General Operating Procedures, Recommendations & Troubleshooting Guide

This document covers the following topics and will provide answers to most questions that commonly occur during operation of an MCM hygrometer.

Introduction

The MCM hygrometer is a precision instrument designed to measure moisture in clean, dry, non-corrosive gases. If the sample gas contains oil mist, aerosols, liquid condensate, particulate matter or corrosive gases, steps should be taken to protect the instrument from damage.

Note that commercially available tubing, fittings and gauges are often contaminated by small amounts of oil during manufacture or testing. The use of contaminated components will eventually degrade the performance of the sensor, slowing the response and giving false wet readings. This condition is noticeable when an initial movement to wetter readings occurs when Push Purge® sensor dry feature is activated. Minor contamination can often be removed by activating Push Purge® with clean, dry gas (such as nitrogen) flowing through the instrument.

When constructing a sample system all components should be cleaned and purged to dryness with nitrogen or oil free dry air prior to connecting the hygrometer.

Where the presence of oil in the sample line cannot be avoided a Balston filter (with a fine particular element) should be fitted. The use of any filter will slow the response time of the system to detect a change in the moisture level in the sample gas, as time will be required for the interior surfaces of the filter elements and body to reach equilibrium with the moisture in the sample. If it is certain, by inspecting the filter regularly, that there is no contamination present in the sample gas then the filter may be removed to increase the response speed of the system.

Note about filters:-

Oil collects on the downstream side of filter elements so failure to inspect the element after each use may allow oil to drip off the filter element, enter the line and reach the sensor. When using coalescing filters, the flow of liquid runs from the inside to the outside of the filter element, unlike other filters.

It is therefore good practice to start the sample gas flowing and check the end of the sample line for contaminants, using a clean white cloth prior to connecting the hygrometer for signs of any drop out from the filter. Before storing or shipping an analyser the instrument should always be purged with clean dry gas to prevent damage to the sensor by any corrosive gases present in the sample. Shipping in a dry condition will reduce time in service and improve the quality of a calibration so the user is encouraged to pay particular attention to the preparation of instruments prior to despatch.

1) Do's and Don'ts

- Do use clean tubing and fittings every time you connect the hygrometer.
- Do use short runs of 1/8" inch stainless steel tubing (high quality electro polished 316 grade) to make the connection from the sampling points to the hygrometer.
- Do use gauges that have been cleaned for oxygen service.

- Don't using nylon piping or plastic tubing because dry readings will be impossible to obtain due to the permeation of moisture from the air through the wall of the tubing.
- Don't subject the instrument to extremely high flow rates or flow pulses. Limit the flow to 1 litre / minute or less. Ideally, 500 ml / minute is recommended.
- When the instrument is to be stored for long periods or when it is time to ship for service and calibration, then it is recommended to pre-purge the instrument with clean dry gas and seal it off with freshly regenerated dry desiccant seals prior to despatch in order to guarantee that the sensor is transported in a clean, dry condition.
- Don't (if at all possible) use "quick connect" type fittings. Although it is a common practice to use such fittings it is recommended to avoid doing so because this can cause a flow pulse when the connection is made to the instrument, which may damage the sensor. In addition the seals on "quick connect" fittings will deteriorate with use and allow atmospheric moisture to leak in to the sample stream, leading to artificially wet readings. Furthermore "quick connect" fittings tend to collect dirt if not carefully handled and stored. If they must be used then it is always advisable to have a flow control valve fitted downstream of the "quick connect" to prevent any pressure surge on the sensor.

2) Instrument checks

Prior to installation and operation on sample gas, the instrument should first be checked to ensure that it has travelled and been received in good condition. Directions for performing these tests are included in the operating manual and completion of the checks and the associated paperwork will initiate the instrument warranty.

Following this initial "as received" test it is imperative to verify the performance of the sensor prior to commissioning on sample gas. The instrument should be supplied with a supply of clean, dry gas (ideally nitrogen, helium, argon or oil-free instrument air) that is passed through a suitably prepared dryer in order to confirm the zero condition of the sensor. One these tests have been completed to satisfaction the instrument can be installed, ensuring that exposure to ambient air is minimised.

3) Sample system preparation

The longer an instrument is connected to sample gas, the greater the risk of build up of contamination on the sensor. The instrument should be connected to the sample system only when the operator is satisfied that the sample system has been purged thoroughly.

