Subject: Re: More HornResponse
Posted by Wayne Parham on Thu, 17 Jun 2010 21:38:35 GMT
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The throat area (40cm2) is much larger than your original model (13cm2). So that's good, and I'd be more comfortable with it. It's basically a 2.5" square hole. I may have gone a little larger, but I am fairly conservative with paper cones because I don't want them to be too stressed at high SPL. I've seen them fold and rip. But this 40cm2 throat is probably fine, and if the manufacturer OK'ed it, that's encouraging.

My experience with horn mouth size is that smaller ones give more ripple. Of course, the boundary conditions can offset this, sometimes quite a lot. This is because a constrained space modifies the radiating pattern, effectively modifying the horn, itself. In fact, a trihedral corner has the same area expansion as a square mouthed 70° conical horn. A horn placed in a corner can be truncated quite a bit and the additional expansion from the corner will complete the flare. So a horn placed in a corner won't need to be nearly as large as one with similar specs used in freespace.

into the "Ang" field, for example, and see what happens to your response curve. But I don't think

the intersection of two boundaries, i.e. radiating into quarter-space.

Most times, I think, horns used indoors in home environments act like they are radiating into an

boundaries (including the ground). A tweeter in the air and not on a baffle would be an example.

My experience with drivers is the same as yours, that the driver parameters have a large impact on bottom end response. I would have expected more leeway with drivers, using rear chambers to set the bottom end with reactance annulling. But there's only so far you can go with that, so some drivers just don't have the ability to go low on a horn, while others can. Similarly, the upper end response is largely driver-dependent, but for an entirely different reason. The cone's breakup characteristics have a lot to do with the behavior up high, and this means two speaker models with the exact same electro-mechanical specs can perform completely differently at high frequencies.

Another thing that sets (on-axis) high frequency response is directivity. A pure conical horn will have constant directivity, so the on-axis response tracks the power response. But horns with other shapes have directivity that changes at different frequencies. Most tend to become more directional as frequency goes up, so even if power response sags, the on-axis response may get some boost from increasing directivity.

The earliest versions of HornResp could not model directivity, or its influence on the on-axis response. I understand that the later versions can, but I never have taken advantage of this feature. I have been using HornResp since version 3, and have always used it just to predict power response. On-axis response usually tracks power response at low and midrange frequencies, so a power response simulation is very useful, even without any consideration for directivity.

Directivity is probably not terribly difficult to model, but it isn't trivial either. A hypothetical infinite conical horn would give purely constant directivity. One that was very large would too, but as it gets smaller, the lower limit of the passband rises. At some point, directivity opens up at low frequencies, and in the transition region, there is some ripple in directivity from mouth diffraction. This is all stuff you can see in any single slit diffraction simulator applet, so modeling it is not too hard.

But what makes it a little more difficult are the numbers of these kinds of features in a real-world horn. There are many places where this kind of directivity modifier becomes relevant. And even more difficult to simulate would be cone breakup. I don't think it's realistic to try and model that. You could, but you'd have to know diaphragm material, strength, thickness and shape. It's just not something that this kind of model can simulate.

So these are the thing that affect high-frequency simulations, and the reasons why you will see deviation at the top-end of the response curve. You'll usually see more output on-axis than the simulation predicts because of increasing directivity and cone breakup. But even so, since these aren't usually significant at low and midrange frequencies, the simulation is very useful for predicting bass horn and midhorn response.

Finally, a word on the differences between constant directivity horns with straight sides verses those with curved sides. A couple paragraphs up, I mentioned that there is a transition region between the range where the horn walls set the pattern and below that where the pattern opens up. In this transition region, there is some ripple in directivity from mouth diffraction.

You'll see many CD horns that have straight walls up to about the last 1/3 to 1/4 of their length, closest to the mouth. They then open up a little more, right near the mouth. This is because the pattern narrows close to the lower limit, where pattern control is lost and it opens up. It is like a blip in the pattern, constant from the top down to the transition region where it narrows slightly as it starts to lose directional control, then opens up as pattern control is lost completely. By opening up the flare near the mouth edge, the pattern is maintained more closely constant down through the transition region. Instead of narrowing before finally opening, it stays about the same beamwidth down to the point where it loses control entirely.

This same widened mouth pattern shaping feature can be done with a gradual curve. The traditional CD horn has the sharp break near the mouth, with straight side walls, then an edge and a slightly wider angle at approximately 1/3 to 1/4 back from the mouth. But the same thing can be done with a horn that slightly curves, gradually opening up near the mouth. This avoids a diffraction edge but maintains constant directivity. Do not confuse this curvature with the shape of an exponential or tractrix horn though. Exponential and tractrix horns generally have deeper throats and do not maintain anything close to constant directivity.

Another place where diffraction can be used to control the pattern is at the throat. Some CD horns have sharp edges in the throat, which makes a sort of launch point diffraction slot. This makes the pattern wide, even at fairly high frequencies. The horn walls then constrain that pattern, and force it into the beamwidth shape desired. This approach has some consequences though. For one thing, the apparent source position is at the edge at off-axis angles, but it is deeper inside the device on-axis. Since the edges are usually positioned on each side of the throat (to increase horizontal dispersion), this makes the apparent source position nearer to the listener off-axis in the horizontal plane. This causes an astigmatic condition which is difficult to work with, particularly in arrays. It also causes internal reflections, which cause response anomalies in both the time and frequency domains. Most people identify this as a harsher sound.

The other alternative is to gradually bend the source from the throat entrance to the wall angle. Since compression drivers are designed to generate plane waves, the entrance is basically straight and this can be curved gradually to the desired wall angle. In practice, the pole piece of a compression driver (which forms the beginning of the horn) is usually 6° to 10°, so the throat of the horn starts there. It can be gradually radiused to the wall angle with an oblate spheroidal or quadratic curve. This results in a much gentler expansion and greatly reduced diffraction which most people think sounds better. However, at the highest frequencies, the pattern is set by the narrow 10° "stub" of a horn inside the compression driver. For a 1" exit driver, this beaming doesn't start until about 15kHz though, so it is probably not significant.