UniqueTek "Tips" File #7:

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"Humidity and Handloading"

By Lee Love

Although the hygroscopic (water absorbing) nature of black powder is well documented, little can be found regarding smokeless powders. Indeed, modern smokeless powders are basically free from deterioration under proper storage conditions in a sealed container. But once you pour the powder into a powder measure, it is exposed to whatever the ambient humidity happens to be. SAAMI (Sporting Arms and Ammunition Manufacturers' Institute) recommends that smokeless powder and primers be "Stored in a cool, dry place." [1] and "If moisture or chemicals enter the cartridge, their effects on the components may result in failure to fire, incomplete burning, or delayed firing." [1] And CCI states that "High humidity combined with big temperature swings can degrade primer performance." [2] But both resources fail to set specific humidity limits either during storage or during handloading.

With regards to loaded ammunition, Lapua states, "The cartridge manufacturers do not generally inform about the storage or usage time for civilian products, because the packages are not hermetic. This is why the condition of the cartridges strongly depends on the storage conditions. In good conditions, about +10°–15° Celsius [+50°–59° F], and in normal humidity the cartridge can be used for at least 5 years." [3] Once again, a specific humidity range for what is considered "normal" is not stated.

I eventually found a recommended relative humidity for smokeless powder storage after reading the SDS (Safety Data Sheet) for products from multiple manufacturers. For example, the current SDS (March 2022) for Accurate Double Base Powders states, "The ideal condition for safe storage is at 21°C (70°F) 50% relative humidity…".

NOTE: In 2012, OSHA changed the Hazard Communication Standard from the MSDS format to the SDS format to be better aligned with the United Nations global chemical labeling system. The information contained in the SDS is largely the same as in the MSDS.

Unfortunately, there is plenty of empirical evidence to suggest that reloading ammunition or storing loaded ammunition in a high humidity environment can cause problems. There are numerous postings in Internet forums of alleged humidity effects ranging from clumping of powder in the powder measure and grain weight changes for a given powder measure setting, to changes in powder burn rates and velocity changes in loaded ammunition. But, to date, I have been unable to find any scientific data regarding humidity effects. Of course, the degree of effect likely varies widely with the brand of gunpowder and/or primers.

If you live in a desert area like Phoenix, Arizona, you rarely give humidity a second thought ... except maybe during a summer Monsoon storm. But many areas of the country regularly experience very high relative humidity (RH) with highs of 90% or more! Humidity this high can likely effect primers and possibly effect certain gunpowders. If you do live in a high humidity area, or your reloading bench and/or ammunition storage is located in a damp basement, you should be aware that the humidity could be affecting the ammo you load. At the very least, you should consider getting a humidity meter (they are called a "hygrometer") to monitor the humidity and make note of it in your reloading log. If you do experience problems with a batch of ammunition, you can refer to your reloading log and see if there is a correlation to humidity.

If your reloading bench or ammunition storage area suffers from continuously high humidity, you may also want to invest in a dehumidifier. You don't need to drop the room to near zero humidity, even if you could, but reducing the humidity and holding at a consistent level will help you load consistent ammo. If I had to make an educated guess at a "recommended" RH, I'd say 40% to 50% (at normal room

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temperatures), with 50% being the maximum acceptable RH. Of course, lower is better, but getting the RH much below 40% may not be practical, or even possible in some locations. And extremely low humidity can aggravate static cling of powder grains inside plastic powder hoppers. Regardless, the exact % RH may not be as important as maintaining the RH at a consistent level from one reloading session to the next. To monitor RH in your reloading room just install a hygrometer.

Hygrometers

Humidity is measured using a Hygrometer. You can find inexpensive hygrometers at Home Depot, Lowe's, Ace Hardware and Amazon for little as $9.99. But inexpensive meters such as these typically have poor accuracy and should be avoided. Even my Atomic Time Clock/Weather Station, although not particularly inexpensive, is not very accurate. The indoor and outdoor humidity sensors disagree by 6% and when I performed a "salt test" calibration on the outdoor sensor (more on the salt test later), it read more than 10% low. Worse yet, there was no way to calibrate the sensor! Some hygrometers don't even state a specification for accuracy and should be avoided.

