Subject: Consider Using Tube Enclosures for your Speakers.....
Posted by Marlboro on Sat, 19 Sep 2009 16:42:38 GMT
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This is an unusual design. The speaker community is not into unusual designs, as a rule. They like boxes, even unusual boxes. They don't like cylinders and they especially don't like PVC tubes, and they don't like to be told that tubes made out of thin walled VERY LIGHT pvc, are better for all the reasons listed below than heavy boxes . Seven foot array speakers are supposed to weigh in at 500 pounds with all that MDF. Everyone knows that.

1. Unlike a box, as the pressure inside a cylinder increases, the walls of the tube become more rigid not less. As the pressure increases, the amount of flex of the tube itself actually get less. Its pure physics. So you can use thin wall PVC pipes, whose integrity actually gets stronger. With a tube such as PVC, there is no flexing and no having holes opening up in the sides of the enclosure. This also means the tubes don't tend to vibrate in the same way a flat wall does.

2. Standing waves are a huge problem with the muddying of sound from box speakers. Standing waves require parallel flat surfaces. In a cylinder, there aren't any except for the end cap(there are very small point to point parallel surfaces) . BUT THE END CAP IS OFTEN many inches away from the speaker through an awful lot of fiberglass. Additionally sound in tubes doesn't bounce back and forth against the walls, it travels down the tube. The physics of sounds in tubes is unusual. There is also a 3db loss per distance just like a near field

3. The resonance of air column of a closed cylinder is measurable, but generally its four times the length of the column. So the frequency of the resonance of the tube is usually related to the length of the column. Mine are 23 inches long. This comes out to a resonance of about 150 hz. My midranges cross generally at 165, so basic resonance is below the level of anything that the speaker puts out. But the tubes actually don't vibrate due to the rigidity of #1. And if they did, they would actually reinforce the low notes. And the vibration is minimal since each tube only carries 6.25% of the total mid range sound of the channel.

Another way you can do it is to arrange for the resonance to take place at about the lowest level that the speaker will be putting out: near the crossover. This will reinforce the bass. I have found this to be true and it does reinforce the bass at those frequencies. If I had made the tube length about 30 inches instead of 23, I could have obtained reinforcing resonance at about 100.

If the tubes were 56 inches long I would get a resonance at about 65 hz. However, the mid range speakers do need to go low enough without distortion to benefit from this. Mine don't go that low.

4. Fiberglass is the best sound absorber; Vance Dickenson had research to prove it . Sound doesn't really get absorbed, it gets converted to heat. Fiberglass is better at absorbing heat than the other kinds of insulation. Additionally, the degree to which the sound is absorbed by fiberglass is measured by the inches of insulation that the sound waves have to go through to reach the "end of the enclosure" before starting back. The attenuation is on the order of .90 per four inches(using 4 lb. per cu ft density.) Since my tubes are 23 inches to the back, not your normal 4-5 inches of a standard square or rectangular box enclosure, the attenuation of the absorption is better than 98%---a lot better. My tubes are 289 cu inches. There are 1728 cu inches in a cubic foot. This is 0.16 of a cu ft, of 4 lb. So the amount of fiberglass that needs to be

in each of my tubes is about 8 oz. I wrapped the fiberglass in polyfil batting to protect the speakers from stray strands of fiberglas, and due to the shape of the cylinder pushed the insulation in very tightly.

After much reading, I came to the conclusion that the biggest issue with midrange speakers is coloration of the sound caused by sound returning back through the speaker cone milli-seconds later than the directed output. The combination of high density fiberglass(but still allowing sound to travel through it, length of travel, etc, reduced the return sound coloration to less than 2% rather than the much higher number in non-long-tube enclosures.

And..... the coloration that does come through is only of the odd ordered harmonic variety(increasing clarity), and only comes from the speaker that emanated it in the first place, not 15 other speakers of varying speaker coloration in a giant gloppo of indifferentiated sound wash.

5. Tubes have the unusual characteristic of eliminating the even order harmonic energy because of the physics of sound in a closed cylinder. This means that half of the additional harmonic energy beyond the fundamental tones created by the speaker into the cabinet never appears at all. What is left is odd ordered harmonics, which at high distortion levels are not pleasant(but array speakers never get to distortion levels when the speakers are only carrying something like 6.25% of the total midrange sound). Additionally there is some research in electricity that gives a suggestion that odd ordered harmonic energy is more heat producing than even ordered harmonics. But the small amount of harmonics that do get back out the speaker in the front, if any, will actually increase the clarity of the speakers. I've noticed that too. My mid ranges actually seem to have greater clarity as they are pushed up in sound volume.

