

Moisture measurement to ensure safety of hydrogen coolant in electricity generators

Application background

Within the power generation industry, it is common practice to use hydrogen as a direct coolant for the generator stator windings. Hydrogen is used because it has an extremely high heat transfer capacity - it is much more efficient at transferring heat than any other medium.

The re-circulating hydrogen removes heat from the generator, transferring it, via a heat exchanger, into a secondary cooling circuit which uses de-mineralized water. Often this de-mineralized water is then cooled either by sea water or river water, dependent upon the location of the power station.



As it is not possible to hermetically seal the generator set casings there is the potential for moisture to ingress from the surrounding air. Similarly, as the heat exchanger gradually becomes more porous with age, it too will allow moisture to get into the hydrogen. So it is important that the circulation loop for hydrogen gas on such an installation should include a desiccant dryer, to continuously remove absorbed moisture. The greatest fear, should moisture be allowed to build up in the hydrogen, is that condensation will occur on exposed live metal parts - leading to the risk of flashover. On generator sets which typically produce 22 kV at 19 kA, this could be disastrous. It is therefore recognised practice within the industry that the dew point of the hydrogen gas leaving the generator set should be maintained at a safe margin below the minimum casing temperature, typically an upper limit of 0 °C dew point at system pressure is observed. Should the hydrogen dew point rise above this upper limit, it is important for immediate action to be taken - either to decommission the generator to effect a repair or more likely to take immediate remedial action by pumping fresh, dry hydrogen into the system.

Measurement technique

Sampling can either be as a continuous on-line measurement from the outlet for the generator frame and the outlet from the H₂ adsorption dryer, or as a spot check.

Michell Instruments offers two suitable measurement technologies for continual sampling in this application:

- Quartz Crystal Microbalance, which measure the frequency change in a hygroscopic-coated quartz crystal as it adsorbs and desorbs moisture.
- Ceramic Impedance Sensor, which measures the partial pressure of water vapor as a change in the dielectric constant of a capacitor.



The QMA401 uses a Quartz Crystal Microbalance moisture measurement technique which is accurate, reliable and very fast to respond. The system incorporates an internal calibrated moisture source, which is used to perform calibration verification and adjustment of the analyzer automatically. The analyzer is equipped with a modern touch-screen UI, which is configurable for the displayed parameters and outputs the customer requires. On-board datalogging, plus USB and Ethernet communications are provided as standard. The instrument is supplied with a traceable calibration certificate.

For lower budgets, the Easidew Online can make this measurement when installed in a sampling system. An in-line instrumentation filter with coalescing element should be incorporated to remove any lubricating oil mist or particulates present in the sample flow. Measurements should be made at full system pressure to accurately represent the risk of condensation occurring under generator set conditions.

If the desired point of installation is designated as a hazardous area, then the ATEX certified Easidew TX I.S. Transmitter and Easidew PRO I.S. can be used. A digital indicator, if required, should be installed remotely from the generator set at a designated safe location, with galvanic isolators installed in the sensor cable assembly. The optional monitor provides full function display and analogue output facilities with two customer configurable alarms which can be set to provide 'warning' and 'immediate shut down' status conditions. Both transmitters provide a 4-20 mA output signal covering the range -100 to +20 °C dp which can be sent to a SCADA.

Michell's intrinsically safe portable dew-point hygrometer, MDM300 I.S., can be used as a spot check tool. Fast response and a wide range of available sampling kits enable the user to make a quick gas analysis.

Within any power station the portable MDM300 I.S. has the added bonus of being able to be used to measure moisture in SF₆, natural gas and instrument air.


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