But accuracy comes at a cost. If you want ± 4% RH accuracy or better, expect to pay about $40 to $60, and ± 3% or better accuracy can cost over $100! For example, the photo at right shows a laboratory-grade hygrometer that has ± 1.5% RH Accuracy with 0.01% RH Resolution and comes with a NIST-Traceable Certificate. But this level of accuracy and high cost (the meter shown at right is $273.00) it is gross overkill for the reloading bench.

One of the reasons that obtaining an accurate RH reading is so difficult is that relative humidity is "relative" to temperature. That is why digital hygrometers almost always display temperature in addition to relative humidity. So, any inaccuracy of the thermometer compounds the inaccuracy of the humidity sensor. If the thermometer reads high, the RH reading will be lower than reality. Likewise, if the thermometer reads low, the RH reading will read higher than reality. For example, if the actual RH is 50% at 72°F but the thermometer is inaccurate and reads 75°F, the RH would be displayed as 45%. All the more reason to buy a quality hygrometer! This is also an example of why Dew Point is a better measure of the actual amount of water vapor in the air. Dew Point (the temperature at which the moisture in the air will condense) will be constant regardless of changing temperature. That is why weather forecasts state the Dew Point in addition to Relative Humidity.

The bottom line is that it is best to buy a quality hygrometer that you can depend upon to give you accurate readings and test the calibration periodically.

Hygrometer Calibration – The "Salt Test"

Even expensive laboratory-grade hygrometers require periodic calibration to maintain their accuracy. So, don't believe any hygrometer is accurate without testing it yourself! Fortunately, there is a simple but remarkably effective way to test your hygrometer. It's called the "salt test". It just so happens that when salt (sodium chloride) is saturated with water and placed in a sealed container, the relative humidity inside the container will always stabilize at 75% with the room temperature between 65°F and 75°F.† All you need is an airtight container (a plastic zip-seal bag works great), some plain table salt, water, and a small container to hold the salt.

Pour 1/2 cup of salt into a teacup or other small open-top container and moisten it with about 1/4 cup of water. Add the water slowly until the salt is nice and damp. Don't add so much water that the salt dissolves, or gets slushy, or you see liquid at the edges or on top of the salt. If you do get it too soupy, just sprinkle in a little more salt (the final amount of salt is not critical). You will find descriptions of the salt

test on the Internet that recommend using a teaspoon of salt in a bottle cap, but the relative humidity will reach 75% faster and be more stable with a larger amount of salt.

TIP: If you put the salt in a small (2.5 oz) baby food jar or other similar jar, you can place the cap on after the test and save the salt for future use.

Carefully place the open container of damp salt into the zip-seal bag with your hygrometer and seal it up. If your hygrometer has a remote sensor probe, only the probe needs to be in the bag. Don't squeeze out the air and make sure the bag doesn't seal off the top of the salt container. You need some air space in the bag to allow for uniform circulation. Be very careful to not get any salt on the hygrometer!
After about 8 to 12 hours (I just leave it overnight) check the hygrometer reading. If it reads 75% then your hygrometer is perfectly accurate. If not, take it out of the bag and immediately adjust it to 75% (refer to the instruction manual for your hygrometer on how to make this adjustment). Don't delay, as the reading will change quickly once it is out of the bag. If your hygrometer cannot be adjusted, then simply take note of how far off it reads and factor that in when you read the humidity. For instance, if it reads 82% in the bag, then it's overstating the humidity by 7%. So just remember to deduct 7% from any humidity reading.

TIP: If you write this offset on a sticker and place it on the face of the meter, you won't forget.

