



METER
FOOD

**WATER ACTIVITY
(AW) IS ABOUT
ENERGY.**

A_w IS THE RATIO BETWEEN THE VAPOR PRESSURE OF THE FOOD ITSELF, WHEN IN A COMPLETELY UNDISTURBED BALANCE WITH THE SURROUNDING AIR MEDIA.

This required measurement is directly related to the microbial susceptibility of food products and is correlated with many of the reactions that end shelf life in foods. Learn why water activity measurements are so powerful.

For a cheap ingredient, water can cause a lot of expensive problems—microbial growth, mold, loss of texture, caking and clumping, rancidity, vitamin loss. The best way to understand water in your product is by learning how to measure water activity.

What is water activity?

Water activity: it's all about energy. A_w is the ratio between the vapor pressure of the food itself, when in a completely undisturbed balance with the surrounding air media. Take a glass of water and a dry sponge. Dip the corner of the sponge into the glass of water. **The water will move** from the glass into the sponge.

Water activity is the force that causes the water to move into the sponge. To understand it better, think about how the water in the sponge is different from the water in the glass. The water in the glass is free, but the water in the sponge is anything but free. It's bound by hydrogen bonds, capillary forces and van der **Waals–London forces**. These are called matrix effects. The water in the sponge has a lower energy state than the water in the glass. Water will flow into the sponge, but to get it back out, we must do work by squeezing the sponge.

The water in the sponge has a lower vapor pressure, lower freezing point, and higher boiling point than the water in the glass. They are different in ways we can measure and quantify.

Water's energy can also be decreased by diluting it with solutes. These are called osmotic effects. Since work is required to restore the water to its pure, free state, this also reduces the water activity. The **total change in energy** is the sum of matrix and osmotic effects.

Use the math to measure water a_w

If we enclose a sample in a sealed container, the relative humidity of the air in the headspace will equilibrate with the water activity of the sample. At equilibrium, the two will be equal, and we can measure the relative humidity of the headspace to know the water activity of the sample. This is the most reliable answer to the question of how to measure water activity.

Secondary methods: hygrometers, capacitance sensors

Like early water activity meters, most modern instruments use electrical capacitance or resistance hygrometer sensors to measure humidity in the headspace above the sample.

These meters use secondary methods: they relate an electrical signal to relative humidity and must be calibrated with known salt standards.

With these sensors, the ERH is equal to the sample water activity only as long as the sample and sensor temperatures are the same. Accurate measurements require good temperature control or measurement. **Capacitance sensors** use a simple design and are often used in relatively inexpensive water activity meters.

How to measure water activity – dew point is a primary method

The best methods that answer the question of how to measure water activity (a_w) are primary methods that use the ratio p/p_0 .

P_0 (the saturation vapor pressure) depends only on the temperature of the sample (as shown in the accompanying graph), so it's possible to measure p_0 by measuring the temperature of the sample. P (the vapor pressure of the water in the sample) can be measured by measuring the vapor pressure of water in the sealed head space above the sample. The most accurate way of measuring that vapor pressure, and one that goes back to first principles, is to **measure the dew point of the air**.

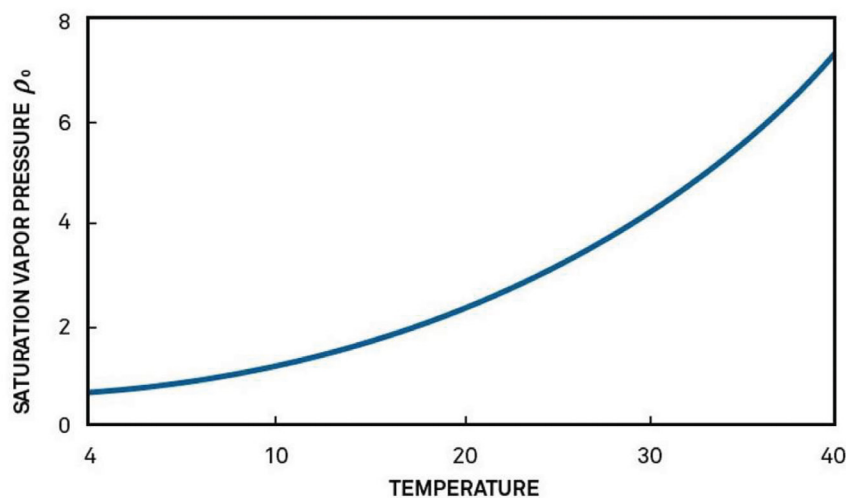


Figure 1. It's possible to measure saturation vapor pressure by measuring the temperature of the sample (Saturation vapor pressure is temperature dependent)

Primary method means direct measurement, no calibration

The major advantages of the dew point (or chilled mirror dew point) method are speed and accuracy. The chilled mirror dew point sensor is a primary measurement method based on fundamental thermodynamic principles. Chilled mirror water activity meters make highly accurate ($\pm 0.003a$) measurements, typically in about 5 minutes. Since the measurement is based on temperature determination, no calibration is necessary. Users should measure a standard salt solution to verify proper functioning of the instrument. For some applications, the speed of this method allows manufacturers to perform at-line monitoring of a product's water activity.

How to measure water activity – dew point is a primary method

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AQUALAB 3

Lightning-fast total moisture analysis to tighten process control and boost quality. Combine moisture content and water activity in one device.

- ✓ MC + a_w in one
- ✓ Results in 60 seconds
- ✓ For the lab or the line

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AQUALAB TDL 2

Precise a_w readings in minutes — even on volatile samples that cripple other instruments.

- ✓ Near-invincible laser sensor
- ✓ Read highly volatile substances
- ✓ Accurate to $\pm 0.005 a_w$

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AQUALAB 4TE

Fast. Precise. Reliable. Meet the renowned instrument that brought water activity to the business world.

- ✓ a_w in <5 min.
- ✓ Highly compliant + compatible
- ✓ Secure data storage

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A powerful measurement for QA/QC and formulation

Water activity is a thermodynamic measure of the energy of water in a product. Why should your company learn how to measure water activity? It is directly related to the microbial susceptibility of food products. It also has direct relationships with many of the reactions that end shelf life in foods. Because it is measured on a scale with a known standard, it is particularly well suited to being a safety and quality specification.

Master the basics

Get the essentials of water activity condensed in this 20 minute webinar. You'll learn:

- What water activity is
- How it's different from moisture content
- Why it controls microbial growth
- How understanding water activity can help you control moisture in your product.

WEBINAR

WATER ACTIVITY 101: MASTERING THE BASICS

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Application Scientist

METER Group, Inc. USA



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