

# Maintaining Relative Humidity Levels for Ukuleles

By Daniel Yong (also known as "Honukani" on many ukulele forums and message boards)

When I first bought my Hawaiian Koa ukulele in Waikiki three years ago, the store manager asked me where I lived on the mainland U.S. I proudly said, "Arizona!". He quickly responded, "That's a very dry state; you should humidify the ukulele when it is not in use. Oh, and by the way, the warranty does not cover humidity problems." My response was, "What does that mean?" He smiled and said, "If you don't humidify, the wood on your ukulele will crack. Just go to your local guitar store, buy a humidifier and insert it in the case. Check it every time you take it out and add water." He inserted the ukulele in a Lanikai (Hohner) UC Hard case shell, shook my hand and we parted ways. I was perplexed and decided to address this issue after my vacation. I had just bought a G-String, concert size, Honu model.

After spending two years experimenting with in-case humidifiers, exchanging ideas with colleagues, and information derived from the Internet, humidifying a ukulele is more of an "art than a science." The contents contained in this document are the opinion and viewpoints of my findings. The products mentioned in this article was used for testing purposes and is for information and convenience of the reader. Such use does not constitute an endorsement or approval or accuracy, adequacy, completeness, legality, reliability or usefulness of any information. This disclaimer applies to both isolated and aggregate uses of the information. I would like to thank my wife, Jennifer, "Ukulele Tonya", "The Dominator", "Flyin-Brian", Pat Tinnell and Derek Shimizu at G-String for encouraging me to embark on this journey.

## Humidity 101 Basics

What is humidity? According to Merriam-Webster Online Dictionary, humidity is defined as "the moderate degree of wetness in the atmosphere." A wooden ukulele is impacted by how much humidity is in the atmosphere. Wood has a certain characteristic in that it either retains a certain degree of moistness. When wood does not have enough moisture, it shrinks and when wood absorbs too much moisture, it expands. On a ukulele, too little moisture can potentially result in the fret board shrinkage, very sharp frets, lower action and a concave soundboard. In some cases, buzzing might occur. Too much moisture can cause the wood to bow and affect the ukulele's responsiveness, resulting in a muted sound and lack of intonation. Both extreme humidity levels and temperatures can also impact the glue that binds the ukulele and the joints.

## What is the ideal humidity level for stringed instruments?

The recommended ranges referenced in this section are derived from the guitar industry. Most experts recommend a 'relative humidity' (RH) target range between 45% - 55%. I have also seen 42% as an acceptable minimum level. According to the "Larrivee Guitar" web site, going past 55% to 70% RH is fine too. Even through trial and error and other factors like the outside humidity level, ukulele case type and internal heating/cooling systems, it is very difficult to achieve 55% the first time. In a nutshell, a minimum RH range between 45% - 70% is acceptable. Relative Humidity (RH) is the measurement scale used to measure the amount of water the air can retain in the atmosphere. A hygrometer is used to measure "Relative Humidity". (RH) There is a correlation between humidity and temperature. The higher the temperature, the more water it can retain. The lower the temperature the less water can be retained.

For humidity, the opposite effect occurs. The more RH in the atmosphere, the air can't take on more water or takes less at a slower pace. The less RH in the atmosphere, the air can accept more water at a faster pace. To increase the wetness or correct the dryness in the air, a humidifier is utilized.

## What are the available types of Humidifiers?

Humidifiers are used to increase the humidity levels of a designated space or area. In all humidifiers, water is utilized. There are two types of humidifiers for ukulele instruments: (1) Room Humidifiers and (2) In-Case Humidifiers.

### A Word about Room Humidifiers

A room humidifier is a household appliance which contains a fan, wick (filter) and water reservoir. A humidifier can also be attached to the furnace or be an evaporative cooler. A room humidifier alone is not adequate for ukuleles. Although, the room is perceived as a closed space, the space contains air gaps and the area is too large for coverage negatively impacts the ability to maintain the RH levels in a consistent manner. To successfully maintain the RH levels, a smaller closed and sealed container such as a ukulele case is required. Besides, a room humidifier is not easily transportable.