TIP: If your hygrometer adjustment is made using a screwdriver, you may be able to leave the bag sealed and just poke a small hole through the bag for the screwdriver blade. This way, the environment inside the bag will remain stable while making the calibration adjustment.

You should plan on performing the salt test periodically to ensure the accuracy of your hygrometer. The battery of digital hygrometers usually needs replacing on an annual basis, so it makes sense to check the calibration when you install a fresh battery.

Choosing a Hygrometer

I did an extensive Internet search for digital hygrometers and found several that had good accuracy within a reasonable price range. But one meter in particular stood out from the rest - the HygroSet™ Digital Hygrometer. It is rated at ± 2% RH accuracy from 20% RH to 90% RH for just $35.00. The best feature is that it has a calibration knob on the front! I was skeptical that any hygrometer costing only $39.99 could have ± 2% accuracy, so I ordered a sample and checked it out myself. Before calibration it was off by only – 2% in the 75% RH salt test … impressive for such an inexpensive hygrometer! After calibration it was dead on 75%. Next, I placed it in my gun safe for a week at 30% RH, then performed the salt test again and it came right back to 75% RH. The reason for this test is that some RH sensors can become desensitized after extended exposure to very low or very high RH. I was so impressed with this hygrometer that I decided to add it to the UniqueTek product line. Item #: T1324

HygroSet™

Below are some other hygrometers I found during my search. Although I have not tested any of these, they come from reputable manufacturers, appear to be of good quality and have reasonably good performance specifications. All are significantly more expensive than the HygroSet™ but some have additional features (e.g., remote sensor probes, extremely wide RH range, Dew Point alarms, etc.) that you may find worth the added expense.

The following four hygrometers are manufactured by Extech and have large easy to read LCD displays. Extech Thermo-Hygrometers are available through many sources on the Internet and retail stores across the country. There is a dealer locator on the Extech web site.

Extech 445815

445715: ± 4%, 10% – 99% RH range, with remote probe, calibration screw.	$59.99
445814: ± 4%, 10% – 99% RH range, with dew point, calibration screw.	$52.99
445815: ± 4%, 10% – 99% RH range, with dew point & remote probe, calibration screw.	$62.99
445703: ± 5% accuracy and cannot be calibrated … so this model is not recommended.^	$51.99

^ This Model has been discontinued by Extech but can still be found on other web sites.

The following meters are manufactured by Testo and have accuracy specifications better than ± 4% RH.

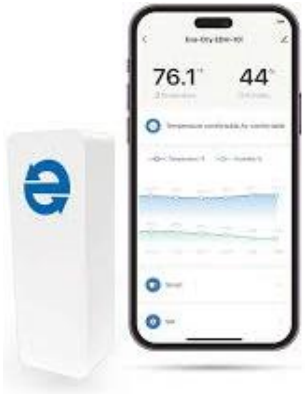
Testo 608-H1

608-H1: ± 3%, 10% – 95% RH range	$154.00
608-H2: ± 2%, 2% – 98% RH range.	$220.00

Testo makes many types of laboratory-grade test meters. They even have a Calibration/Service facility. I called them regarding the two hygrometers listed above and they said that the 608-H1 cannot be recalibrated but has a track record of holding accuracy over time. The model 608-H2 can be returned for Calibration/Service, at which point it undergoes a multi-point electronic calibration with the meter in an enclosed environmental chamber. There is a dealer locator on the Testo web site.

As you can see, the cost tends to increase significantly for hygrometers with higher accuracy and broader relative humidity range. In my humble opinion, even a hygrometer with ± 4% accuracy is sufficient for the purpose of reloading, but only if it can be calibrated and you are willing to check the calibration periodically with a salt test. But my first choice is still the HygroSet™. With its ± 2% RH accuracy, easy calibration and low cost, it is hard to beat.

