Keith Mayeaux
Virtual Products, LLC

41041 Black Bayou Road
Gonzales, LA 70737
USA

What is Relative Humidity?

What is Relative Humidity (RH)? RH is a term that indicates the amount of moisture in the air *relative* to the amount of moisture it has the *potential* to hold at a given temperature. For example, an RH of 50% means that the air contains 50% of the water vapor that it could potentially hold at a given temperature.

How does RH change in a case or enclosure?

The RH level can change constantly and drastically due to many factors. Some of these factors are: (a) the region of the world where the case or enclosure is located, (b) seasonal weather changes, (c) local weather changes, (d) changes in temperature, and (e) proximity to moisture producing and humidity elevating sources, such as a lake or coastal environment. Small portable cases or enclosures can be subjected to other factors causing rapid changes in RH as they are moved from indoors to outdoors and from buildings to automobiles or airplanes, and so on.

How do changes in RH create the potential for damage? 3 Considerations.

- "Too Wet" Conditions!

Conditions that are *"too wet"* cause wood and wood veneers to swell. Most gunstocks and wooden musical instruments have glues or adhesives binding the various components. The wood and adhesives swell at different rates. This may cause joints to crack. Also, with wooden instruments, the swelling can affect sound quality and the capacity of the instrument to hold its tuning.

In papers and paper goods, and in some instances cameras and electronics, conditions that are "*too wet"* create a favorable environment for the formation and growth of mold, mildew, and fungus. This can occur in safes, cases, and enclosures where the relative humidity is consistently in the 65-70% range, or above.

The rate of corrosion in electronics and electronic components is increased dramatically when exposed to high relative humidity conditions. As the %RH approaches the 90-100% level the equivalent of many months of corrosion (at a lower %RH condition) can occur in a short period of time.

- "Too Dry" Conditions!

Conditions that are *"too dry"* cause wood and wood veneers to shrink. The wood and adhesives in gunstocks and wooden musical instruments shrink at different rates. This, too, may cause the

joints to crack. In wooden instruments, the shrinking also changes the sound quality of the instrument and its capacity to hold tuning.

Extremely dry conditions will cause paper and paper goods to dry out and become brittle. Static electricity can cause anomalies and failures in electronics and electronic components under extremely dry conditions.

- Fluctuating RH Conditions

Constantly fluctuating RH takes the worst of *"too wet"* and *"too dry"* conditions and multiplies them, adding its own adverse effects. Wood and wood veneers undergoing fluctuating RH conditions shrink and swell continually. This shrinking and swelling causes the joints to crack, warping, and the finish on the wood to develop hairline cracks and appear "cloudy" over time.

Why ordinary desiccants and dehumidifiers won't solve these problems!

The goal of ordinary desiccants, such as silica gel, is to bring the relative humidity level to 0% or, in effect, a *"too dry"* condition. This is not a good solution since an extremely dry environment can be as destructive as an extremely wet or damp environment.

Additionally, ordinary desiccants have a very small capacity to absorb moisture (water vapor), even when exposed to very high humidity levels. Therefore, they are fully expended, or saturated, well before accomplishing their task. The result is that ordinary desiccants typically reduce the RH level to some low value temporarily and then expend their small capacity – *and stop working!* After they are spent the RH bounces back to its original level and begins again to fluctuate. The desiccant then needs to be replaced or regenerated.

The bottom line with silica gel desiccants and other dehumidifiers is that there is no continuous and effective control of relative humidity. Except for the short period of time that the desiccant is lowering the %RH before expending itself, the RH is allowed to fluctuate based on ambient conditions.

Why humidifiers won't solve these problems.

At their best, ordinary humidifiers only work to convert an extremely dry environment to one of varying or fluctuating relative humidity. They work by wetting a sponge (or some other object) in an attempt to create a higher relative humidity environment.

Once the humidifier is placed into the dry environment, it attempts to raise the %RH to its own 100% level. In so doing, it dries out. At the point it dries, the %RH is then allowed to fluctuate, as before, based on ambient conditions.

The bottom line with both dessicants and humidifiers is that the RH is not "controlled."

The Answer - *Zorb-It*™!

Ideally, the %RH would be maintained at a constant (or near constant) long-term %RH at approximately mid-range or mid-scale without the need for intervention from the user. This would eliminate "too wet", "too dry", and "fluctuating" %RH conditions.

