Subject: Effect of gaps and back chambers.........
Posted by Adrian Mack on Mon, 11 Aug 2003 09:48:42 GMT
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Hey everyone,Today I decided to do some frequency response/transfer function tests on a midrange Tractrix horn with 300Hz cutoff frequency that I recently built. I decided to see what the effect was when I put a gap between the front chamber and driver, when there was no gap, and when there was a back chamber with and without lining. Measurements were taken outdoors to avoid room reflections, and the microphone was placed on axis (possible not exactly on axis but rather a slight difference because it was hard to get it exact) at 42cm distance. The driver used was an Eminence Alpha 6. Below is the response when there was no gap, and no back chamber:As you can see, there is a massive rolloff from about 460Hz where it roller-coasters downward. There's about a 6db difference between 500Hz and 1KHz. I then decided to take a measurement with a 3mm gap between driver and mounting plate. Here we can see there is no more roller-coaster action from 500Hz to 1KHz. It's now within about 3-4db which is pretty good. But just for experiment sake, I tested it with a 5mm gap and the results are below. In this case, the top end has been brought up a bit more as evidenced by comparing the amplitude at 1KHz on this graph and the one before it. They are both good, but the larger gap extended HF response, but only marginally. Something to note however is the 3db dip at 600Hz. Although this should not be an audible difference, its worth noting for the rest of this discussion. Below is what happened when I gapped it by 8mm. Essentially, there was no difference. Below is when it was gapped 10mm. Again, there was no real difference again, although response between 1KHz to 2KHz has been brought up, a little bit. So basically, it seems that gapping the front chamber does have merit - but only small gaps are needed to make a difference. Anything gapped more than 5mm really won't have much effect, and certainly would make no audible effect. I then did a small study of backchambers. I used an empty icecream container, and when it was put on had a net volume of 2L. Here is what it looked like with no gap, and 2L back chamber with no lining. Nice! Compared to when there was no back chamber and no gap - this is so much better. It's now very flat up to 1KHz, much like the gap did - except there's no 600Hz dip. I then conducted a test using about a 2cm layer of lining in the back chamber. Here is what it looked like. We can see 500Hz to 1KHz response is a bit flatter, but since the difference is only about 1db, they are both essentially the same. What we can notice is the junk above 2KHz - although a fair bit of that is likely contributed to noise and such, the stuffing should, in theory attenuate some of the resonances as Hornresp predicts when you model with lining in the back chamber. I did not try any other sized back chambers, as I really only did the back chamber measurement because I had something that fit perfectly, and that was the plastic icecream container. I'm sure that a different sized back chamber would alter things significantly, Hornresp tells me that back chambers of very small volumes makes the horn usable to a lower frequency before it drops off. It also means excursion is increased though. Hornresp also tells me that while it betters performance at the low end, the upper cutoff before it drops is lowered greatly. Using larger back chambers doesn't sacrifice performance at the top end though, and neither will an extremely large back chamber - its only very small back chambers that sacrifice the top end to gain the low end. Essentially both gapping and using back chambers made 500Hz to 1KHz very flat, and the back chamber did a slightly better job at this because there was no 600Hz dip. But above 1KHz - the front chamber, showed less of a dropoff. But it was only a difference of 2db at 1.5KHz between a 5mm gap and a 2L back chamber. Now... it's pretty clear that this horn performs within 3db from about 450Hz to 1.1KHz when we use either a gap between the driver and front plate, or when we use a back chamber. I wanted this horn to go to 1.6KHz so that the compression driver which I am crossing over too would not have to perform as low. So I decided to take some in-room measurements, where all the reflections, etc come into play. Above is a chart when I took a measurement at 42cm from the dustcap on axis. It was not gapped and had no back chamber. It was placed in half space conditions, meaning the back of the horn was up near one wall. Notice how it's flat to 1.4KHz. Those spikes you see weren't from the horn itself, it was caused by the room. With a small shift of the microphone, that 1.5KHz spike disappeared (but I forgot to take a screenshot of it). But that's the thing, and everyone knows it already. Once shifted a bit so that it's no longer on-axis - the frequency response is going to change dramatically, and it did, it roller-coastered downward above 1KHz when I moved the microphone even by smaller amounts. This happens outdoors too of course, but of course, indoors the room can make things even more complicated. So there's a few conclusions that can be drawn here. The gap increases the upper frequency cutoff, and from my tests also introduced a dip of 3db at 600Hz, but that won't be an audible problem really. Bruce Edgar in his '86 Speaker Builder article "The Edgar Midrange Horn" says that the gap is used to clip off peaks and it acts sort of like a highpass filter. This could be true for when response is already flat with no gap - but apparently, mine wasn't, and the gap made it flat at the expensive of a small dip. Using a back chamber is also a very interesting thing. My conclusions are that the back chamber can be used to better high frequency performance as well. Hornresp doesn't quite predict the same thing, but that's OK as this is what happened with my horn using the test setup that I've used, and all measurement anomalies in the setup. But in any case, a back chamber is a good thing. I did not do any experiments with front chambers, as this would be a real pain in the ass! In any case there's always a front chamber because there's volume in front of the cone, but I did not experiment with different sizes. However Hornresp predicts that using small front chambers retains flat response to a higher frequency, where oversized front chambers sacrifices the upper limit greatly. The minimum front chamber volume is the volume of air in front of the cone - but we can change this if we use filler blocks to take up some of the volume. CAD programs must be used so that the block can be made to the exact size and to ensure that the cone won't hit it. Anyway... I just thought I'd post my findings. I hope it's been interesting or useful to some of you!Adrian