Since the last update of this Tips file, a couple of manufacturers have made hygrometers that transmit temperature and humidity readings wirelessly to a remote display. A few years ago, I tested one of these early models and found the RH precision was very poor (19% difference when they were set right next to each other (see photo at right) and there was no way to calibrate either the display or the sensor. This product is no longer manufactured.



At Shot Show 2025, I found a new and more advanced product. It is made by Eva-Dry and transmits via any 2.4 GHz Wi-Fi router to an app on your cell phone. So, you don't even need to be home to monitor the readings! The app supports multiple sensors so you could place a separate sensor inside each storage cabinet in your reloading room … or anywhere else in your house that you want to monitor. Its stated RH precision is, disappointingly, a bit confusing. On the web site it says ± 5% RH from 0% to 100%. But, within the app it states ± 2% RH from 20% to 80%. I tested two different sensors in the Salt Test, and one was –5% and the other was –3%.
Unfortunately, the RH can't be calibrated. I commented about this to the manufacturer and suggested that, although the sensor cannot be calibrated, it would be easy for them to write code in the app to input an offset. I also asked for the ability to set an alarm to notify you if the RH goes too high.
I just got word (7/29/25) that the manufacture is working on an update to the app. Hopefully, they'll includer the additional features!
EDH-10i: Smart Temperature and Humidity Sensor: $29.99

Since Shot Show, I did a product search on the Internet and found several other products similar to the EDH-10i. But this is the only one I've had the opportunity to test.
Watch out for super inexpensive hygrometers that are now flooding web sites like AliExpress, Amazon and Temu. I recently found mini hygrometers advertising ± 2% RH accuracy at just $7.99 per 6-Pack! I would not trust them for as far as I could throw them!

Although this Tips file isn't about gun safes, I thought I'd go ahead and include some information as you might be tempted to try a sensor like the one above in your gun safe.
Transmitting from inside a gun safe is tricky at best. After all, you are trying to transmit a radio frequency from inside a closed steel box. In the electronics industry, this is called a "Faraday Cage". Anyway, I tried it and had trouble getting the sensor to connect to my Wi-Fi router. I finally tried hanging the sensor on the door (using Alien Tape) as close as possible to the crack in the door. It was able to get a connection, but it dropped frequently. Adding a Wi-Fi extender/repeater in the same room as the gun safe might have helped significantly, but I did not try it. So, although these sensors might be OK for closets and non-metallic storage cabinets, I would not expect any of them to work reliably inside a gun safe.

Where to Mount a Hygrometer?

– At Your Reloading Bench

With regards to your reloading bench, as long as the hygrometer is in the same room you are probably OK. Just make sure it is away from heating or air conditioning vents or drafty doors. Also, do not mount it on an external wall as external walls are often warmer or cooler than the rest of the room and this will affect the RH reading. My hygrometer is mounted on the wall directly behind my reloading press as this location is an interior wall, away from drafts and heat sources, unlikely to be disturbed, well lighted, and at eye level for easy reading.

– In a Storage Cabinet or Gun Safe

Mounting a hygrometer in a gun safe or a storage cabinet for powder, primers or loaded ammunition is a slightly different consideration. It may appear contrary to logic, but humid air is less dense than dry air. This occurs because the molecular mass of water (M=18) is less than the molecular mass of dry air (M≈29). Therefore, given a fixed volume of air at constant temperature and pressure, the more humid the air, the lower its density. Think of it as if you were replacing heavy air molecules with lighter water vapor molecules. In practical terms, this means that the humidity will tend to be higher at the top of an enclosed space than at the bottom, because the more humid air is lighter and will tend to rise. So, in a gun safe or a storage cabinet for powder, primers or loaded ammunition, you should install your hygrometer near the top, not the bottom. This also goes for a desiccant canister if you use one!