## In-Case Humidifiers

In-case humidifiers are almost compact, portable devices that are inserted into the cases. There are currently three types of humidifiers: (1) Sound hole tubes (2) Sponge, (3) Gel-Based and (4) Clay.

### Sound-Hole Tube Humidifiers

Sound hole tubes are inserted in the 'sound hole' of the ukulele with a clasp or lid which hangs on top of the strings. The main disadvantage with soundhole tubes is that the humidity is restricted to the soundbox and there is no coverage for the neck or fret board. If used alone, soundhole types are the second least effective of the in-case humidifiers, next to Gel-based tubes, because they dry too rapidly in arid regions, requiring refills at two-three day intervals. Could a similar sponge-like material could be enclosed into the sound-hole tube humidifier type without causing water leakage?

Product Name	Description	Advantages	Disadvantages
Dampit	Long rubber tubes in various sizes with holes. The tube is lays in the body. Distilled water is recommended.	<ul style="list-style-type: none"> <li>Easily available in music stores</li> <li>Less expensive than of sound hole types</li> </ul>	<ul style="list-style-type: none"> <li>Dries too quickly. In hot arid conditions, must be filled very 2-3 days.</li> <li>Water leakage occurs if too much water is applied</li> </ul>
Oasis	Neoprene with top lid to fill the water with gel based technology. Sits on top of the strings. The shape of the tube indicates when to refill. Distilled water is recommended.	<ul style="list-style-type: none"> <li>Changes color to indicate water refill</li> <li>No water leakage</li> <li>Easy to refill.</li> </ul>	<ul style="list-style-type: none"> <li>Dries too quickly. In hot arid conditions, must be filled every 3-5 days.</li> </ul>

### Sponge Humidifiers

Sponge in-case humidifiers can be mounted with Velcro within the case or seated on top of the inner compartment. The sponges are most effective in arid regions because it provides a rapid RH increase within 24 hours and is consistently able to maintain the RH level for a long period of time. Sponges are prone to water leakage if overfilled, not great for transport, and deforms in shape if the water has too much calcium. In areas where water quality is poor, the sponge will hardened and will require distilled water. For all its disadvantages, the sponge type is the best method for humidifying.

Product Name	Description	Advantages	Disadvantages
HumiCase Humidity Control Pack	Contains two specially treated sponges, an activator bottle and a mini-digital hygrometer. Distilled water is recommended.	<ul style="list-style-type: none"> <li>Very effective especially when using the activator.</li> <li>Great for ukuleles that are played frequently or taken out of the case on a frequent basis.</li> </ul>	<ul style="list-style-type: none"> <li>Most Expensive, compared to the other humidifier types.</li> <li>Water leakage occurs if too much water is applied because the sponge can deform in shape</li> <li>If water quality is poor, the sponge can hardened after a period of time.</li> <li>Hygrometer included in the pack is not very accurate. Readings can be off by 2-5%.</li> </ul>
Planet Waves Humidifier for Small Case Instruments	Contains special foam insert than ordinary sponge. The foam shrinks less than 1% when dry. Distilled water is recommended.	<ul style="list-style-type: none"> <li>Limited water leakage with syringe</li> </ul>	<ul style="list-style-type: none"> <li>Not readily available in major music stores.</li> </ul>

### Gel-Based Humidifiers

Gel-Based tubes are what can be found in cigar stores. Basically, it's a plastic tube with a cap and gel is added to a specific target line. Water is added to the minimum target line. When the water dissipates, it needs to be filled again. If water is added above the minimum target line, the water can seep out of the pinholes of the lid. If used alone,

these tubes are not very effective. It is the least effective of the in-case humidifiers. In one case, a gel-based tube turned brown and contained residue from a KoAloha Pikake soprano.

