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This month: *Testing Standards, Coefficients, and Product Comparisons*

Theory and Background

I have witnessed and participated in a number of online discussions centered on how acoustical absorbers are measured, what the test results mean, how to fairly compare different products, etc. The subject is not always an intuitive one. This has led to the unfortunate situation of there being a lot of misinformation on the Internet pertaining to absorption and how it is quantified. Some people have even presented some wild theories and inaccurate explanations of acoustics, absorption measurement, and how the results should be interpreted. I would be remiss if I didn't start this presentation with a statement to the effect of: "Acoustics is grounded in the laws of physics. Beware of people trying to change those laws."

So let's start at the beginning: In the late 19th and early 20th century, a gentleman by the name of Wallace Clement Sabine was charged with improving the acoustics at one of *Harvard University's* hallowed halls. Almost by accident, Mr. Sabine discovered a relationship between room volume, surface area and sound decay. About 100 years later, we are still using the *Sabine equation* to make predictions about how rooms will sound.

As time went on, myriad scientists and acousticians have continued Sabine's work. Very soon after Sabine himself completed his work at *Harvard*, he helped set up the world's first acoustical laboratory – *Riverbank Acoustical Laboratories*. *Riverbank* was and still is a facility devoted entirely to acoustical testing. Almost concurrent with the establishment of *Riverbank*, the government took an interest in standardizing acoustical testing. This was largely due to the work being done by architectural acoustics pioneers such as Leo Beranek, Richard Bolt, Carl Eyring, Paul Sabine, F.R. Watson, and many others. There was a definite need to establish measurement standards, especially as other acoustical laboratories began popping up. The users of acoustical materials needed to be confident that regardless of the laboratory, they could trust the absorption numbers they were using.

Jump ahead to today and an organization called *ASTM International* which is responsible for preparing standardized testing methods, including many that pertain to acoustical materials and systems. The *ASTM C423* test standard is the *Standard Test Method for Sound Absorption and Sound Absorption Coefficients by the Reverberation Room Method*. Besides sound absorbers, any construction materials, acoustical diffusors, even office partitions and theater chairs should be tested in accordance with this standard. If the test is not conducted in strict accordance with this standard (or its international equivalent, *ISO 354*[1]), any *absorption coefficients* or *Noise Reduction Coefficients* (*NRCs*) that are published are probably meaningless.

So what are these absorption coefficients? What is an NRC? For a complete explanation, I refer you to the FAQ that I put together on our website. (Note that I will assume throughout the rest of this *Acoustology* that you have read through this FAQ.)

What the Numbers Mean

There are two main uses for absorption coefficients:

1. Absorption coefficients can be used to predict the acoustical properties of a room. This is more appropriate for large rooms because an absorption coefficient is a statistical quantity. The larger a room is, the more it is statistically reverberant. The more statistically reverberant the room is, the more accurate the prediction will be using measured absorption coefficients. Hence the reason why the test itself is given the condition "*by the Reverberation Room Method*." Using absorption coefficients to predict the acoustics of a small room – such as a studio – is not entirely "wrong." However, a studio room typically has very little reverb. For a small room, the difference between 0.2 seconds and 0.3 seconds of "reverb" does not tell us much. (Contrast this with the difference between 2.0 and 3.0 second in a large room – the same *percentage* difference – and it could mean the difference between understanding and not understanding speech!)

   Please note: I would be remiss if I completely dismissed the importance of absorption coefficients and reverberation time in small room design. The above merely reflects my personal reluctance to place "all my

[1] It is worth noting that the *ISO* and *ASTM* standards are not identical. For more information, please see the respective websites (links in text above) for more details.

eggs" in the RT "basket," as it were. I have written elsewhere on this topic, particularly at http://forum.studiotips.com if you are interested in further reading.

2. Absorption coefficients are extremely useful to compare two materials side by side and evaluate which is better for your particular application. It is very simple to do. The numbers are typically given in octave bands. Simply compare the numbers in the same octave bands between two (or more) materials. The higher values indicate the better absorber.

