VAISALA / APPLICATION NOTE

Measuring Humidity and Dew Point in Environments with Chemical Contaminants

Vaisala HUMICAP® humidity and DRYCAP® dew point sensors both feature good chemical tolerance. However, sometimes the chemicals present in the measured gas can gradually change their performance. For these demanding applications Vaisala has developed chemical purge function, which helps to maintain measurement performance under chemical exposure.

This article

- Explains how chemicals affect sensor performance
- Describes the operational principle of chemical purge
- Advises when to use chemical purge
- Gives practical examples from demanding applications

Effect of Chemicals on HUMICAP® and DRYCAP® Sensors

HUMICAP and DRYCAP sensors are thin-film polymer sensors consisting of a substrate on which a thin polymer film is deposited between two electrodes. The polymer film absorbs or releases water vapor according to humidity changes in the environment. As humidity changes, the dielectric properties of the polymer film change, and so does the capacitance of the sensor. Capacitance is then converted into a humidity reading.

Some small molecules, typically hydrocarbons, slowly penetrate into the sensor polymer. The time scale for the phenomenon is long and changes in the sensor performance are typically observed during a longer time period.

Absorbed chemicals lower the capability of the polymer to absorb water molecules and thus reduce the sensitivity of the sensor. The change in the measurement performance is usually interpreted as drift as sensor gain decreases. The changes can be verified by measuring the response of the sensor in constant known humidities. Figure 1 shows sensor drift due to chemical exposure, measured in 0% and 75%RH.

Chemical Purge - How It Works

The sensor is rapidly heated to 160-180°C during chemical purge by forcing a current through the temperature element of the sensor.

Heating results in rapid evaporization of the chemical contaminants that have been absorbed into the polymer. Chemical purge thus cleans the sensor internally, improving its stability and accuracy, see Figure 2.

Chemical purge cycle lasts about 6 minutes and includes a heating and a settling stage. When sensor temperature has been re-stabilized to the condition prior to the purge, the sensor continues in its normal measurement mode. The output value of the transmitter is locked during chemical purge.

Figure 3 shows an example of the chemical purge cycle in conditions where the sensor is under chemical exposure of ethyl acetate (concentration 700 ppm). Two purge intervals (720 and 120 min) are applied. The deteriorating sensor performance is restored by chemical purge. In this case the shorter purge interval (120 min) better maintains the measurement performance.

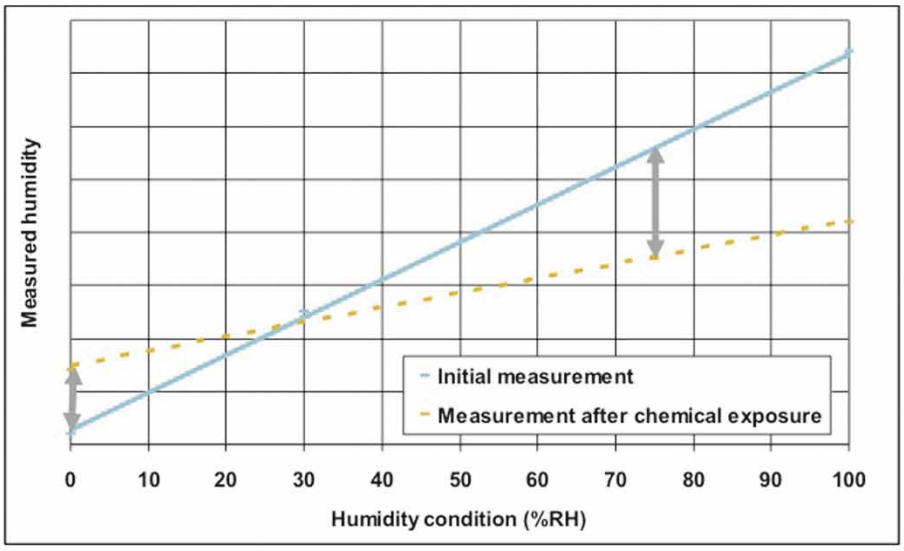

Figure 1. Sensor performance is influenced by absorbed chemicals.