## **Clay Humidifiers**

Clay in-case humidifiers are loosely seated on the top of the inner compartment. The hardened clay shaped in a circular shape is soaked in water for five minutes. The humidity is released very slowly through the two pinholes on top the lid and will take some time for the RH level to increase. If used alone with two clay humidifiers, it is the most versatile and effective of all the humidifier types. The clay is susceptible to mold when applying the water on top of the clay and closing the case, instead of soaking the clay for five minutes.

<b>Product Name</b>	<b>Description</b>	<b>Advantages</b>	<b>Disadvantages</b>
Herco Humidifier for Cellos, etc. Also known as the Guardfather	A plastic film-like canister containing clay with a small pinhole on the top of the cap. Soak the water for five minutes and close the cap.	<ul style="list-style-type: none"> <li>• Very inexpensive of all in-case humidifiers.</li> <li>• No water leakage.</li> <li>• Can be used for transport and storage.</li> <li>• Very compact enough to add more than one humidifier.</li> </ul>	<ul style="list-style-type: none"> <li>• Releases humidity very slowly.</li> </ul>

When choosing the appropriate in-case humidifiers, consider these factors when deciding on the right type of humidifier: (1) Water Leakage, (2) Transportation, (3) Storage, (4) Playing Frequency (4) Arid Regions.

Water leakage occurs when there is too much water for the in-case humidifier to hold. Consider using sponge humidifiers if the ukulele is going to be stored in a permanent location, where water leakage would not be a major issue and if the ukulele is taken out of the case on a frequent basis. If the ukulele is going to be transported via mail or by air, then consider using two clay humidifiers and don't use the gel-based tubes due to airport security concerns. In arid regions, use a combination of two in-case humidifier types, instead of one. The least effective in-case humidifier types are the sound hole tubes and gel-based tubes. Sponge types are the best of all the in-case humidifiers.

## **Hygrometers**

Hygrometers are instruments for measuring humidity. In my experience, hygrometers that are not digital can result in an approximate 2-3% margin of error, so it's highly recommended to purchase a digital hygrometer. It's not critical, although, if the RH level cannot be maintained at 45-55% for a period of two weeks, then a 2-3% margin of error would provide inaccurate readings. In most temperature and hygrometer sensors, the temperature indicator is on the top of the sensor with the RH at the bottom.

## **In-Case Configurations**

A very good compact hygrometer is the Western Caliber III digital hygrometer which updates every 10 seconds. (Size 3.5" L x 1.25" H x .25" T) Unfortunately, this hygrometer type requires the ukulele case be re-opened to view the temperature and humidity levels. If you don't mind opening and closing the cases on a weekly basis, then this type would be acceptable. Opening and closing the case for several minutes, does not significantly impact the humidity and temperature. The current weather, seasonal conditions and length of time that the ukulele is exposed could influence the ukulele cases' temperature and humidity.

## **Remote Wireless Configurations**

Remote wireless configurations are the best because the ukulele case doesn't have to be opened to monitor the temperature or humidity. The best digital wireless hygrometer (333 or 433 MHz) is an Oregon Scientific or Radio Shack model. A wireless sensor transmits to an external display console every 30-60 seconds at a distance of 328 meters. A main advantage of remote wireless sensors is limit having to re-open the ukulele case to monitor the RH level. When a ukulele case is opened, the integrity of the humidity is compromised. Depending on the outside temperature and humidity, the RH level in the ukulele case can drop to approximately 5 - 7% within 20 minutes. Not drastic or extreme enough to cause the wood to crack, however, re-opening and closing frequently will cause some concern. Oregon Scientific makes a wireless forecaster which accommodates three wireless hygrometer sensors. Oregon Scientific also makes the Radio Shack model, and it is unknown at this time whether Radio Shack will

continue to sell them. Consider buying all three remote sensors, instead of one, since ukulele players have a tendency to acquire more than one ukulele, also known as “Ukulele Acquisition Syndrome.” (UAS)

## **Testing the Configurations**

I created three test configurations to prove that my setup works. Over a period of a year, I have been able to maintain the recommended humidity level ranges between 40% - 70% for approximately three weeks between water refills. The test duration was for 28 days in the month of February and the temperature and humidity levels were measured at the same time period on a daily basis.

