Canadian Audiologist

The Official Publication of the Canadian Academy of Audiology

The Limitations and the Benefits of a Flared Tubing

Published February 25th, 2014

Marshall Chasin, AuD

The science of flared or belled tubing is something that many of us were more aware of the 1980s than we are today. In the 1980s, with the limitations of the class A amplifier stages commonly used in the hearing aid industry, whenever possible, it was always better to amplify the higher frequencies acoustically than electronically. This was directly related to the high distortion with class A amplifiers with more intense (and high frequency) signals.

While this is no longer a concern with the ubiquitous use of the cleaner sounding Class D output stage that has been in use for about a quarter of a century now, there were some other benefits of a flared or belled tubing – we may have thrown the baby out with the bathwater. And, with the advent of slim tube hearing aids (with the receiver in the hearing aid), the Libby horn which flared from an inner diameter (ID) of 2 mm to 3 or 4 mm, is no longer widely used as well.

However let's return to the scientific basis of the Libby horn or any flared length of tubing. There are two equations governing the acoustic behavior, and these are the same two equations we can use in speech acoustics, musical acoustics, or the design of loud speaker systems.

> **Equation 1.** F = v/2L where v is the speed of sound (340,000 mm/sec)
> **Equation 2.** Amplification factor = 20 log (ID of wider portion/ID of narrower portion)

The first equation (F = v/2L) tells us at which frequency a flare or horn will begin to have its effect and the second equation (amplification factor) tells us the maximum amount of improvement (increase) in transmission in decibels.

Equation #1 says that the increase in gain and output will not be realized until the higher frequency region. Specifically for a 75 mm length of tubing – still found in modern behind the ear hearing aids – a flare will begin to have its effect at F = 340,000 mm/sec / 2 × 75 mm = 2266 Hz, and the acoustic amplification effect will gradually increase with frequency. For shorter eared individuals such as small children (shorter L), the effect may not be seen until closer to 3000 Hz.

Equation #2 tells us how much of a benefit we can obtain. In the case of the 4 mm Libby horn (that flared from ID of 2 mm to 4 mm) we have 20 log 2, which is 6 dB. That is, for a doubling from 2 mm ID to 4 mm ID we can obtain up to 6 dB of "free amplification." However, notice that we can obtain this benefit for any doubling and this includes from 1 mm ID to 2 mm ID tubing. This is the same formula that speech scientists use to determine how much we can increase our vocal intensity when we open our mouths wider, or musical instrument designers to determine how large the trumpet flare should be.

Some of the benefits that can still be recognized with a flared tubing (even for slim tube fittings) is an additional 6 dB of increase for both the gain and the output for sounds above about 2200 Hz.

Using an acoustic flare will improve battery life since the amplification occurs after the hearing aid circuitry.

Another benefit is that both the hearing aid gain and the hearing aid output will be increased by the flare. This is a much more desirable situation than if we simply turned up the high frequency gain using software. It may be that our clients require more high frequency gain and output than their hearing aid can provide. Use of a flared tubing will allow our clients to have sufficient gain and a sufficient output (for that gain) almost free of charge and may be able to continue on with their current amplification.

This can be accomplished by trimming off the last 20–22 mm of the slim tube and gluing on a piece of #13 tubing (which has an ID of about 2 mm). I typically use a receiver-in-the-ear tip which fits snuggly over the piece of #13 tubing.

This sounds “low tech,” and indeed it is but there is still a place for basic acoustic science in our modern day hearing aid fittings.

Reprinted with kind permission from HearingReview.com.