Online Dissolved Gas Analysis with Megger InsuLogix® G2

Figure 1: InsuLogix® G2

Accurately measuring low levels of acetylene dissolved in insulating fluid (oil) in the presence of 'interfering gases' is vital for promptly identifying critical arcing faults in power transformers. Online dissolved gas analysis (DGA) monitors with this ability have historically been too costly to allow large-scale, fleet-wide deployment. This application note describes a new solution – the Megger InsuLogix® G2 – which provides accurate measurement of acetylene in oil, in addition to measuring hydrogen as an early fault indicator, at a price point that justifies its deployment on medium and large power transformers.

Background

Monitoring fault gases in transformers has a long history, dating back to the introduction of the Buchholz relay in 1921, which essentially responds to an increase in pressure as the fault gases are produced. A significant step forward was the introduction of online DGA in the 1970s, initially for assessing the level of moisture in the oil. While moisture is not a fault gas, its increased presence is likely to negatively impact the life of the transformer. Soon after, DGA technology was extended to allow the level of hydrogen (H2) in the oil to be monitored. This was a major step forward as active fault conditions could now be detected in near-real-time at their incipient stage by measuring the concentration of a specific combustible gas.

Megger limited
Archcliffe Rd, Dover
Kent, CT17 9EN United Kingdom

T +44 (0)1304 502 100.
F +44 (0)1304 207 342.
E uksales@megger.com,
www.megger.com

Registered No. 190137 -
Registered to ISO:9001:2008
Certificate No. Q 09250

In the late 1970s, online measurement of gases in oil using ‘fuel cell’ technology was introduced. With four combustible gasses detected in various percentages of their true concentrations, the technology remains popular today. It provides coarse detection of incipient faults, but it cannot discriminate between critical arcing faults and low energy faults. Also popular for the past two decades has been hydrogen with moisture sensors. These can be used to implement a relatively simple, low-cost warning/alarm solution that provides a first level response to incipient faults, with hydrogen as a key indicator for partial discharge or corona.

These approaches to online DGA are undoubtedly useful, but they share a major shortcoming: they lack the ability to detect critical high energy (arcing) faults reliably, accurately and clearly.

Through separate measurements and complete detection of hydrogen and acetylene true concentrations, the InsuLogix G2 is an excellent alternative to fuel cell technology. The InsuLogix G2 also represents the ideal solution for those transformers' operators using hydrogen-only sensors and looking to improve the gas monitoring strategy to be able to clearly identify arcing faults.

Acetylene as a fault indicator

Megger’s new InsuLogix® G2 provides a cost-effective and dependable solution to the challenge of detecting arcing faults unambiguously and in real time. It achieves this primarily by monitoring acetylene levels in the oil, the importance of which can be seen by considering the information presented in Figure 2, which is taken from IEEE C57-104 2019.

Megger limited
Archcliffe Rd, Dover
Kent, CT17 9EN United Kingdom

T +44 (0)1304 502 100.
F +44 (0)1304 207 342.
E uksales@megger.com,
www.megger.com

Registered No. 190137 -
Registered to ISO:9001:2008
Certificate No. Q 09250

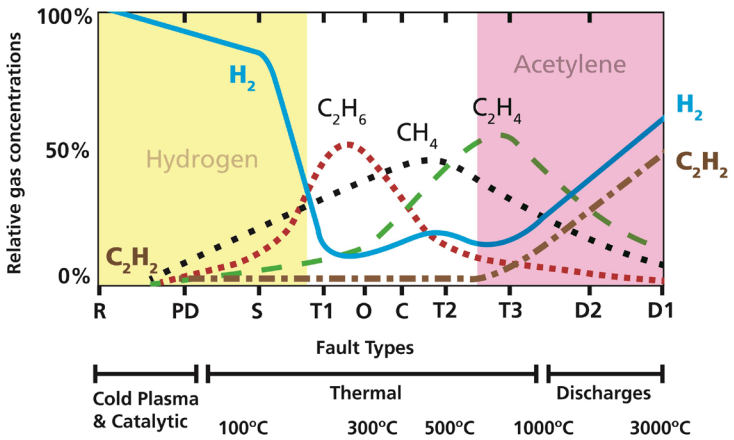

Figure 2: Relative dissolved gas concentrations in mineral oil versus fault types

As this diagram shows, hydrogen and acetylene (C_2H_2) are the two key gases that need to be monitored to provide a high level of protection for a transformer. As the fault begins to develop, hydrogen is typically the most prevalent gas generated. However, acetylene gas development levels of greater than 2 ppm and increasing, indicate a critical arcing fault that would be easily missed if only hydrogen were monitored.

By combining two strategies – incipient fault detection based on hydrogen measurements and critical fault detection based on acetylene measurements – the InsuLogix® G2 helps to prevent serious faults from being prolonged. The hydrogen and acetylene combination provided by InsuLogix G2 has been the missing link between hydrogen monitors and multi-gas monitors (>7 gases).

In-between are intermediate monitors (3 to 5 gasses) which either do not provide enough information or are expensive to purchase and to maintain. This has limited the “smart grid” approach, where all critical transformers in a grid can be monitored in real time with central software.