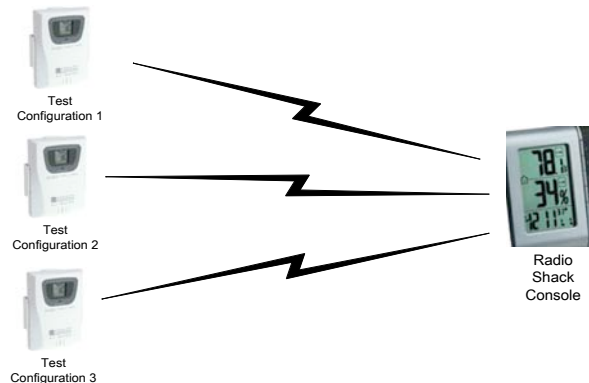
### **Test Conditions**

The following conditions were applied before testing began:

- The humidifiers were filled with water on the first day and were not filled during the testing.
- For the HumiCase humidifiers, the HumiCase Activation solution was used on the first day and was not filled during testing.
- The Hercos were soaked in water for over 20 minutes, more than four times the recommended 5 minutes.

### **Test Environment**

For this test, the Radio Shack Wireless Indoor/Outdoor Thermometer and Hygrometer console display (Model 63-1089) and the remote wireless thermo sensors were utilized. The remote sensors were approximately 30 feet from the console and located in another room. By default, each sensor transmitted a new reading every 30 seconds. Fresh batteries were inserted into the console and remote consoles prior to testing. Each remote sensor recorded to channels 1, 2, and 3 respectively. As previously notated, Oregon Scientific makes the Radio Shack model. Oregon Scientific makes several models versions of wireless indoor/outdoor thermometer setups.



### **Test Configuration 1: Occasional Play – Approximately Once a week**

The ukulele was taken out of the case for at least eight hours on a weekly basis and transported in a car over a period of two hours for a total of 10 hours. The Herco clay humidifiers were left inside the case during transport. When not in use, the ukulele was stored in a semi-dark location on a desktop. Over a period of four weeks, the ukulele was exposed to the external temperature and humidity levels for approximately 40 hours.

### **Test Configuration 2: Infrequent Play – Approximately Every 10 days**

The ukulele was taken out of the case for at least eight hours on an approximately two week interval and transported in a car over a period of two hours for a total of 10 hours. The Herco clay humidifiers were left inside the case during transport. When not in use, the ukulele was stored in a dark location in a cabinet. Over a period of four weeks, the ukulele was exposed to the external temperature and humidity levels for approximately 20 hours.

