Application note: N°F069

March 2016

Trace moisture measurement in SF_6

Vocabulary:

Dielectric medium: A dielectric medium is a substance that is a poor conductor of electricity. If the voltage across a dielectric medium becomes too great, the medium will begin to conduct current.

Arc: During the opening of current carrying contacts in a circuit breaker, the medium in between opening contacts become highly ionized through which the interrupting current gets a low resistive path and continues to flow through this path even if the contacts are physically separated. During the flow of current from one contact to another, the path becomes so heated that it glows: this is called an arc.

A circuit breaker is an automatically operated electrical switch designed to protect an electrical circuit from damage caused by an overcurrent, an overload or a short circuit. According to their arc quenching media the following dielectric mediums are used: air, oil, vacuum and SF6.

SF_6 gas

SF_6 gas, Sulfur Hexafluoride, has excellent insulation properties. SF_6 also has high electronegativity, meaning that it can absorb free electrons. When a free electron collides with the SF_6 gas molecule, it is then absorbed and forms a negative ion.

Negative ions are much heavier than free electrons and therefore the overall mobility of the charged particles in the SF_6 gas is low.

The mobility of charged particles is majorly responsible for conducting current through a gas.

SF_6 is used as a gaseous dielectric medium in the electrical industry due to these properties (for example for high voltage circuit breakers and switchgear).

The oldest type of circuit breaker is the oil circuit breaker. When an arc is drawn under oil the arc vaporizes the oil and creates a large bubble of hydrogen that surrounds the arc. The oil surrounding the bubble conducts the heat away from the arc and thus also contributes to the deionization and extinction of the arc.

The major disadvantage of the oil circuit breaker is the the flammability of the oil and the maintenance (changing and purifying the oil).

On top of the points already mentioned, the major advantages of SF_6 gas is that is an excellent arc extinguishing medium, it has superior arc quenching capabilities and it can regenerate after an arcing.

SF_6 gas is a green house gas. It is necessary to mitigate and control the emissions of the decomposition products from SF_6 destruction processes because most of them (S_2F_{10}, SF_4 and HF) are highly reactive, corrosive and toxic, and a few of them are also potent Green house gases.

Discussed in this edition:

Why the need to measure trace moisture?

In order to ensure the insulation properties of SF_6 gas, it is critical to measure the trace moisture within the SF_6 gas.

Under the spark condition, the final toxic products of SF_6 decomposition in the presence of water vapor are hydrogen fluoride (HF) and sulfur dioxide (SO_2) or sulfuric acid (H_2SO_4).

As seen from the formula below, it is cruciual to keep the number of water particles (relative humidity) within the gas extremly low.

Although the SF_6 gas injected is dry and done sealed under high pressure, due to the big difference between the air chamber inside and outside with the water vapor partial pressure, water molecules still have a strong invasive ability.

Especially after running for a long time, the gas relative humidity of high-voltage electrical equipment should be checked.

$$SF_6 \quad [spark] \rightarrow SF_4 + 2F \quad [H_2O] \rightarrow SOF_2 + 2HF \quad [H_2O] \rightarrow SO_2 + 2HF \quad 2[H_2O] \rightarrow H_2SO_4 + 4HF$$

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rotronic MEASUREMENT SOLUTIONS

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What solution can Rotronic offer?

The heart of the latest humidity measurement products are the Rotronic capacitive humidity sensor, HygroMer IN-1, respectively the low dew point sensor HygroMer LDP-1. Both sensors, with the best long term stability on the market are ideal for the monitoring trace moisture in SF_6 gas.

All products with this logo contain an AirChip3000.

AirChip3000 advantages:

- *Relative humidity, temperature and dew point outputs*
- *Can store 2'000 points*
- *Sensor self-test function*

HF 5 Wall mount transmitter

Rotronic products:

Probes:

- ***HC2-LDP102-M***
  -40...85°C,
  -70...85°Cd
  Ø15mm,
  ±0.2°Cd (-50...20°Cd) and
  ±0.2K…
- ***HC2-LDP102-EX***
  ATEX II 1/2 G Ex ia IIC T5 Ga/Gb
  ATEX II 1/2 D Ex ia IIIC T80°C Da/Db IP66

Transmitters:

- ***HF5 series***
  For interchangeable probes,
  2 or 3/4 wire configuration,
  Various analogue and digital outputs,
  All psychrometic calculations available…
- ***HF520-EX***
  ATEX II 2(1) G Ex eb mb [ia Ga] IIC T5 Gb
  ATEX II 2(1) D Ex tb [ia Ga] IIIC T80°C Db

Handheld:

- ***HP23-A***
  For interchangeable probes,
  2 probes,
  All psychrometic calculations available…

Measurement/flow cell:

- ***LDP-FCSB1***
  Flow: 0.8l/min
- ***LDP-MCS***

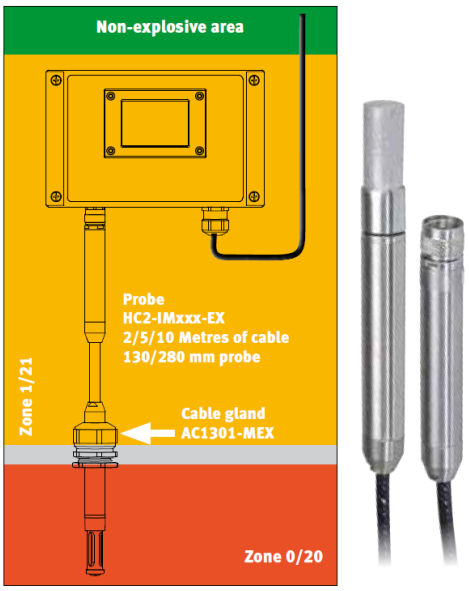
Low Dew Point Probe

Customer benefits:

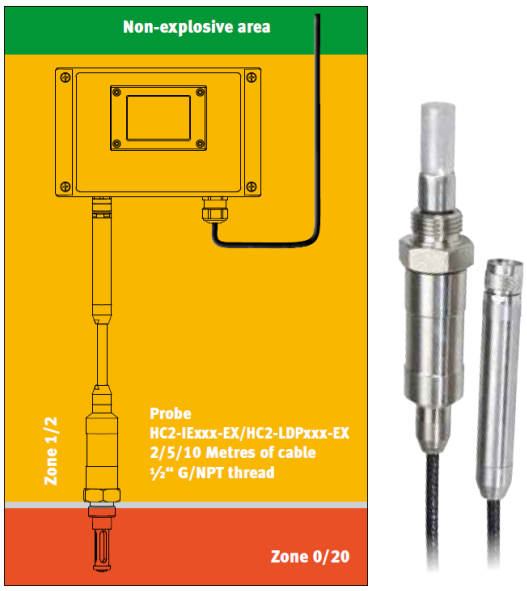
Calibration:

The HC2-LDP102-M probe, together with HW4 offers all users the possibility to calibrate and adjust the device should drift occur. If the user has no capacity to adjust the probe in house, then the probe can be sent off to a local laboratory instead of having to send the probe back to the factory, which will reduce down time of the probe.

Cable probe for flexible installation



Screw-in cable probe for pressure pipe or low dew point



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