InsuLogix® G2: Operating principle

The Megger InsuLogix® G2 uses a tuneable laser diode spectroscope (TLDS) gas sensor. This passes a laser beam through the gas and measures the amount of light absorbed. Different gases absorb light in different parts of the spectrum, so by analysing the absorption, it is possible to make measurements relating to one specific gas while ignoring other ‘interfering gases’ that may be present. In the InsuLogix® G2, the laser system is selectively tuned to the spectrum of acetylene.

Interfering gases and compounds in transformer oil include, but are not limited to, hydrogen, water, ethane, methane, ethylene, carbon monoxide, carbon dioxide and heavy compounds such as alcohols, ketones and aldehydes. When it is necessary to measure small concentrations of a target gas such as acetylene, the interfering gases and compounds contribute significantly to measurement errors when conventional technologies are used.

With its inherent selectivity, the TDLS system used in the InsuLogix® G2 provides an effective solution to this problem at an economical price. The instrument gives accurate readings of hydrogen and moisture and has a lower detection limit (LDL) of 0.5 ppm for acetylene, providing information that makes it possible for users to react quickly and confidently to both incipient and critical faults in power transformers. In line with best practices for all online monitoring programs, however, it is recommended that the InsuLogix® G2 should be used to complement rather than replace off-line testing within a laboratory.

InsuLogix® G2: Key features

The InsuLogix® G2 is a compact, robust instrument with an IP66 ingress protection rating, allowing it to be installed in almost any location without the need for additional protection. It features a single valve design, reducing installation time and allowing it to be easily transferred between transformers. It has no consumable components and requires no routine maintenance.

The instrument's integral display provides easy local access to acetylene, hydrogen, moisture and temperature measurements, while the web-based user interface allows secure remote access not only to current data but also historical measurements and trends. Results can be presented in the form of a convenient dashboard display, as in the example shown in Figure 3. The unit also has 12 customisable solid-state relay outputs that can be configured, for example, to provide warnings and alarms at preset measurement levels.

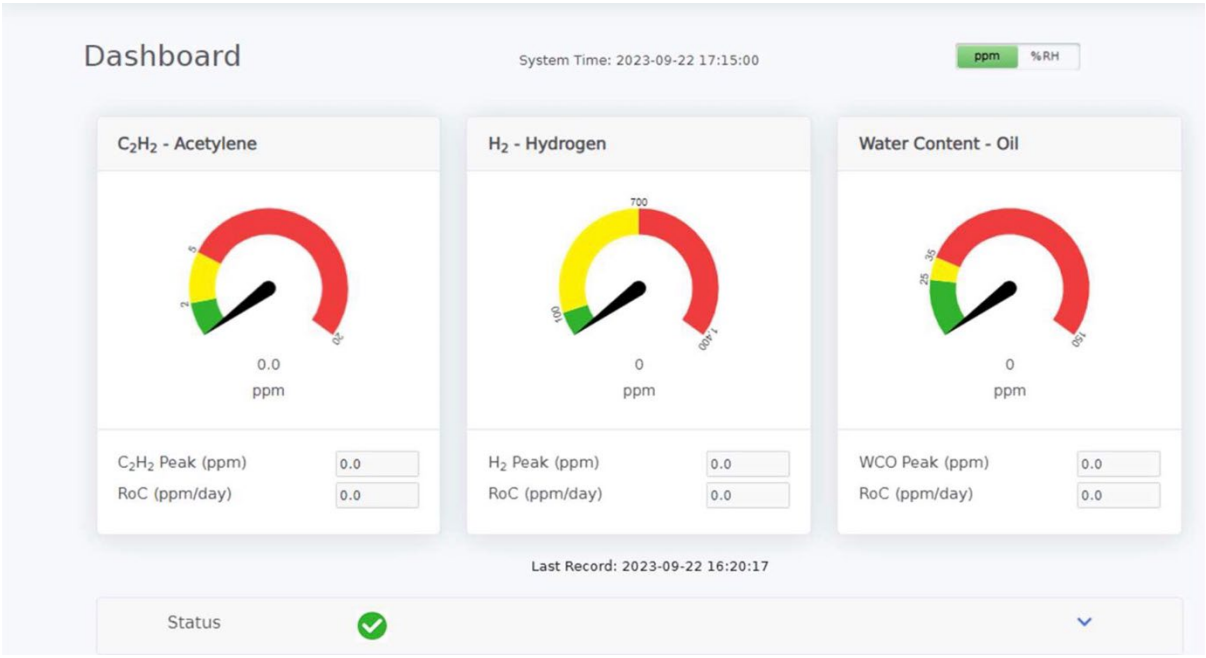

Figure 3: Example of a dashboard display for InsuLogix® G2

Megger limited
Archcliffe Rd, Dover
Kent, CT17 9EN United Kingdom

T +44 (0)1304 502 100.
F +44 (0)1304 207 342.
E uksales@megger.com,
www.megger.com

Registered No. 190137 -
Registered to ISO:9001:2008
Certificate No. Q 09250