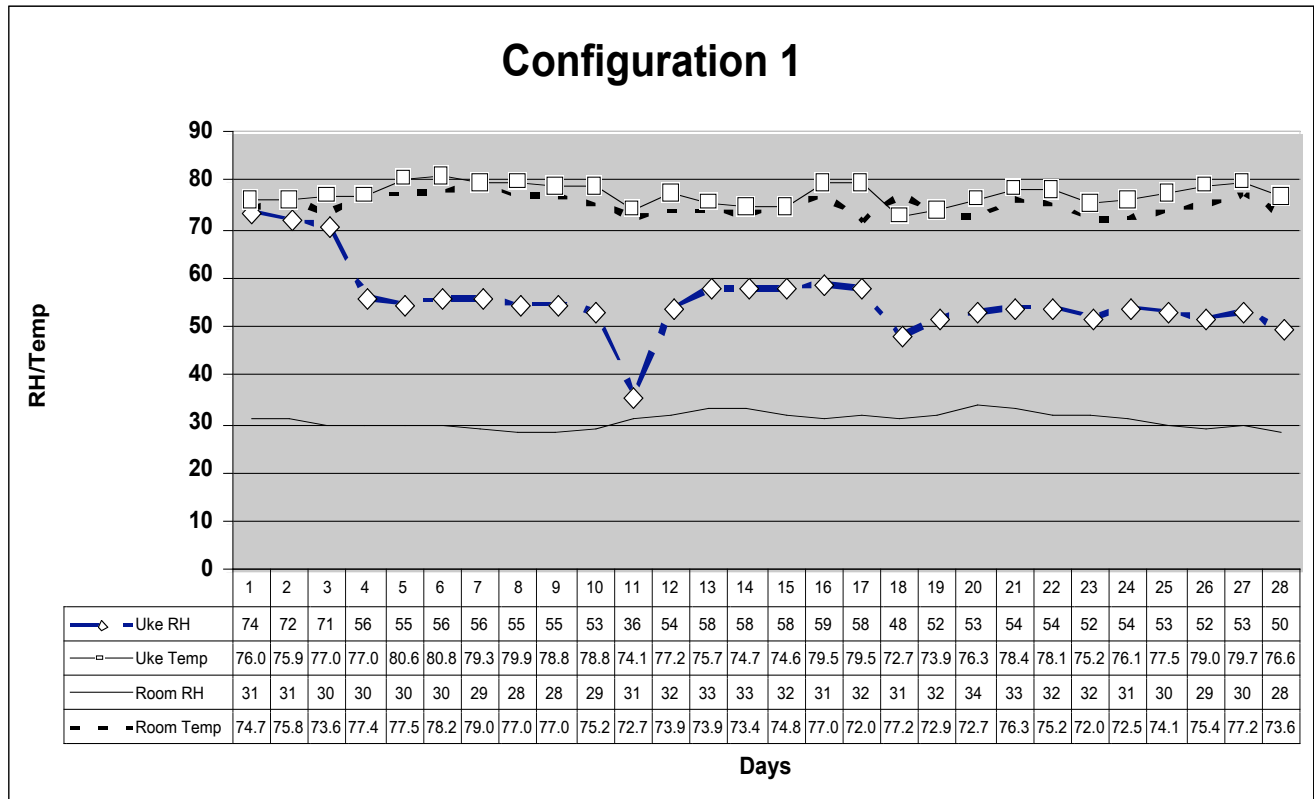
### **Test Configuration 3: Collector – Not taken out of Case**

The ukulele was not taken out of the case during the testing period. The ukulele case was stored in a cabinet in a dark location.

Config	Ukulele	Ukulele Size	Wood Type	Case	HumiCase (Qty)	Hercos (Qty)
1	2006 G-String	Tenor	Hawaiian Koa Rosewood Frets	Hohner UC hard shell case	2	2
2	2006 KoAloha Pikake Koa	Soprano	Hawaiian Koa	Hohner UC hard shell case	1	1
3	2005 G-String Honu Koa	Concert	Hawaiian Koa Rosewood Frets	Hohner UC hard shell case	2	2