The sample system should contain the fewest number of components possible, all of which should be made of high quality stainless steel (electro polished 316 grade). Connect 1/8 inch bore stainless steel pipe to the outlet of the sample system and establish a flow at a fast rate to purge the sample system pipework of components in order to establish an equilibrium condition. Purge for a least ten minutes.

Confirm that no liquid condensate or particulate contamination is present by applying tissue / blotting paper to the end of the sample tube. If contamination or condensate is present, do not connect the instrument and continue purging until satisfied that the sample system is clean.

4) Setting the flow rate

When satisfied that the hygrometer is ready for sampling and that the sample system is adequately purged, reduce the sample flow to approximately 500 ml / minute.

Loosen the desiccant seal on the instrument vent port but do not remove completely (if the inlet and vent ports are not indicated on your instrument then you may choose to vent through either port). Loosen and remove the desiccant seal from the inlet port and connect the sample pipe as quickly as possible. Once connected, remove the desiccant seal from the vent port. Attach a suitable vent line and ensure that there is no backpressure. Connect the removed desiccant seals together using the supplied linking connector. Note that if the vent flow can be felt on the back of a dry hand then the flow rate is too high.

5) Sample connection and measurement

Following connection of the sample gas, turn the instrument on and allow time for the reading to stabilise. When a stable reading is obtained activate Push Purge®, which should be sufficient to drive the displayed reading to an off-scale dry value. Record the time taken to reach a stable value prior to Push Purge® and the time taken to recover back to a steady condition following Push Purge®. Compare the two readings, prior to a post Push Purge®. If a lower reading is obtained after Push Purge® then this is an indication of either sensor contamination or that the sampling system has not yet reached equilibrium.

If the reading obtained after operating Push Purge® agrees with the previous reading then this is taken as confirmation that the instrument is behaving correctly.

6) What if the flow is too high?

If the flow rate through the sensor is too high the cooling effect of the gas stream will prevent the sensor from reaching its operating temperature and the instrument will display false (wet) readings. Adjusting the flow and observing if there are any differences in readings easily identify this condition. A system in equilibrium will not show any variations in readings with changes in flow.

7) Testing for leaks

Gross leakage of moisture into the system will be evident if the displayed reading is much wetter than expected. If the moisture level in the system is stable and the reading has stabilised, then small leaks can be detected by varying the flow rate through the hygrometer. Reduce the flow rate from the recommended 500 ml / minute to 100 ml / minute; if the moisture level is stable and the sample line is in equilibrium with the sample gas, no change in the reading will be observed unless a leak is present. If a leak is present the displayed moisture reading will become wetter when the flow rate is reduced, since there will be less sample gas to dilute the moisture leaking in from the atmosphere. The dryer the moisture level being measured, the more evident leakage will be when the flow rate is reduced. This technique will detect leaks, which are too small to be found with soap solutions or helium leak detectors.

8) Sources of leaks

Common sources of leakage are rubber gaskets or “O” rings, valve packings, threaded connections and loose fittings. At low moisture levels, leakage will be a problem even if the valves and fittings are in perfect condition. In this case, fittings employing metal-to-metal face seals should be used.

9) Regenerating desiccant seals

The desiccant caps supplied with the instrument can be regenerated by removing the plastic tops and putting the desiccant and its steel holder into a drying oven at 105°C for a minimum period of 12 hours. Any oven capable of maintaining a temperature slightly above the boiling point of water can be used for this purpose.

10) Troubleshooting

The operator can solve some of the problems most commonly experienced if he is aware of some simple troubleshooting techniques. Please read this section in conjunction with the separate troubleshooting documents (ref. MCM_UG_002 and MCM_UG_003).

10.1) Hygrometer reads wetter than expected

This problem is usually caused by contamination of the sensor, a leak in the sampling system, an excessive sample flow rate or operating the sensor above atmospheric pressure.

Note the reading and activate Push Purge®.

Observe if the reading displays a wetter value, even if only momentarily. If it does, the sensor may be contaminated. If the reading gets dryer until it goes off scale then the sensor is not contaminated and possibly the gas stream is wetter than anticipated, or a leak is present. If the reading is dryer than it was before pressing Push Purge®, the moisture level may still be decreasing. Press the Push Purge® and check the reading after stabilisation until the same value is obtained each time. If the reading still seems too wet and Push Purge® does not change the reading, then carefully checked the tightness of every connection in the system. Pay particular attention to the tightness of the packing nuts of any valves. Ensure that adequate time has been allowed for the system to dry down after connecting the hygrometer to the system. Ensure that all sample lines consist of 1/8” stainless steel tubing, wherever possible. Never use plastic or rubber tubing in a moisture sampling system as water vapour can easily permeate through the tubing and enter the sample stream.

