rod mechanically.

The current path is composed of fixed contact, moving contact and moving contact support. Arc energy is used effectively to make compact interrupter. At the initial stage of opening, the movement of the puffer cylinder compresses SF₆ gas in the puffer cylinder. In addition, pressure of the SF₆ gas is increased further due to arc heat while the arc current is large. Then the compressed gas flows in order to distinguish effectively the arc generated at arc contacts. In case of the arc current is small, the compressed SF₆ gas, which is produced by the movement of the puffer cylinder, flows to distinguish the arc. Removing the access cover makes it possible to carry out the inspection and replacement of nozzle and arcing contacts.
Oil-hydraulic operating mechanism has almost free from rust and corrosion unlike other operating mechanisms such as motor-spring or pneumatic systems. Oil pump, oil tank, main valve unit, pressure switches and gauges are incorporated as one block unit and connected directly to main cylinder.

Therefore, a compact, very reliable and pipeless hydraulic operating mechanism is realized. The valve seal of oil system is made of metal seat and metal ball, which eliminate damage of valve seat due to eccentricity and are good for permanent use without necessity of replacement.
**Busbar**

The single-phase conductor made of aluminium or copper, depending on the current rating, is supported by the gas tight insulators.

**Disconnectors and earthing switches**

Line disconnector is incorporated together with earthing switches in one housing as a combined disconnector/earthing switch. Bus disconnector is assembled in each bus enclosure. Disconnectors and earthing switches are normally motor or manual-operated. The disconnectors have a switching capability of bus-transfer current, small capacitive current as bus charging and small inductive current as transformer magnetizing current, if required. The make-proof earthing switch is provided with the motor-charged spring operation mechanism. Maintenance earthing switches on the both sides of the circuit breaker are linked together by an operating rod and operated by the common operating mechanism. Earthead side of the earthing switch is brought out from the earthead meal housing and earthead to it through a removable bolted link for primary injection test.

**Current transformer**

The current transformer is of foil-insulated bushing type with ring core mounted in CT housing. The cable through type current transformer is also used for cable feeder unit, if necessary.

**Voltage transformer**

The voltage transformer is of induction type. SF₆ gas provides the high-voltage insulation. The high-voltage winding discs are well insulated by plastic foils.

**Surge arrester**

The surge arrester consists of zinc oxide(ZnO) element with excellent low residual voltage characteristics and long service life.

**SF₆ gas system**

Rated SF₆ gas pressure is unified at 0.6 MPa, gauge for all compartments. SF₆ gas pressure changes depending on the ambient temperature as shown in Fig. 9 pressure-temperature characteristic curve. The monitoring of SF₆ gas is carried out by means of temperature compensated pressure switches in the manner as tabled below.

<table>
<thead>
<tr>
<th>Components</th>
<th>Rated SF₆ gas pressure [MPa]</th>
<th>Low alarm pressure [MPa]</th>
<th>Operation lockout pressure [MPa]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Circuit breakers</td>
<td>0.6</td>
<td>0.55</td>
<td>0.5</td>
</tr>
<tr>
<td>Disconnectors and earthing switches</td>
<td>0.6</td>
<td>0.55</td>
<td>Note 1</td>
</tr>
<tr>
<td>Other components</td>
<td>0.6</td>
<td>0.55</td>
<td></td>
</tr>
</tbody>
</table>

Note 1: Operation lockout at 0.5 MPa(at 20 °C) is upon request.

The SF₆ gas filled disconnector/bus chamber is sealed off from the adjacent unit by gas tight and arc-proof insulators. A similar insulator seals off this chamber from the circuit breaker. All gas zones are monitored by gas density relays. Three phase chambers are monitored in common. The switchgear has a very low gas leakage rate. Guaranteed gas loss is less than 0.5 % per annum.

The SF₆ gas system is designed to provide a safe and reliable power distribution system with high voltage ratings.

**Fig. 6** Line disconnector and earthing switch

**Fig. 7** Current transformer

**Fig. 8** Voltage transformer

**Fig. 9** Pressure-temperature characteristic curve of SF₆ gas

**Fig. 10** SF₆ gas system
Typical Arrangement

Fig. 11 Transformer feeder bay

Fig. 12 Bus coupler bay

Fig. 13 Overhead line feeder bay

Fig. 14 Cable feeder bay

Min. 8000

Min. 7000

Unit: mm

5430

3870

6110

4050

3900
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