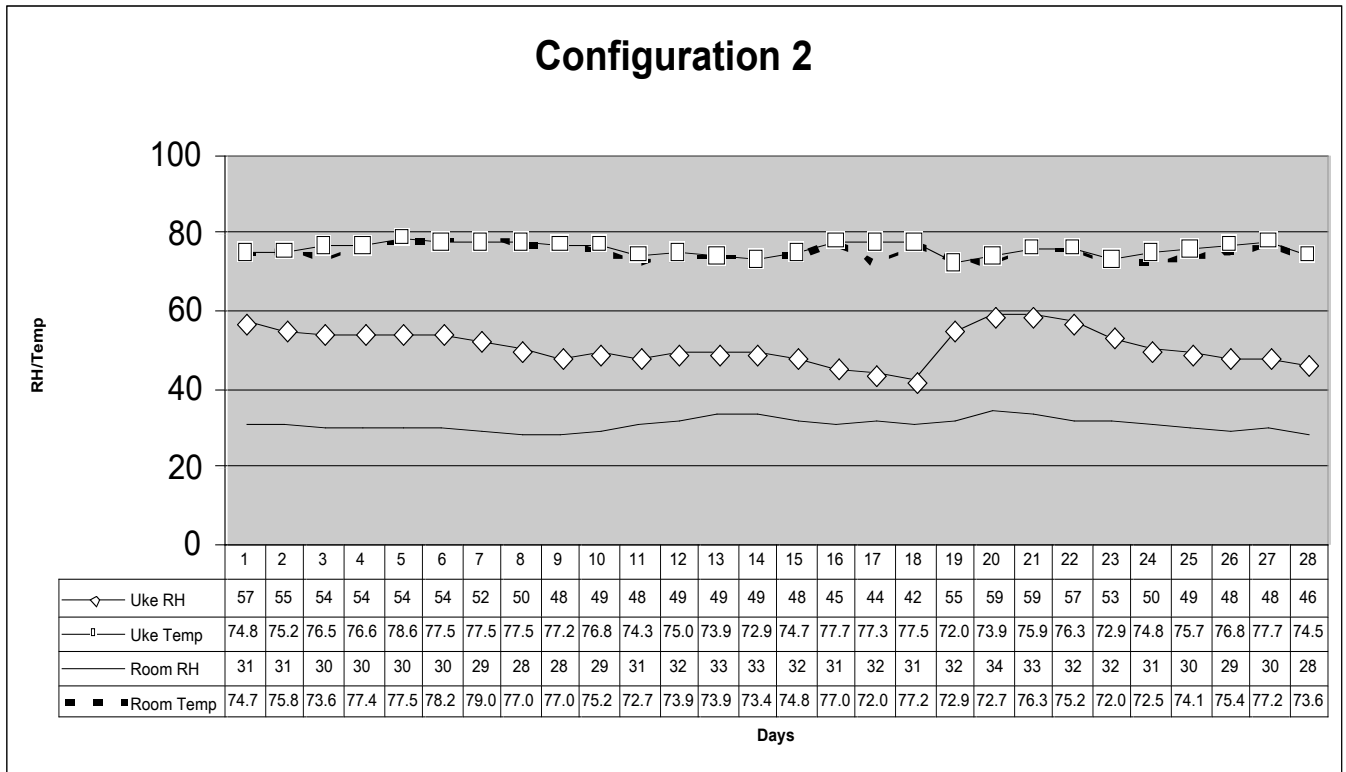
## Detailed Test Results

### Test Configuration 1: Occasional Play: Approximately Once a Week - G-String Tenor



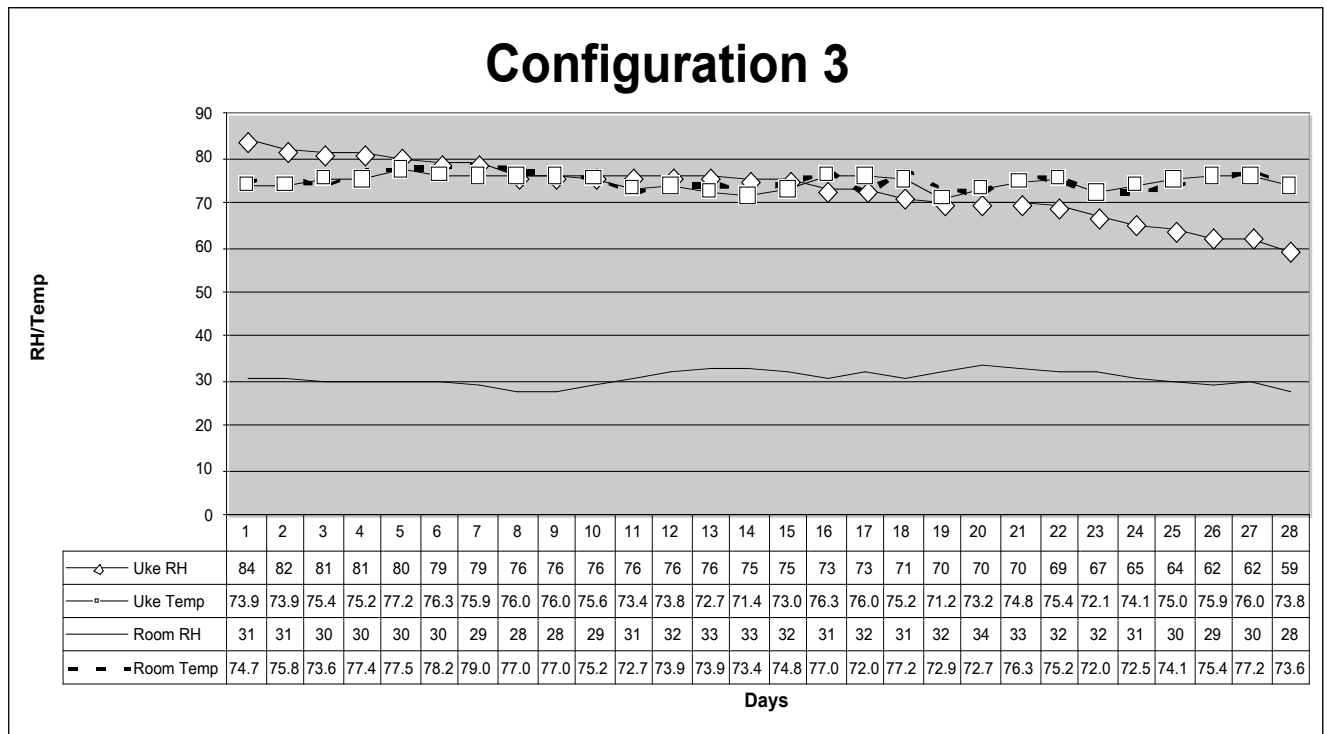
- For the recorded 28 days, in the ukulele case: Average 56% (RH), Temperature 77.2 F.
- For the indoor temperature: Average 31% RH, Temperature 75.1%.
- Although the temperature level results compared to the ukulele case and indoor were consistent in close proximity, the average RH level average difference was approximately 25% RH. If the ukulele was not exposed, the RH level could be maintained in the 21 – 28 RH range. If the external humidity was 31%, this configuration is capable of providing a minimum of 51% humidity.
- The significant RH and temperature drops on days 4, 8, 11 and 18 are attributed to taking the ukulele out of the case for a maximum of eight hours. The average recorded humidity levels in the ukulele case between when the ukulele was taken out and refilled are below: Overall Average: 53% RH, 77.7 F.
  - 1<sup>st</sup> test period = 3 days: Average RH 56%, 80.2 F.
  - 2<sup>nd</sup> test period = 3 days: Average RH 48%, 77.2 F.
  - 3<sup>rd</sup> test period = 7 days: Average RH 56%, 76.3 F.
  - 4<sup>th</sup> test period = 11 days: Average RH 53%, 77.1 F.
- In summary, the configuration provides an adequate level of humidity for a person who plays the ukulele on an occasional basis and has a soprano size ukulele. This configuration provides an average of range of 21 – 28% RH humidity boost from the indoor humidity level.