Dehumidifiers

If your reloading bench or ammunition storage area suffers from continuously high humidity, you may also want to invest in a dehumidifier. If the room is not air conditioned, simply adding an air conditioner will often take care of humidity reduction. But it will only help when it is running. So, a dedicated dehumidifier may be a better solution. There are so many manufacturers and models available on the market, and new models come out every year, it is not possible to review them here. Prices range from about $150 to $700 for portable units.

Dehumidifiers are rated according to their capacity: the number of pints of water removed in a 24-hour period. Units with 25-, 40-, 50- and 60-pint capacities are typical. The larger the room and higher the humidity, the larger capacity you will need. It is usually better to buy a unit with slightly higher capacity than you think you need. The easiest way to get the correct capacity is to discuss it with a knowledgeable person at the store. You'll need to know just two things.

1) Typical humidity of the room. High humidity is often a seasonal problem, so you'll want to measure it when it is at its highest.
2) Room area in square feet. (assumes a standard 8ft ceiling)

Once the capacity has been determined, the purchase decision is simply cost and features. Look for features such as:

- Auto-Off: Senses room humidity level and turns the unit on and off accordingly, saving energy
- Auto Defrost: Shuts off unit if frost forms on the coils, then turns on again after frost has melted.
- Shut-Off: Shuts the unit off when the water container is full
- Signal Light: Tells you the water container is full
- Hose Attachment: Connects the tank to a floor drain. Normally a section of regular garden hose works
- Pump: Pumps the water up to a sink, window or other elevated drain, if a floor drain is not available.
- Wheels: Allows mobility

As for features, where the water goes is one of the most important to me. Most units have an internal tank that must be removed and dumped periodically. If your humidity is very high and the tank capacity is small, it could need to be emptied several times daily! The next option is for a simple gravity drain that connects through a hose to a floor drain somewhere nearby the unit and continuously drains the water. If you don't have a floor drain, this obviously won't work. But some units now have both a tank and a pump. When the tank gets full, the pump automatically drains the tank by pumping the water through tubing to an external drain. The advantage of a pump is that if you don't have a floor drain, the pump can push the water high enough to reach a utility sink or other convenient connection to the drain plumbing in your house. With this feature you can run the dehumidifier continuously, if needed, without fear of an overflow. If the pump fails, there is still an automatic shutoff if the tank gets too full.

You may also want to research dehumidifiers in Consumer Reports magazine or on the Internet. Many retail stores (e.g. Lowes, Home Depot, etc.) have dehumidifier buying guides on their web sites that are very helpful. The more you know before you go to the store, the more likely you will buy a dehumidifier that is suited to your particular needs.

Regardless of which dehumidifier you decide to use, you should also have a separate hygrometer that you are confident gives accurate readings. The hygrometers that are built into dehumidifiers can be of questionable accuracy. And you will never know for certain unless you test it against a hygrometer of known accuracy. Also, the dehumidifier may be located across the room from your reloading bench and the room humidity can vary depending on where in the room the measurement is taken. So, having a hygrometer mounted close to the reloading bench is a good idea.

Desiccants

A desiccant is a substance that absorbs or adsorbs moisture to create or maintain a dry environment. Using desiccants to control humidity in an entire room isn't practical as the volume of air is simply too large. But desiccants can be used to good effect in enclosed spaces like the cabinets where you store gunpowder or primers and, of course, they are great in your gun safe. Two of the most common desiccants are Bentonite Clay and Silica Gel. But there are others as listed below.

Common Desiccants

- **Bentonite Clay** is a very fine-grained (colloidal) clay. The name derives from a deposit found at Fort Benton, USA. It is typically sealed in Tyvek® or Kraft Paper bags and can be regenerated by heating and used many times. Clay will successfully regenerate for repeated use at very low temperatures (120°F) without substantial deterioration or swelling. However, this property also means that the clay

will readily give up moisture back into the container as temperatures rise. Clay is a good basic desiccant that works satisfactorily below 120°F (49°C).

