

Water Vapor Analysis

Why we use GC/MS for analysis

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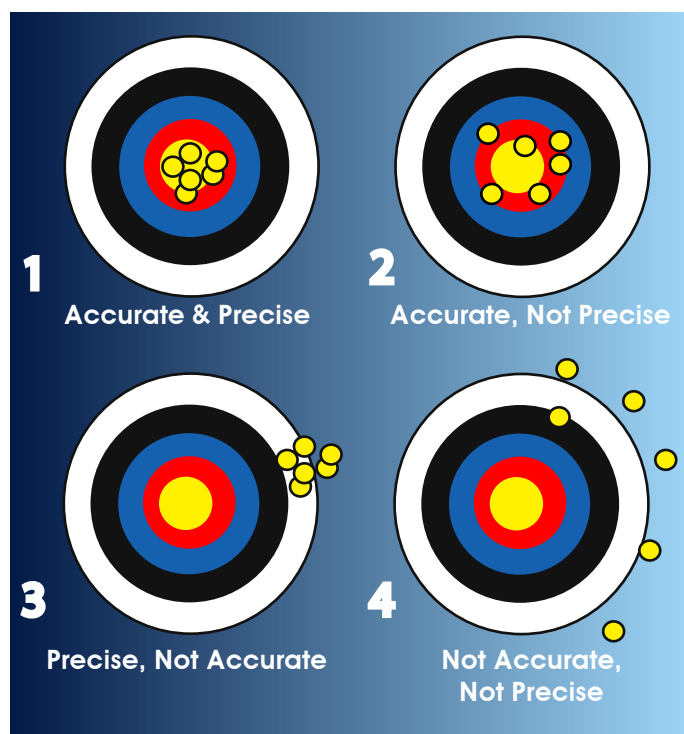
Trace Analytics, Inc. uses gas chromatography-mass spectrometry (GC-MS) as its chosen technique of analysis for water vapor. This technique was selected after careful evaluation over a variety of techniques including detector tubes. The primary reason for selecting GC-MS was because of its superior accuracy and precision capabilities not because it was the least expensive method available. On the contrary, it is probably one of the most expensive due to the associated costs for the instrumentation, maintenance, NIST traceable standards, and trained personnel required to operate the instrument. A GC-MS is commonly used for identification and quantitation of environmental, industrial hygiene and other samples.

Trace's use of GC-MS is an acceptable method for analysis of water vapor according to NFPA 1989 Standard on Breathing Air Quality and the Compressed Gas Association's Commodity Specification for Air.

Accuracy and Precision

A discussion of accuracy and precision is in order because the terms are frequently and incorrectly used interchangeably. Precision and accuracy describe two different sets of unique measurements that are important when comparing analytical methods and/or results.

Diagrams 1 through 4 depict bull's eye targets and four shooters' target practice results. Shooter #1 was able to group the shots accurately (in the center of the target) and precisely (close together.) Shooter #2 was pretty good too. He was accurate but not very precise. Shooter #3 was very precise but way off target. And Shooter #4 was a rotten shot! **What does this have to do with the choice of your laboratory?** You want to choose a lab that can provide you with test results that are on target and reproducible. At Trace, we have procedures in place to assure that each sample will be within $98.8 \pm 2.4\%$. Our quality control and quality assurance procedures include among many things 1) daily calibration using NIST traceable standards, 2) reference standards that are run after every 10th sample to assure that the instrument is responding correctly throughout the day, and 3) 20% of daily analyses are QA and QC related.



Two other terms that are frequently used when discussing accuracy and precision are relative standard deviation and confidence interval. First, bear with us for a few paragraphs and explanations. If you take a number of readings for the concentration of water vapor using any analytical technique, the numeric results will likely be described by a normal distribution, i.e., the data will fit a bell-shaped curve. The standard deviation (SD) measures the spread or the variation of the individual measurements about the mean (or average) and if divided by the mean become the relative standard deviation (RSD) and may be expressed as a percent.

The term confidence interval (CI) is used to describe the likelihood that a given reading will lie within certain limits about the mean; it is the mean value \pm some number times the SD. CI's are frequently expressed as the mean $\pm 1, 2,$ or 3 SD and are, respectively, the 68%, 95%, and 99.9% CI (actually 68.26, 95.44, and 99.74%).

So, what does a CI really mean? A 68% CI means that an individual result will lie within the range only 68% of the time, or about 2 out of 3. A much more reasonable and widely used CI is the 95% CI which gives you a range within which the data will lie 95% of the time, or 19 out of 20 times.



How to compare 68% CI to 95% CI? Easy; double the range of the 68% CI to obtain the corresponding 95% CI. For example if a claim is made that a detector tube is accurate to $\pm 30\%$ at the 68% CI, that corresponds to $\pm 60\%$ at the 95% CI. If a claim is made that the GC/MS is accurate to $\pm 5\%$ at the 95% CI, that corresponds to $\pm 2.5\%$ at the 68% CI. Do you want data that is $\pm 60\%$ accurate or $\pm 5\%$ accurate?

An Example. Let's say that you obtained a reading of 25 ppm water vapor from two labs, one which uses detector tubes and states an accuracy at $\pm 30\%$ with a 68% CI and one that uses an analytical technique that provides an accuracy at $\pm 9\%$ at the 95% CI. The actual ranges (rounded) appear below:

	Lab A	Lab B
Technique	GC/MS	Det. Tube
95% CI	$\pm 9\%$	$\pm 60\%$
Reported reading	25	25
Actual Range, ppm	23-27	10-40

In addition, if a detector tube is not used as prescribed by the manufacturer, the results may not even be within $\pm 60\%$. If, for example, the manufacturer specifies a flow rate of 2.0 liters/minute, the actual flow rate is anywhere from 1.3–4.1 liters/minute, based on recommended pressure settings and pressure gauge inaccuracies; it is probably safe to assume that the 95% CI is much wider than the already high $\pm 60\%$. Additionally, most detector tube manufacturers claim a level of accuracy if, and only if, the flowrate is maintained at $\pm 5\%$ of the target flowrate, e.g. 2.0 ± 0.1 L/min. **What does this have to do with the choice of your laboratory?** You need to be aware that there are many ways to report accuracy. Some are better than others.

Sampling Containers

Trace uses a 22 millileter (mL) vial with a self-sealing proprietary polymer stopper to capture gases and water vapor samples. We have performed extensive validation studies that show that the containers hold a known quality of air with no serious loss or gain of moisture, as well as other gases of interest. The studies track results for a 0, 7.5, 15, 30, 45, and 60 day holding periods. We perform a validation study as required by method changes but at least every 5 years.

Our decision to avoid using detector tubes, heavy pressurized cylinders and sampling bags was based on providing our customers with accurate analyses, simple yet valid sampling procedures, and inexpensive shipment of samples to our laboratory.

What does this have to do with the choice of your laboratory? Trace's **AirCheck✓Kit** is a simple and easy way to obtain valid samples from your compressed breathing air supply. Since the samples are lightweight (only 3 ounces including the shipping container), you can return the sample to our laboratory for less than \$1.00 postage or use your favorite carrier for a minimum amount.

Our Commitment

Trace does one thing – test the quality of compressed breathing air. Our A2LA accredited laboratory facilities and personnel are dedicated to the sole purpose of providing compressed air quality analyses to fire departments, dive facilities, government facilities, and general industry users worldwide. We are the experts in our field.

Please feel free to contact your **AirCheck✓Team of Experts** with your technical questions.

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