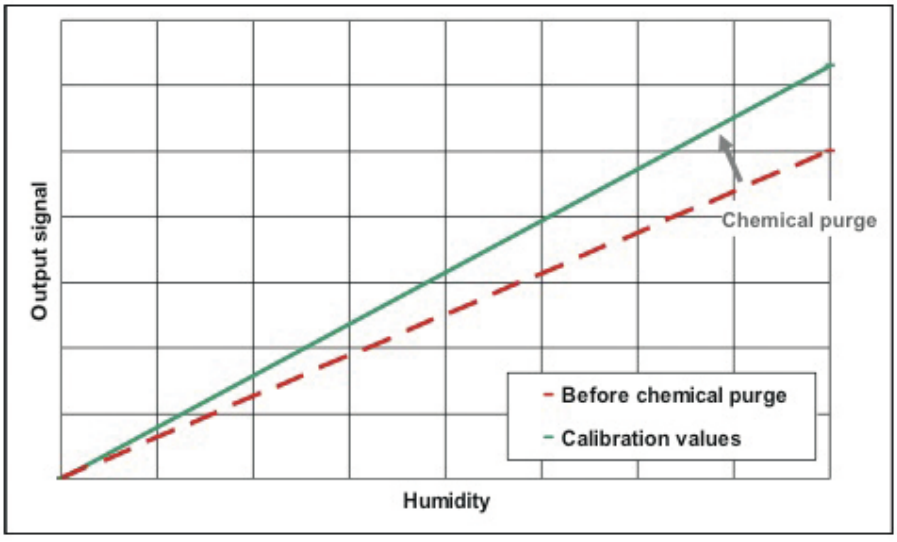

Figure 2. Sensor performance is restored by chemical purge.

When to Use Chemical Purge?

Chemical purge helps to correct possible long term drift and extends the required calibration interval in environments where gaseous chemical impurities are present. Hydrocarbon based solvents, cleaning chemicals and sterilizing agents are all chemicals with a tendency to penetrate into the sensor. They all can be driven out using chemical purge.

For chemical purge to work as planned, the temperature of the sensor needs to be below +100°C. When temperature is above this limit, chemical impurities evaporate spontaneously and chemical purge is not necessary.

Chemical purge should always be performed before calibration or whenever there is a reason to believe that the sensor has been exposed to an interfering chemical.

When installing a DRYCAP dew point sensor into a dry process and during a start-up, chemical purge can be used to drive out excess water molecules from the sensor. This allows the sensor to reach equilibrium much faster and the response time of the sensor is notably reduced. This is especially beneficial when taking spot measurements with Vaisala DRYCAP® Hand-Held Dewpoint Meter DM70.

Chemical purge doesn't work with corrosive or aggressive chemicals (acids, ozone, ethylene oxide etc.). In addition, when the penetrating molecules are very small (e.g. methanol or acetic acid), the penetration into the sensor is so rapid that chemical purge doesn't help to keep the sensor clean.

Examples of Demanding Applications That Benefit from Chemical Purge

Wood Drying

Wood drying is a demanding application where the sensor is exposed to a variety of chemical compounds that evaporate from wood during the drying process.

Volatile compounds include alcohols, ketones, aldehydes, esters, terpenes, organic acids, phenols, aliphatic and aromatic hydrocarbons and more, amount and exact composition varying according to wood species. The temperature in wood drying is typically around 85°C and the humidity level in the initial stage is close to 100%RH.

Figure 4 shows sensor performance data from a test in a wood dryer. The measurement data extends over a three-year test period. It can be seen that the sensors featuring chemical purge keep performing extremely well over the whole time period, whereas the sensors without chemical purge suffer from drift.