- **Silica Gel** is small clear porous pellets of silicon dioxide. It is generally considered nontoxic. It can be regenerated by heating to 150° - 180° F and used many times. At least one silica gel product (e.g., Eva-Dry) has an integral heating element and is regenerated by simply plugging it into an electrical outlet. Because silica gel is clear and colorless, it is not possible to detect when it is wet or dry. So, a color changing chemical is often added to cause the silica gel to change color when wet.
  - Cobalt Chloride: Changes from **blue** when dry to **pink** when wet.
  - Methyl Violet: Changes from **orange** with dry to **green** when wet.

  The latter is becoming more popular due to its low toxicity.
- **Anhydrous Salts** including Calcium Chloride (e.g., DampRid, Thirsty Hippo, DampFree, Container Dri® etc.) and Calcium Sulfate (e.g., DRIRITE®), are less common than silica gel, although having a higher degree of moisture absorption.
  - **Calcium Chloride** has a disadvantage in that the salt crystals liquefy when enough moisture has been adsorbed. So, the collected liquid water must be drained periodically, and the crystals replenished. And care must be taken to not spill the salty water … which would be very bad in a gun safe.
  - **Calcium Sulfate** has an advantage as it does not liquify or shed salty water. But it can be more difficult to find and more expensive.

  Regeneration of anhydrous salts, although possible, is impractical as temperatures in the range of 400° - 450° F (DRIRITE® recommends 450°F for at least 2 hours) is required to release the absorbed moisture. And higher temperatures can alter the crystal structure and render the desiccants permanently inactive.

  Although the initial cost of anhydrous salt desiccant products is usually low, regeneration at home is inconvenient due to the high temperatures. And the cost of replenishing the Calcium Chloride salt crystals can quickly add up to greater than the cost of either clay or silica gel desiccants which can be more easily regenerated.
- **Molecular Sieve (aka zeolites or aluminosilicates) and Alumina.** These are both less common and more expensive. They are typically used to drying gas streams in laboratory and manufacturing processes. Regeneration of Alumina desiccant requires temperatures around 200°C (392°F). So, they are impractical for home use.

Closing Thoughts

To reiterate one last time, monitoring humidity in your reloading room may help you load more consistent ammunition, and the exact % RH may not be as important as maintaining the RH at a consistent level from one reloading session to the next.

References:

Unfortunately, many of these documents are either no longer available and/or have been edited and reformatted such that they no longer contain the pertinent statements quoted in this Tips file. That does not negate the validity of the original publications. Those with hot links are currently available.

1. "Properties and Storage of Smokeless Powder" SPORTING ARMS AND AMMUNITION MANUFACTURES' INSTITUTE; INC. (SAAMI) https://saami.org/publications-advisories/advisories/
2. "Primer Storage and Safety", http://www.cci-ammunition.com/safety/primer_safety.aspx
3. FAQ, "How long a cartridge can be stored and still be usable?", https://www.lapua.com/support/faq/
4. "2022-Accurate-Double-Base-St-Marks-SDS.pdf", SDS Section 7 "Handling And Storage", Sub-section "Conditions for safe storage", page 5, Revised 12/11/2021 by St. Marks Powder, https://hodgdonpowderco.com/safety-data-sheets/

† Salts for Calibrating at Other Relative Humidity Values

Various salts yield different RH levels as shown in the examples below. But they are more difficult to find (what could be easier to find than table salt) and most hygrometers allow only a single point calibration. Professional or "laboratory-grade" hygrometers usually calibrate using two points (commonly 75% and 33%), which assures a more linear response across a broad range of RH values.

- Potassium Sulfate: 97%
- Potassium Chloride: 84%
- Sodium Chloride: 75%
- Potassium Carbonate: 43%
- Magnesium Chloride: 33%
- Lithium Chloride: 11%

Product Prices:

All product prices are based on Manufacturer's Suggested Retail Price (MSRP) at time of this revision. Brick & Mortar and Web retailer prices may vary significantly and change (up or down) without notice.

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