**Test Configuration 2: Infrequent Play: Approximately every 10 Days - KoAloha Soprano**



- For the recorded 28 days, in the ukulele case: Average 51% (RH), Temperature 75.8 F.
- For the indoor temperature: Average RH 31%, Temperature of 75.1%. The partial dotted lines in the graph above, indicates the indoor temperature and is extremely or equivalent to the ukulele case temperature.
- Although the temperature level results compared to the ukulele case and indoor were constant or in close proximity, the average RH level average difference was approximately 21% RH. If the ukulele was not exposed, the average RH level was between the 16 – 22 RH range. So, if the external humidity was 31%, this configuration is capable of providing a minimum of 47% humidity.
- The significant RH and temperature drops on days 8 and 18 are attributed to taking the ukulele out of the case for a maximum of eight hours. The average recorded humidity levels in the ukulele case between when the ukulele was taken out and refilled are below: Overall Average: 51% RH, 75.9 F.
  - 1<sup>st</sup> test period = 7 days: Average RH 54%, 76.8 F.
  - 2<sup>nd</sup> test period = 11 days: Average RH 47%, 75.7 F.
  - 3<sup>rd</sup> test period = 10 days: Average RH 52%, 75.1 F.
- In summary, the configuration provides an adequate level of humidity for a person who plays the ukulele on an infrequent basis. This configuration provides an average of range of 16 – 22% RH humidity boost from the indoor humidity level.