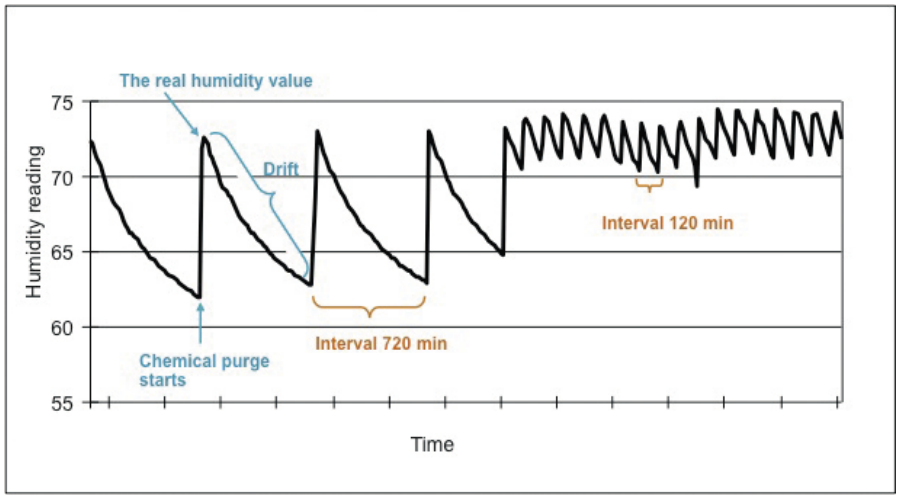

Figure 3. Chemical purge cleans the sensor and restores the humidity reading to its real value. Conditions: Ethyl acetate exposure (700 ppm), purge intervals 720 and 120 min.

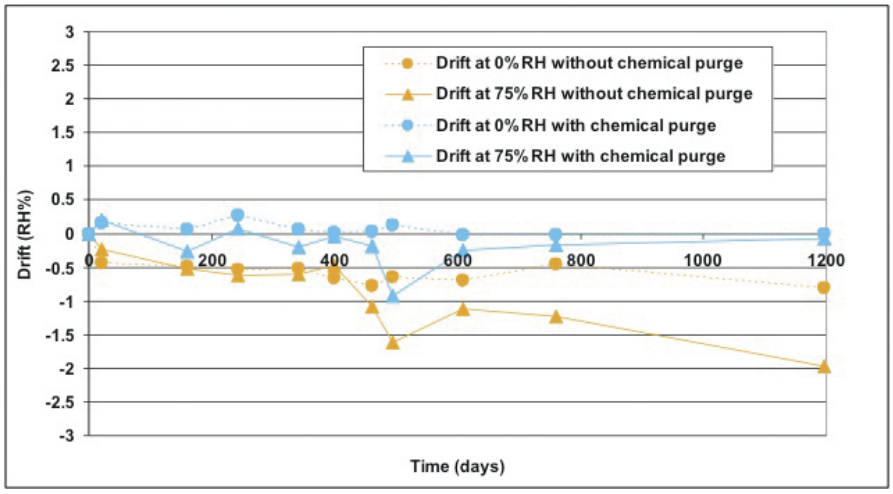

Figure 4: Sensor drift with and without chemical purge measured in a wood drying process. Test period of 3 years.

Lithium Battery Manufacturing

Lithium batteries are manufactured in dry conditions as the raw materials have a low tolerance for moisture. Typical process dew point is around -50…-40°C. The solvents (e.g. ethylene carbonate, dimethyl carbonate, or ethyl methyl carbonate) evaporating from the electrolyte solutions can potentially contaminate the dew point sensor. The chemical purge interval needs to be optimized to a level which ensures trouble-free operation of the sensor. Typical purge interval in the application is 1 hour.

Chemical Purge Option in Vaisala Humidity and Dew Point Instruments

Chemical purge option is available in all Vaisala DRYCAP® dew point instruments and selectable in the following Vaisala HUMICAP® humidity instruments: HTM330 and HMT310 series transmitters; HM70 hand-held meter, HMP155 probe, and HMM210 series modules.

When a new Vaisala humidity transmitter is ordered with the chemical purge option, the purge is set to start at regular intervals. This interval can be modified using a serial line command or from the product display/keypad. Chemical purge can be set to run on startup. It can also be initiated manually or be turned off in case it is not needed.

You can view the complete range of Vaisala humidity and dew point products at www.vaisala.com/humidity and www.vaisala.com/dewpoint.

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