6. Using individual tubes for each of the midranges adds lots of complexity to the project, but the isolation of each speaker does wonders for the total clarity of the system.

7. Because it is a closed tube, you can actually calculate the exact resonance of the tube and also its harmonics(which of course are only the F3, f5, f7, etc. which is 50 60 db down from the fundamental.) A 23 inch tube has a fundamental of 145hz and F3 of 435,, and a F5 of 740. The fundamental will actually reinforce the upper bass of the small speaker, and actually allow a lower crossover to about 144 or so.

8. The whole speaker is much lighter. When you are talking about moving around a speaker that is 7 feet high by 8 inches wide by 23 inches deep, all that MDF might weigh 400 lbs. That's an awful lot of weight to be carrying around or pushing around for a man of my advanced age!

Subject: Re: Consider Using Tube Enclosures for your Speakers.....
Posted by AudioFred on Sun, 20 Sep 2009 11:06:31 GMT
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Marlboro wrote on Sat, 19 September 2009 11:42This is an unusual design. The speaker community is not into unusual designs, as a rule. They like boxes, even unusual boxes.

Successfully marketing a high end speaker requires the designer to balance manufacturing costs against the need to visually differentiate one's product from all the others. The less expensive speakers are usually placed in a box because a box is easy (and cheap) to manufacture. As the retail price point increases it becomes more important to make a visual statement, because many consumer purchase decisions are made on the basis of physical apperance.

Cylindrical enclosures can have a stunning physical appearance, and as you mentioned they are far more rigid than a box, but building a line array with multiple cylinders is labor intensive, making it cost prohibitive for all but the most expensive products. At least one high end line array manufacturer agrees with you, and they charge enough for their line arrays to cover the higher manufacturing cost.

http://www.scaena.com/main.htm

Fortunately, those of us who DIY provide free labor, so we can do what works best even though the commerical builders are limited by cost constraints. Did you use 3" pvc pipe? How did you attach the drivers?

Subject: Re: Consider Using Tube Enclosures for your Speakers.....
Posted by Marlboro on Sun, 20 Sep 2009 13:17:52 GMT
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Exactly.... there is no way that any manufacturer could put together a line array using tubes, unless they were willing to charge many many thousands of dollars for it.

This is a technique limited to the DIY speaker builder. It took months of weekends to cut all the slots and the holes.

And there is the visual element. Some people would like the stunning visual sort of modern look, and others would find that their wives and decorators would not accept it in their 'decor'. For those who don't like it you would need to put some kind of 1/4 inch wood veneer on the sides to match sensibilities.

I used 4 inch pvc pipe. The closing in the back was easy since these pipe have PVC en-caps that can be glued using PVC cement, which makes them essential to the pipe itself. Once you use the glue the pipe never comes apart again.

In the front I drilled a circular slot that the pipe fit into, in the oak baffle in the back. I then glued the pipe into the slot using Epoxy. On the outside of the slot, I sealed the edge with a bead of heavy duty liquid nails construction cement, and then painted the tubes and the back of the baffle black. The circle slot was wider that the hole that was cut in the front for the 3 inch speakers. That hole has to be champhered to allow air movement of the speaker diaphragm into the tube itself.

As I said, there are many benefits, but the labor is nearly impossible for a manufacturer, although I can think of a number of ways after building one set to streamline and speed up the costs.

If people want, I can take a photo of the back where it attaches to the oak baffle.

Marlboro

Subject: Re: Consider Using Tube Enclosures for your Speakers.....
Posted by jp on Sun, 20 Sep 2009 20:17:03 GMT
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Marlboro
You are technically extremely convincing ! I will certainly attempt to build a pair of arrays using this same design principle . I will plan and will ask for your support when ready .First of all is choosing wich drivers to use ? I would'nt like to go through using so many domes as U did, so I will consider using palnar BG's , wich I think have passed the test succesfully on Zaph Audio comparative test, and their price is not prohibitive . As for the Mid/Woof driver , it will have to be a 4" max diameter . I am a fan of paper cones or reed cones or any natural fiber cones !! That's it as a start.
JP

Subject: Re: Consider Using Tube Enclosures for your Speakers.....
Posted by Marlboro on Sun, 20 Sep 2009 22:13:30 GMT
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What kind of price range would you be looking at for the 3-4 incher?

