# Best Water Activity Meters 2019

## The Definitive Guide

# Who makes the Best Water Activity Meter?

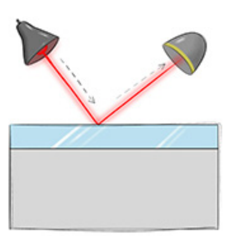
**Some people measure water activity because they have to.** They're just looking for a number and they don't really care what it is. Those people should head straight for Amazon, pay their 600 bucks, and pray that no one gets sick.

**But if you're a food, pharmaceutical, or personal care product manufacturer that takes safety seriously, a high accuracy water activity meter can be critical for your operation.** And if you spend the time to pick the right instrument, you will enjoy its benefits for quite a while, because the best can last a decade or more.

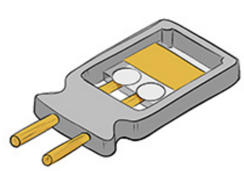
# Is it an instrument? Or is it a sensor?

There's a confusing array of instruments to choose from when you're shopping for a water activity meter, but essentially you're choosing between four different sensor types: **chilled mirror, capacitance, tunable laser, and resistive electrolytic.**

It's important to consider the sensor type, because this determines the speed, accuracy, longevity, and reliability of your instrument. Sensors that measure water activity directly (chilled mirror and laser) are faster and more accurate than sensors that measure a secondary property like resistance or capacitance and convert it to water activity (resistive electrolytic and capacitance).

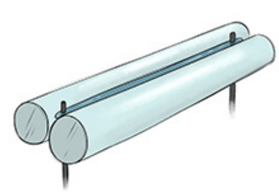


Chilled Mirror



Capacitance

Tunable Laser



Resistive Electrolytic

# Do you need to measure volatiles?

If you're measuring chemicals or solvents, you probably know you'll have to look for a specialized sensor. But other ingredients that volatilize in air, such as ethanol, alcohol, vinegars, propylene glycol, and certain spices can also cause problems with a sensor.

**The tunable diode laser is a sensor specifically made to deal with volatile ingredients.** All other sensors struggle. Volatile ingredients can affect readings and reading speed for each of the other sensors, even when you use filters. Worse, electrolytic and capacitance sensors take readings by acting like a sponge, absorbing and desorbing the vapor over the sample. When they absorb volatile ingredients, it can change the response of your sensor and even destroy it.

Several of the instruments claim to measure some volatiles with certain sensor/filter combinations. **Our tests showed that the only instrument that can handle the tough stuff (we are not talking "bread aroma" here) is the laser sensor.** It's not quite as fast as chilled mirror, and not quite as accurate overall, but if you measure many samples with volatiles, there is no other sensor choice.

# How long will your instrument last?

If you've just spent $8000 for a lab instrument, you're probably hoping it's going to last you for a while. Here's where the build quality of the big three (Novasina, METER/AquaLab, and Rotronic) makes a difference. **We tested an instrument from Amazon, and while the initial price was quite attractive, it failed within the first week of testing and we were unable to get any support from the seller.**

Sensor aging is also an issue for some sensors. The sponge-like nature of resistive electrolytic and capacitance sensors makes them slower and less accurate as they absorb contaminants over time. This clearly impacted the older sensors in our tests. Novasina offers replacement sensors. With Rotronic, you have to replace the whole sensor head. The cost of these replacement parts is about the same (around $2000).

Sensor age did not appear to have an impact on test time, accuracy, or stability of chilled mirror sensors, but should you need to have one replaced, it would cost $850.

Our oldest laser instrument was only 4 years old. Unsurprisingly, age did not impact the laser sensor readings (time or accuracy), but if a sensor did fail, replacement cost would be around $2100.

# Speed and Accuracy

If you have to read more than a few samples a day, a slow instrument can end up costing you money. On average, laser and chilled mirror sensors are more than three times faster than resistive electrolytic sensors, and more than 5x faster than capacitance sensors. In our side by side testing, the speed differences caused bottlenecks as the slow instruments bogged our testers down.