10.2) Instrument is slow to respond to a change in moisture level

Check that there is an adequate flow of gas reaching the instrument. A flow rate of approximately 500 ml / minute is recommended. A low flow rate is unlikely to be a problem if the sample lines are kept short. More commonly, slow response is caused by contamination on the sensor, which impedes the passage of moisture in and out of the sensor. If this condition cannot be remedied using Push Purge® the instrument should be returned for repair.

10.3) Instrument reads off-scale dry

If the instrument reads off-scale dry, regardless of the sample gas being analysed, it is very likely that the sensor has been damaged by excessive flow or chemical attack. Consult with MCM or return the instrument for repair.

11) Returning the instrument for recalibration or service

If the instrument was purchased from an agent or distributor, it should be returned to them for repair or recalibration.

If the instrument was bought directly from MCM it should be returned prepaid and insured in the original shipping carton with the desiccant seals reattached, using fresh desiccant.

12) Things we have learned since 1968

Since MCM's formation in 1968 we have addressed hundreds of different applications and supplied several thousand hygrometer solutions to clients around the world. During this time we have faced many challenges and learned many lessons. The list below contains some of the most fundamental principles that apply to the field of hygrometry and each and every one should be considered in detail, as the application (or non-application) of recommendations *will* have an effect on the measurement. If you are in any doubt about the quality of your sample system or validity of the process data then you should always refer back to this list; the chances are that even if the problem is new to you then we will have seen it many times before.

12.1) Sample System

The accuracy of moisture measurement is absolutely dependent on the integrity of the sample system. The best hygrometer in the world cannot give an accurate or rapid reading if the sampling system allows moisture from the ambient air to leak in or if the walls of the sampling line adsorb a relatively large amount of moisture.

12.2) Contamination

Any substance in the sample gas stream that can deposit on the sensor or attack it chemically must be avoided or removed with an appropriate filter. If a contaminant cannot be avoided, then the flow rate and period of exposure of the sensor to the sample gas must be minimised and immediately followed by purging of the instrument with clean dry gas as well as periodically activating Push Purge® to clean the sensor.

12.3) Dry Level Analysis

For measurements made at very dry levels the use of metal-to-metal seals and a diaphragm or bellows valves is recommended. It should also be noted that several days may be required to dry down the sampling system and response times will be controlled by the rate at which the

sampling system can respond to changes in the moisture level. The volume and length of the sampling system should be reduced to an absolute minimum or satisfactory results may not be obtained. The dry down in the system can be speeded up by heating the components of the system using a heat gun starting with the inlet of the sampling system while purging the system with dry gas.

12.4) Incompatible Gases

Certain gases are incompatible with standard MCM hygrometers due to the fact that they chemically attack the sensor or interfere with the accurate detection of moisture. These include strongly polar molecules such as chlorine, hydrogen chloride, sulphur trioxide and ammonia.

12.5) Use of Calibration Gas Cylinders

Note that, when using cylinder gases, the moisture level in the gas will vary with changes in the cylinder pressure and temperature. Both should be noted when recording the hygrometer reading. Water will be adsorbed on the walls of any cylinder. At any temperature, there will be a characteristic water vapour pressure in the gas in the cylinder due to the adsorbed water, which is unaffected by the cylinder pressure. Consequently, when the cylinder is full, the concentration of moisture delivered from the cylinder on a volume basis will be lower, even though the partial water vapour pressure of the moisture in the cylinder does not change as the gas in the cylinder is used. The partial water vapour pressure in the cylinder will change as the temperature of the cylinder changes. As the temperature of the cylinder drops, the vapour pressure will also drop causing the gas in the cylinder to be dryer. These factors should be taken into account when checking the operation of the hygrometer using cylinder gases as they are often used in industrial environments to validate in line analysers and will be temperature sensitive if left unrolled and unmonitored for prolonged periods. This can lead to significant uncertainties and as such should be considered as check gases rather than Standards, especially when used outdoors.