That is exactly what ***Zorb-It*** accomplishes! When a ***Zorb-It*** packet is sized correctly for a case, safe, or enclosure, ***Zorb-It's*** unique formulation works to maintain a near-constant %RH over many years without the need for intervention from the user. In fact, if the packet is not damaged over time, it never needs replacement or regeneration!

How Zorb-It granules control Relative Humidity?

The heart of the revolutionary ***Zorb-It*** packets is its granules. The granules can absorb and release enormous quantities of moisture from the surrounding air without becoming saturated. (Please see the table included regarding ***Zorb-It's*** capacity vs. the total water vapor contained in an enclosure.) For comparison, ***Zorb-It*** conservatively has a 1,000% greater capacity to absorb water vapor than silica gel.

- The Process: How It Works!

When first placed in service, a packet of ***Zorb-It*** granules will begin rapid absorption of moisture. The packet will absorb at least five to ten times more moisture than a conventional desiccant before reaching equilibrium with the RH of surrounding air. Equilibrium is a condition that occurs when the granules have absorbed as much water vapor as possible at a given RH condition. This will usually take several days to occur, even in very humid environments. However, immediate protection is provided for the enclosure. Note that, unlike ordinary desiccants, the ***Zorb-It*** granules are not expended or saturated at this point. After reaching equilibrium, if the RH trend is rising, the ***Zorb-It*** granules absorb yet more water vapor therefore maintaining the %RH at a constant level.

During periods when the RH trend in the enclosure is declining below its long-term average, the ***Zorb-It*** granules begin to release moisture in vapor form (regeneration) in order to maintain a constant long-term average %RH. This regeneration process cannot wet the air above its average RH level.

By absorbing moisture when the RH rises and then releasing some of the vapor phase moisture when the RH drops, the packet maintains a constant RH within an enclosure, such as a case, safe, or cabinet. Its large capacity to hold moisture and its ability to regenerate itself distinguishes ***Zorb-It*** dramatically from ordinary desiccants.

During cycles of absorption and regeneration, the ***Zorb-It*** packet(s) may alternate between putty-like and hardened states. This is a normal occurrence indicating that the packet is performing as designed!

Comparison of Packet Capacity and Water Vapor in an Enclosure

The table below shows the Packet Capacity Ratio (PCR). This is a relative measure of the packet's capacity as compared to the amount of water vapor in an enclosure at a 50% RH level at 70°F.

Frequently opened enclosures or enclosures that are susceptible to rapid changes in RH conditions require a higher **PCR number**, typically **10 or above**.

Enclosures that are **always stored indoors** and/or **infrequently opened** require a lower **PCR number of 5 to 9.5**.

Packet Capacity Ratio (PCR)[A] Table

Packet Size	Packet Qty.	Packet Capacity[B]	Packet Capacity Ratio (PCR) Number							
			200 in.^{3}	1 ft.^{3}	2 ft.^{3}	5 ft.^{3}	10 ft.^{3}	15 ft.^{3}	30 ft.^{3}	45 ft.^{3}
2"x2"	1	0.3	**9.5**	**1.0**	--	--	--	--	--	--
2"x2"	2	0.6	**19.0**	**2.0**	--	--	--	--	--	--
4"x4"	1	5.8	**191.0**	**22.0**	**11**	**4.5**	--	--	--	--
4"x4"	2	11.6	**382**	**44**	**22**	**9.0**	--	--	--	--
7"x13"	1	43.2	--	--	**83**	**33.0**	**16.5**	**11.0**	**5.5**	**4.0**
7"x13"	2	86.4	--	--	**165.5**	**66.0**	**33.0**	**22.0**	**11.0**	**8.0**
Total Water Vapor[C]			0.0302	0.260928	0.521856	1.30464	2.60928	3.91392	7.82784	11.74176

[A] PCR is derived by dividing Zorb-It's capacity at 50%RH level by the grams of water vapor in an enclosure at the 50% RH level.
[B] Packet's capacity in grams of water vapor.
[C] Total amount of water vapor in the indicated size enclosure at 50% RH and 70°F

Factors to consider when considering which packet to use:

(1) The cubic volume of the enclosure. Multiplying the LxWxH derives cubic volume. For cubic volumes which fall between two packet sizes, consider multiples of the smaller packet or one of the next larger size packet, if room in the enclosure permits.
(2) The prevailing local RH condition where your case, safe or enclosure is stored?
(3) (a) How frequently will the enclosure be opened (frequently or very infrequently)? (b) How susceptible is the enclosure to rapid changes in RH conditions? In other words, is the enclosure mobile or out of doors?