You might be tempted to sacrifice accuracy to save a few dollars. When it comes to safety equipment though, if you don't pay up front, you'll pay in the end. It may be through lost profits—over-packaging and over-drying because you aren't confident about the safety of your product. Or it might be in waste from rejected shipments, recalls, or customer complaints. **In any case, accurate sensors are expensive, but inaccurate sensors cost a lot more.**

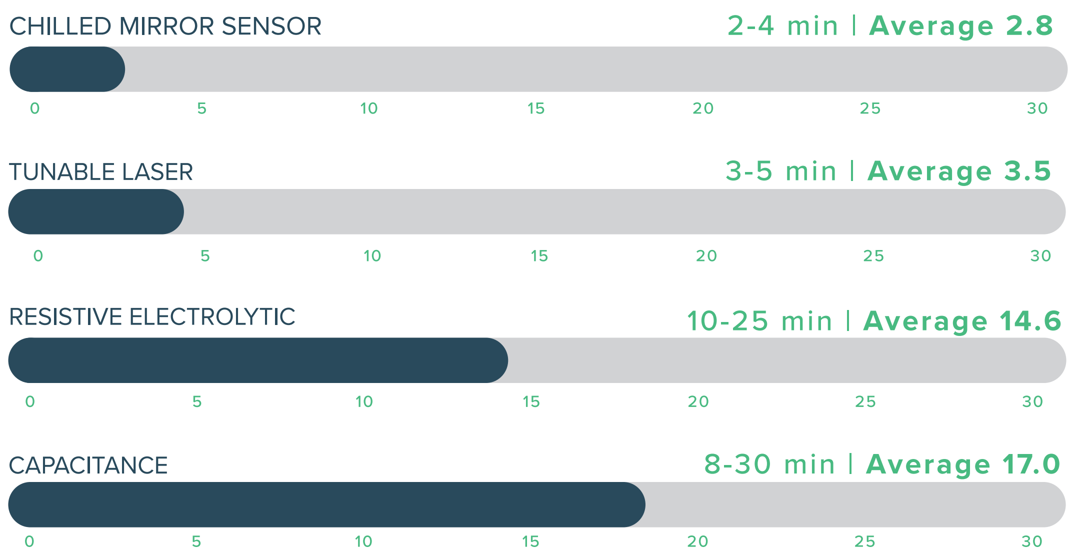
**At 2-4 minutes on average per test, chilled mirror dew point sensors are significantly faster and more accurate than any other sensor, and their performance doesn't degrade over time.** Their Achilles heel: they can't measure certain volatiles.

**Laser sensors are slower than chilled mirror but faster than the other sensor types. They take 3 - 5 minutes per test.** They're also less accurate than chilled mirror sensors but slightly more accurate than resistive electrolytic sensors. Laser sensors claim 0.005 aw accuracy. In our tests, they met but did not exceed that claim. Their major advantage: they can measure volatile ingredients that no other sensor can measure.

Resistive electrolytic sensors are about 3 times slower than chilled mirror sensors, but faster than capacitance sensors on average **(they take 10 to 25 minutes per test)** and significantly more accurate (they got a solid C in our accuracy testing).

Capacitance sensors are the slowest**—they took 13 minutes to well over an hour per reading—**and their accuracy report card is all Ds and Fs.

**Sample Read Times**



## Issues with “Fast Mode”

**Is it possible to make resistive electrolytic and capacitance sensors faster?**

Instrument makers Novasina and Rotronic have both tried, and each has failed in its own way.

One reason these instruments are so much slower in measuring samples is that they have to wait not just for sample-headspace equilibrium, but also for sample-sensor equilibrium. Fast mode works by ending the reading before equilibrium is reached and estimating what the true water activity would be.

