



Water vapor analysis with detector tubes has been an industry standard for over 40 years

Direct-reading colorimetric indicator tubes, or detector tubes, provide users with a fast, easy-to-use, on-site method of testing for a variety of gases and vapors. Detector tube technology has been available since the 1920s and has been in widespread use from the 1970s to present. The National Institute for Occupational Safety and Health (NIOSH) initiated a detector tube certification program to ensure accuracy and quality of the method, which remains active through an independent third-party laboratory. Water vapor detector tubes have many advantages, including their efficient utilization of material, ease of use, numerous practical applications, and the ability to be effectively used and interpreted by laymen without chemistry knowledge. All of these advantages contribute to their widespread use and status as industry standard.

Standard Deviation, Accuracy and Quality

As with all methods of analysis, accuracy and quality are of the utmost importance. In breathing air applications, regulating organizations, such as NFPA¹, have underscored this importance by providing specific guidelines for accuracy and other means of ensuring high quality results. In most applications, water vapor detector tubes provide results well within the limits of these requirements.

Relative Standard Deviation

Relative standard deviation is a measurement of the detector tube's precision. It is an indication of how far a group of repetitive measurements strays from the average of all the measurements, expressed in percentage.² This data point indicates the consistency of a given method. Standard deviation should not be confused with accuracy.

Water vapor detector tubes have no need for annual calibration since they are certified in batches. They expire every two years and are designed to work in a wide array of environmental conditions. Their accuracy fares well in comparison to the laborious and costly comparative instrumentation. Each batch of detector tubes undergoes quality assurance checks by the OEM prior to sale.

Water vapor detector tubes measuring 5-200 mg/m³ provided by Trace Analytics, LLC are ISO 9001 certified, have been qualified and validated per ISO 17025:2017 to meet multiple breathing air specifications, and offer a $\pm 20\%$ relative standard deviation on the results. This is a result of our supplier's 70+ years of manufacturing colorimetric tubes and the consistent volume delivered by the tube's internal composition, as well as rigorous, continuous validation by Trace Analytics, LLC.

Accuracy

The accuracy of a detector tube system is the level of agreement between the system and a standard target vapor of known concentration (Table 1).³ The industry accuracy specification for detector tube systems is $\pm 25\%$ of reading as established by NIOSH in their certification program in collaboration with the American Industrial Hygiene Association (AIHA).^{4,5}

Table 1. Accuracy determination based on known water vapor concentrations.

Average Accuracy Percentage of Trace Analytics' Brand Detector Tubes	
Compressed Air System and Water Vapor Scale	Accuracy (%)
Low Pressure Air System (0-200 mg/m ³)	± 16
High Pressure Air System (0-250 mg/m ³)	± 14

Concentration, Specificity, and Conversions

While water vapor detector tubes can be read directly in the field, conversion to parts per million volume (ppmv) and pressure dew point (PDP) requires special knowledge of the specific sampling apparatus and standard chemistry laws. Ensuring these calculations are performed correctly and verified according to quality standards requires the expertise of an accredited laboratory.

Water vapor detector tube concentrations are expressed as the content of the substance in question within a reference substance. For the measurement of water vapor in compressed air, a concentration is found for the amount of water vapor within a volume of compressed air. The length of the stain does not correspond to the concentration as a direct measure but is a measure of the mass reaction of the water vapor in the compressed air. When the water vapor (H₂O) from the compressor system interacts with the detector tube substrate a chemical reaction occurs that results in a color change (Equation 1). This color change is measurable based on the calibrated scale on the side of the tube, which is highly dependent on final air volume sampled. Figure 1 is a representative water vapor detector tube whose reaction with the selenium dioxide and sulfuric acid results in the indicating layer changing color at the water vapor concentration of 30mg/m³.

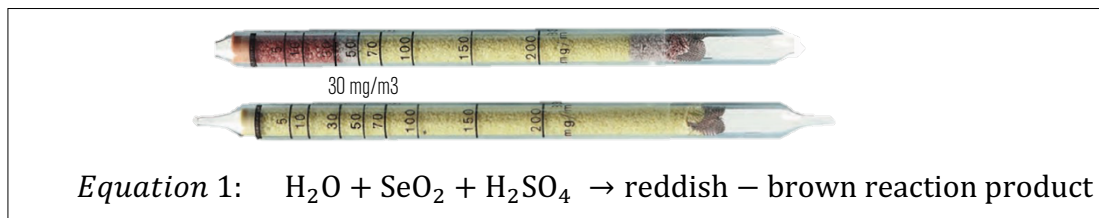


Figure 1. Example of an unsampled (Bottom) and sampled (Top) water vapor detector tube. The color reaction stops at the end of the reddish-brown reaction (30mg/m³). Specificity & cross sensitivities are a limitation for water vapor detector tubes. Alcohols and unsaturated hydrocarbons (e.g. ethene, acetylene and benzene) of high concentrations may cause diffused discoloration of the indicating layer.⁶

After the technician determines the detector tube reading (e.g. 30mg/m³), concentration is then converted to final water vapor results in parts per million volume (ppmv) and pressure dew point (PDP). A reference table can be provided by the laboratory for onsite estimation of final results, so the field technician may determine if resampling is required.

Significant Cost Savings and Speed of Results

While electronic instrumentation exists to test and monitor water vapor levels, these instruments are costly, require technical expertise to use, frequent third-party calibration, and significantly extended sampling times. This technology is appropriate for certain applications, but will require significant improvement and innovation to rival the flexibility of water vapor detector tubes.

At Trace Analytics, we have extensively researched and tested portable dew point hygrometers for integration into our sampling setup. We have found that they are extremely cost prohibitive, and because they take a significant amount of time to heat up to provide the most accurate results, would extend sampling times by 20 to 30 minutes. Furthermore, due to the sensitivity of the instrumentation, they require frequent calibration, and therefore, if an error were to be found during calibration, all previous results obtained with the instrument would be rendered invalid. This is a risk we deemed too great to take with our customers' samples.

While portable dew point hygrometers are a newer, updated technology, we have found them to be impractical for most breathing air applications. Water vapor detector tubes have clear advantages. We have confirmed, with years of data, that accredited detector tube analysis methods are accurate, up-to-date, and easier to use. Moisture analysis with detector tubes can be used inexpensively on-site to obtain a representative moisture reading, and allow real-time troubleshooting if failures are determined at time of sampling. This means less down time for equipment, faster response time for corrective maintenance, and the ability to retest all within the same day.

Training and Sampling Preparation

Trace's distributors and customers have 24-hour online access to step-by-step training videos and written instructions designed to aid personnel on how to appropriately sample and document data from sampling media, including colorimetric indicator tubes. Our customer service team is trained and available to answer any sampling questions by phone or email. Logging into the AirCheck Academy affords individual users the opportunity to obtain certificates of competency and to easily train new personnel.

Moisture is not only a process variable to be measured in compressed breathing air applications, but also a common contaminant which must be controlled. Excess moisture in a compressed air system can cause equipment damage that can increase the user's risk for an accident or injury. It can also cause regulators to freeze or malfunction, corrosion and oxidation of tanks, bacteria to grow, and reduce the efficiency of compressor filters to remove carbon monoxide. Trace's customer base includes fire, diving, industrial, and government facilities worldwide. Understanding the basics of moisture measurement is a necessary first step in mitigating moisture's potentially harmful effect. Onsite detector tube analyses is an inexpensive and dependable method for determining moisture content in compressed breathing air.

References

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