High Voltage Switchgear Quench Gas

Background

Moisture in Sulphur hexafluoride (SF_6) arc quenching gas can cause rapid and severe deterioration of high-voltage switchgear.

During electrical power distribution at transmission voltages (ranging typically from 100 to 400 kV), power switching or load current interruption is a major problem as a result of arcing between the two contact points. The insulation properties of SF_6, used to pressurise such switchgear enclosures, effectively control arc formation. However, the ingress of moisture over time results in electrical discharge, causing the SF_6 to decompose into by-products, such as hydrolysable fluorides.

These fluorides are good dielectrics, so that pulverulent metal fluorides on insulating surfaces do not impair the operational efficiency of the respective equipment. This only applies when the moisture content of the gas or its enclosure is low. In the presence of water vapour, the by products include the highly corrosive HF, which accelerates switch contact corrosion to the point of physical breakdown. The pervasive nature of HF means that the damage may spread to the surrounding areas of the switchgear enclosure and thus further the extent of damage caused as a result. It is clear that the presence of moisture in the gas must be maintained to a minimum to avoid the formation of this acid.

It is also important to maintain low moisture level, to prevent formation of condensation with the potential for leakage current across the surface of insulating parts.

Measurement Technique

Moisture measurements are important at the following stages:

- Checking the moisture content of new SF_6 in cylinders by industrial gas producers prior to supply and immediately prior to use by the switchgear manufacturer or transmission company - SF_6 cylinders appear to be particularly susceptible to moisture ingress in storage - SF_6 in good condition should have a moisture content of <10 ppm_V equivalent to dew point <-60 °C dew point (at atmospheric pressure).
- Dry gas purging of new switchgear enclosures during the final stage of manufacturer or following internal maintenance works prior to pressuring and sealing with SF_6. Most commonly, high purity nitrogen or another inert gas from cylinders is used, by repeated pressurisation and venting to atmosphere, until the moisture content within the enclosure have been reduced to <10ppm_V equivalent to dew point <-60 °C dew point (at atmospheric).
- In service field checks/continuous monitoring to ensure that moisture content in the SF_6 is maintained below the critical level of 100 ppm_V, -42 °C dew point (at atmospheric).

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For cylinder gas checking and drying of switchgear enclosures prior to filling, use the Cermax Portable Dewpointmeter. This portable, wide range instrument provides rapid determination of moisture content displaying in a variety of engineering units, including ppm_W for SF_6 and can store up to 10,000 measurement points with its built-in data logging facility which is accessed via the drop-down menu on the front panel. The drop-down menu can also be used to select a secondary input (external temperature or pressure transducer). Stored data is easily downloaded to a host device (such as a PC) by using Windows Terminal or a similar data transfer program.

The above instrument can also be used to quickly spot check the SF_6 from switchgear enclosures in service using drawn off samples (see details of sampling arrangements which incorporate an in-line instrumentation filter to remove any sample borne particles resulting from the corrosive effects of hydrofluoric acid, and thus

prevent sensor contamination) - the sample can be recycled or vented to atmosphere - rapid readings minimise the amount of sample gas required.

Permanent installation is being increasingly considered. For continuous on line moisture measurement, use the Cermet II Dewpoint Hygrometer - which requires mains power - or Transmet Dewpoint Transmitter which, operating from a 24 V dc source, provides either 4-20 mA or RS232/RS485 signals and is therefore suited to multiple measurement point installations, feeding into a central plant control computer system. In both cases, the sensors should be installed in the upper parts of the switchgear enclosure avoiding particulate contamination build up which is limited by a sintered stainless steel sensor guard fitted as standard.

Certain users prefer the added reliability and accuracy afforded by the use of a fundamental cooled mirror dew-point meter. The S4000 Integrale offers a measurement range to -60 °C dew point with multiple engineering units, including ppm_W for SF_6. Measurement accuracy is ±0.1°C dew point and with a response speed of around 10 minutes at -40 °C dew point, the user can obtain maximum confidence with minimum sampling losses.

Reference Users

ABB, Alstom Transmission Switchgear Limited, National Grid plc, Powergen, Siemens

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