We can get a sense of accuracy by testing salt standards in fast mode. **The result: Novasina’s “Fast Mode” is as accurate as its equilibrated mode (both get a C+), but the increase in speed is negligible (an average of 12 min per sample vs. an average of 16 for a true reading).**

Rotronic gets significantly faster with its “aw quick” mode—an average of 7 min per sample vs. an average of 58 min for an actual reading. But the accuracy score of quick mode is just one point shy of an F, as compared to a D for fully equilibrated samples. And the issues with fast mode get worse when you measure actual product.

## Fast mode: from bad to worse

The truth is that making a fast mode prediction is easier when you’re measuring standards. They’re homogeneous, they come to equilibrium quickly, and the instruments are calibrated to these standards in the first place.

Actual products—beef jerky, dog kibble, peanut butter, milk powder, potato chips—expose the weaknesses of the sensors and particularly show up the problems with fast mode readings.

Chilled mirror and laser sensors make fully equilibrated readings in an average of 3 minutes—significantly faster than resistive electrolytic and capacitance sensors even in fast mode. **Every laser and chilled mirror sensors report is a full equilibrium reading, so they don’t need a “fast” mode.**

Rotronic’s capacitance sensor and Novasina’s resistive electrolytic sensor both take much longer (10-25 min for Novasina, 15-150 min for Rotronic) to make an equilibrated measurement, so they rely on fast mode (7-16 min for Novasina; 4-6 min for Rotronic) to make up the difference.

We evaluated fast mode measurements by measuring the same product on the same instrument with exactly the same conditions in fast and fully equilibrated mode. **Then we evaluated the data by asking how often the fast mode readings match the equilibrated readings within the manufacturer’s claimed accuracy.**

**The answer: hardly ever.** The best performer, the LabTouch, only got close 3 out of 9 times, Differences between the predicted and actual readings ranged from a best of 0.005 to a worst of 0.121, with an average difference of 0.027. (Note that a 0.121 difference is more than 10% of the total range of water activity and could cause catastrophic issues with respect to safety and quality in any product). **In every case, fast mode gave a water activity that was too low.**

The two Rotronic instruments were within specified accuracy on only 2 out of 9 samples. In the best case, the equilibrated reading was the same as the fast mode reading; in the worst case, it was off by -0.076, with an average difference of 0.031. Again, the 0.076 difference between predicted and actual is big enough to cause a reputation-damaging incident. **Unlike the Novasina fast mode, the Rotronic fast mode performance seemed arbitrary, with some fast mode readings coming in significantly higher, and some significantly lower than the actual readings for the same sample.**

Though these manufacturers don't explicitly say how fast mode works, the results would suggest that Novasina gets a faster reading by loosening its stability specs while Rotronic is making an estimate using some kind of predictive algorithm. **Based on the data, we would not recommend using either instrument in fast mode.** Users who choose to do so should exercise caution and do thorough testing with their own products to determine whether or not their safety and quality systems can handle differences between predicted and actual readings.

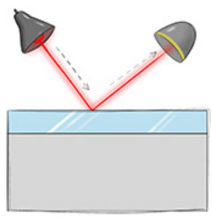
# When instruments get dirty

In the course of testing food products, the instruments can sometimes get contaminated with particles of food and greasy or sticky substances. **Only one of the manufacturers, METER/AquaLab, tells you that you need to clean your instrument frequently.** So are the other sensors unaffected by contamination?

To test this, we contaminated the sample chambers of each instrument with ground up dog kibble, milk powder, bacon grease, and marshmallow fluff, then measured the water activity of salt standards. **The best performer? Chilled mirror sensors.** A dirty chamber brought the chilled mirror accuracy score from an A (98%) to a B+ (88%). Our brand new resistive electrolytic sensor also dropped 10 points from a C+ to a D+. Dirty chambers affected the other sensors more severely. Our capacitive sensor dropped 16 points from a D to an F. And the laser sensor dropped a whopping 28 points from a B+ to an F.