### Test Configuration 3: Collector: Not Taken Out of Case - G-String Concert



- For the recorded 28 days, in the ukulele case: Average 51% (RH), Temperature 75.8 F.
- For the indoor temperature: Average 31% [RH], Temperature 75.1%.
- Although the temperature level results compared to the ukulele case and indoor were constant or in close proximity, the average RH level difference was 42 RH. So, basically, if the external humidity is at 31%, the RH level in the ukulele case would be approximately 74%.
- The ukulele was not taken out of the case and the RH at the beginning of the test (Day 1) began at 84% and dropped to 59%. A gradual drop of 25% RH.
- In summary, this configuration provides an adequate level of humidity for at least 28 days, if the ukulele was not played or the case was not opened.

### Test Results Summary

Based on the test results below, the three configurations utilizing both HumiCase and Herco humidifiers is an acceptable configuration to ensure a minimum recommended RH target level of 45% for Koa ukuleles. By combining two humidity types with a remote temperature wireless sensor, the ukulele should be well protected to last for future generations.

Config	Ukulele Size	HumiCase	Herco	# of times and time period taken out of case?	Average RH (Ukulele Case)	Average Temp (Ukulele Case)
1	Tenor	2	2	4 times/4 days	53% RH	77.7 F
2	Soprano	1	1	3 times/3 days	51% RH	75.9 F
3	Concert	2	2	0 times/0 days	73% RH	74.6 F

## **Humidification Tips**

The following guidelines will help the ukulele stay humidified. As in high-end guitars, the high-end quality ukuleles are constructed using thinner woods and finishes and is more sensitive to climate and humidity changes than laminates.

- (1) In warmer seasons like spring and summer, it is easier to control the humidity level because the temperature is warmer and the air can readily accept water easily. Monitor the humidity levels on a weekly basis. It is easier to maintain the humidity level nearest to the lowest 45% level, than at the highest recommended level.
- (2) In winter months, closely monitor the humidity levels every two-three days. In colder air, it is very difficult to maintain the humidity level because the temperature is lower, and the RH is lower.
- (3) At a minimum, use a combination of two humidifier types.
- (4) Use distilled water if the water in the area has too much calcium. The calcium will harden the sponge humidifiers and would reduce their effectiveness.
- (5) When not in use, store the ukulele in the case. Ensure the case is completely closed to prevent compromise from the external humidity and temperature.
- (6) Always check or refill the humidifiers when the ukulele is returned in the case.
- (7) Do not store the ukulele near heat or direct sunlight. A closet or a dark area in a room is required.
- (8) Do not store the ukulele in a car for any period of time, except for transport. Storing an ukulele in hot temperatures can cause the glue that binds the instrument to loosen up.
- (9) For transport, two Herco humidifiers can be used. The HumiCase humidifiers can be removed and used again when the ukulele is in storage.
- (10) When using sound-hole type humidifiers, wipe off the excess water. Water does not agree with the sound box of the ukulele.

## **Other factors that can significantly impact the humidification process**

There are other factors that could significantly impact the ability to maintain the humidity in the case. It is important to consider these factors and to make adjustments when necessary. These factors are:

- (1) The type of ukulele case – must be appropriately sealed to retain the humidity level in a consistent manner,
- (2) The size of the ukulele – larger sizes requires more humidity,
- (3) The square area in the case that will require humidity,
- (4) Room temperature and humidity levels,
- (5) Air systems (air conditioning and heating systems) will either add or lower the room's humidity
- (6) Storage location of the ukulele, either in a dark place vs. sunny hot area
- (7) Frequency of opening the cases and
- (8) Geographical location including the seasons. The colder the temperature, the less stable the RH level, whereas, the warmer temperatures provides a consistent RH level.

## **Sources**

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