If you go above three inch you will need to use either sonotubes or more expensive thick wall PVC sewer pipes. If you were to use sonotubes I would probably use an epoxy based paint inside and out. This would stiffen them up and at the same time give you the softer sandwich inside. Given the option now, I would probably do that for a new version. Not that the vibration is an issue, but a sandwich would probably help if you want to split hairs.

Zaph has some good choices, but one would need to know how much you were willing to spend for each of them. About three years after I put together my 3 inch midsm Selah came out with a double row of three inchers using what looks like 32 of the HiVi B3S 3" Shielded Aluminum Driver Square Frame(less than 11 bucks each at PE)---Symmetrica, I believe. But these are aluminum coned items and like you I would prefer not to be using aluminum.

At $26 the Dayton RS 100S would look really good to me, and I would have used them if they'd come out as promised back in 2004, but then they were going to be offered at about $6 each.

And alternative to the B&G's might be two Fountek horn tweeters per side. You would certainly get the sensitivity you need and though they are $310 each... its a thought.....

Marlboro

What's YOUR poison?

Subject: Re: Consider Using Tube Enclosures for your Speakers.....
Posted by thomas216 on Mon, 21 Sep 2009 15:20:32 GMT
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I used some of Marlboro suggestions when I was building my first line source. The problem I had was the driver frames were truncated, if I used an entire piece of PVC I could not get the C to C spacing as close as possible. I came up with a different solution, a little more labor intensive but it worked out. The pictures in the Photobucket LINK below are self explanatory, except I mounted the PVC piece non parallel, and the drilled holes outside the PVC are for sand to drain into the bottom layers once the sides are mated to the cabinet. The cabinets weigh about 125 lbs but are dead

http://s212.photobucket.com/albums/cc167/tomr3399/

The other pictures in the album are of a new array project using 16, four-inch full range "NSB" drivers per side and will use 60 3/4" inch tweeter per tower. This is an evolving set of arrays, I will also try running the full range driver way beyond the comb filter point to see if this as actually destructive or not.

Tom R

Subject: Re: Consider Using Tube Enclosures for your Speakers.....
Posted by selahaudio on Mon, 21 Sep 2009 16:10:27 GMT
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Tubes have strong resonances so you must make sure they're heavily damped. I'm not so sure this is the best solution for an array because the spacing could be widened with a PVC tube. You also have reflections with the walls being very close to the driver frame.

Subject: Re: Consider Using Tube Enclosures for your Speakers.....
Posted by Marlboro on Mon, 21 Sep 2009 16:17:18 GMT
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You certainly have a right to your opinion.

However, I have already stated that tubes should be damped with full 4 lb/cu inch fiberglass, which is pretty intense, and that the physics of sound in tubes causes it not to bounce around willy nilly like in box speakers but to move down the length of the tube. Additionally, the resonances of

air columns in tubes is well reseached. So you know up front exactly where the resonance will be. In a closed tube you also know that half of the air column resonance will not be there.
Additionally since you have only one speaker per tube resonating, circumstances are way more easily controlled than in a box, with sound flying around willy nilly, and multiple speakers sending the sound everywhere.

Subject: Re: Consider Using Tube Enclosures for your Speakers.....
Posted by Wayne Parham on Tue, 22 Sep 2009 02:09:22 GMT
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Have you ever looked at Martin King's spreadsheets for designing transmission lines? They're extremely useful tools for examining this very sort of cabinet.

For a while, I think he pulled the software off his website because of abuse. But I seem to recall it was back up. If you get the chance, take a look. I've used it and I find it extremely useful (payed the commercial licensing fee too, fwiw). Measurements correlate very well with the simulations.

Subject: Re: Consider Using Tube Enclosures for your Speakers.....
Posted by Rocket on Mon, 19 Oct 2009 16:18:24 GMT
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Well,
Consider me convinced! Dang dude, I would have never thought you put this much "math" into it. I am remarkably impressed.

Tell me what you think of this:
Using your tube technique, but leaving them open, adjusting the length to load the drivers enough to get the FS that one desires. Obviously an open baffle design.

Use the little B/G planars for highs. OB woofers like the ones from GR research for the lows...

Whatcha think Marlboro Man? (you too , Rick)

Oh, and what about using fiberglass tubes?

- R

Subject: Re: Consider Using Tube Enclosures for your Speakers.....

Posted by Marlboro on Mon, 19 Oct 2009 23:48:51 GMT
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Some of the best benefits of tubes come from using them for the mid ranges in closed configuration. But you still have many benefits.

But you want to choose whether closed or open on the basis of the Q components of the speakers you choose, or choose the speaker so that you can have an open or a closed tube.

I don't know that the material of the tube is important. It may be.