**Dirty chambers made "Fast Mode" on both electrical properties sensors even worse.** Contamination caused the Rotronic accuracy to drop 40 accuracy points, from a barely-passing score of 60 to an unacceptable score of 20. The Novasina did better, but its Fast Mode performance with a dirty chamber still dropped 16 points to finish at a D- (63).

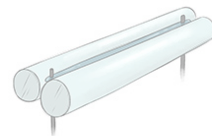
# Recommendations



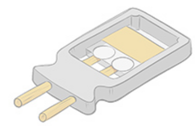
Chilled Mirror Sensors

Cost:
**From $7500**

Laser Sensors



Resistive Electrolytic Sensors



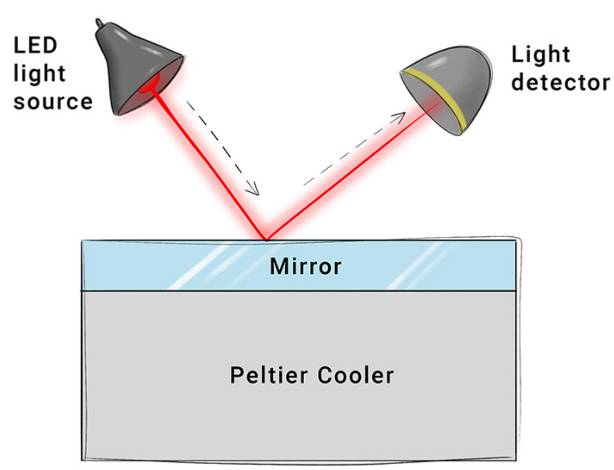
Capacitance Sensors

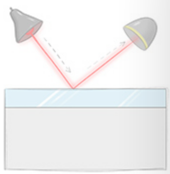
## Chilled Mirror Sensors

**Pros:** Nailed every standard from low to high with impressive accuracy and precision, typically in three minutes or less—half to one tenth the time of the competition. The standard knock on chilled mirror is that you have to keep the sensor clean, but these sensors were actually the top performers in our dirty sensor testing. Older sensors performed as well as brand new ones.

**Cons:** Can't read certain volatiles—see the list the manufacturer provides here.

**Bottom line:** Chilled mirror sensors offer terrific accuracy, long sensor life, solid performance even when dirty, and the fastest read time of any water activity device you can buy.

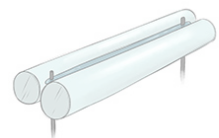




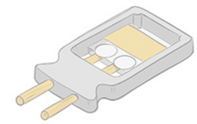
Chilled Mirror Sensors

Laser Sensors

Cost:
**From $13,500**



Resistive Electrolytic Sensors



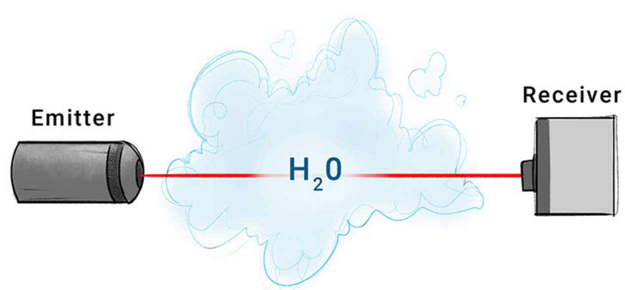
Capacitance Sensors

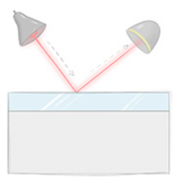
# Laser Sensors

**Pros:** Can measure any sample, including alcohols, organic solvents, and propylene glycol. Accuracy and speed were both very good, though not as good as chilled mirror.  Our oldest sensor was only 4 years old, but the laser should not experience any degradation in performance over time.