But there's a catch…actually, there are a few…

Pertaining to #2 above, there are a few things to that you should be aware of when making product comparisons or reviewing comparisons that others may have prepared:

1. Are the products even comparable? I.e., there is not much value in comparing drywall and 12" thick acoustical foam. It should be obvious which one is the better overall absorber. Not so obvious, though, are sample sizes. Is it appropriate to compare 1" thick acoustical foam to 1" thick glass fiber? It depends. If you have only 1" of thickness to give up, then that is probably a good comparison to make. However, if you are more concerned about which is easiest to install, you may want to compare *all* the different thicknesses of *each* material, and perhaps even compare their relative costs and how easy they are to install.

2. Mounting Methods. Beware of how the test materials are mounted in the test chamber. There are many methods, but there are two common mounting methods that almost everyone uses. These are known as "A" mounting and "E" mounting. (In accordance with a different standard method – *ASTM E795*.) For "A" mounting, products are laid flat on the floor of the test chamber. The "E" mounting is typically given a three digit suffix, e.g., "E530." This represents the depth (in millimeters) of the sealed airspace behind the acoustical material tested. The "E" mounting method is typically used for acoustical ceiling tiles. Some other notes on mounting methods include:

    a. One "trick" to be aware of concerning mounting methods is performing an "A" mounting test, but with some furring or other spacers behind the panels. Technically, this mounting is not "A" since the material is not flat against the chamber floor. However, it is not "E" either since the air space is not sealed. I.e., there is more surface area exposed to sound. This is not necessarily a bad thing. However, if one material is tested with an open airspace and a different, competing material is tested flat to the chamber floor, they *cannot* be fairly compared. The only comparison that can be made is the difference between the two materials *when they are mounted as specified*. Both materials would have to be measured using identical mountings to actually compare their raw performance.

    Example: A 3" panel from Company A is tested with a 3" airspace between it and the floor. A different type of 3" panel from Company B is tested flat on the floor. The numbers from one panel will probably be significantly different than the other. However, the A panel is actually a 6" thick "system" as opposed to a 3" panel. To make a fair, side-by-side comparison, the A panel would have to be tested flat on the floor ***or*** *the B panel would have to be tested with* an identical *3" airspace between it and the floor. Company A may make the argument that both panels are tested in accordance with the manufacturer's recommendations. While that might be true, it still does not give a fair comparison. You, the customer, are being asked to believe that a 6" system and a 3" panel are more or less the same, save for their absorption numbers.(!)*

    b. Be especially wary of non-standard mounting methods. E.g, results from tests where materials were hung on the chamber walls are useless for comparison purposes since no one else tests their products that way. While there is something to be said for "as-they-would-be-used-in-a-room" testing, the reverberation chamber is not the place to conduct those sorts of tests. If that were the case, we could simply throw out all the decades of hard work that went into making the standard methods what they are today.

    c. Also note that there is a special mounting method from *ASTM E795* known as "J" mounting. This method is usually reserved for things like theater chairs, unit absorbers and even people. The results of this test are reported strictly as *sabins per unit* or *sabins/unit*. Absorption coefficients ***cannot*** be calculated from sabins/unit data per the standard method. This is because the area of the object under test is open to interpretation. For objects tested in this manner, you should see the values reported in octave bands, but as sabins/unit as opposed to absorption coefficients.

Conclusions

If nothing else, I would hope you can take the following away from this – rather lengthy – installment of *Acoustology*:

- Testing for acoustical absorption is important. It gives us a clear-cut method for comparing materials.
- Materials *must* be tested in the same manner to make "apples-to-apples" comparisons. It is very important that product comparisons do not involve "what-ifs."
- Other non-acoustical factors, such as cost, ease of installation and appearance should also be taken into consideration when comparing different materials.
- Combinations of materials – even from different manufacturers – can often lead to better overall performance. We assist customers on a daily basis that make use of high-quality products from *Auralex*, as well as from other manufacturers such as *ASC* and *RPG*.
- Question everything. ☺
- For a very good presentation of many different acoustical products, be sure to visit the Bob Golds Absorber page.

Note: Modified for content on December 7, 2004…and again on June 24, 2005.