**Cons:** Less accurate than chilled mirror and slightly slower. A dirty chamber disproportionately affects this sensor.

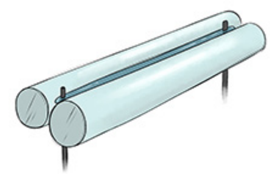
**Bottom line:** If you have to read the water activity of volatile samples, this is your sensor. You must run it in an environment where you can keep it clean.





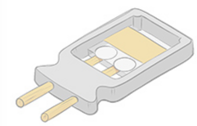
Chilled Mirror Sensors

Laser Sensors



Resistive Electrolytic Sensors

Cost:
**From $5000**



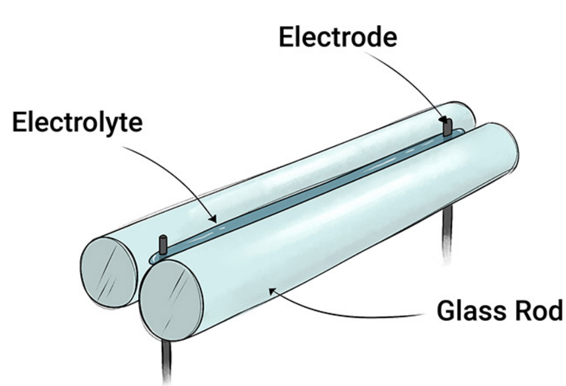
Capacitance Sensors

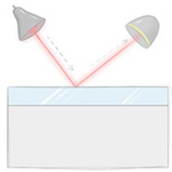
## Resistive Electrolytic Sensors

**Pros:** Solid (C+) accuracy in equilibration mode.

**Cons:** Slow, even in “Fast” mode. A dirty chamber makes accuracy unacceptable for water activities above 0.7. Sensors degrade over time. Not acceptable/ practical for measuring most true volatiles. Lower cost models have limited accuracy and capabilities.

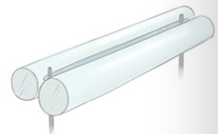
**Bottom line:** Resistive electrolytic sensors are solid performers backed by a quality company. But they can’t compete with the top-performing chilled mirror sensors on speed or accuracy, and their ability to measure volatiles is overstated.



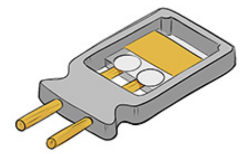


Chilled Mirror Sensors

Laser Sensors



Resistive Electrolytic Sensors



Capacitance Sensors

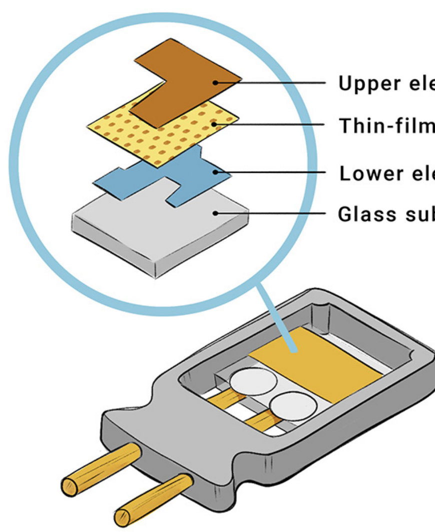
Cost:
**From $3000**

## Capacitance Sensors

**Pros:** Inexpensive. Less affected by volatiles than chilled mirror or resistive electrolytic sensors.

**Cons:** Slow. Significantly lower accuracy than other sensors. Sensors degrade over time. Not acceptable/practical for measuring most true volatiles. Disproportionately affected by a dirty chamber. Fast mode has unacceptable performance, especially in the presence of contaminants.

**Bottom line:** These sensors look like a good budget option, but the cost adds up over time. They are slow in equilibration mode and are not accurate enough for most applications, even if you're willing to wait for a reading. "Fast" mode has unacceptable accuracy and should not be considered an option by any serious user.



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**wateractivity.org**