Subject: Re: Horn loading and frequency
Posted by DMoore on Wed, 26 May 2010 00:44:42 GMT
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Well, you are right about most horns having too small of a mouth area to be "optimal". But then we have to define the word "optimal". I take it to mean (as I gathered from your post) that it means a design for the best overall response (bandwidth, smoothness and efficiency) that one can achieve in the given radiating angle.

Assuming that a particular driver in a particular back chamber is capable of resonating at the desired low frequency, putting a horn on the front or rear of it will alter its performance, of course. Further assuming that the horn is front-loaded (the most efficient variety) then the individual characteristics of the horn itself determine the outcome. These characteristics can be reduced to two factors: flare rate and overall channel length.
Generally speaking, the throat channel area (cross-section) determines efficiency, the overall flare rate(s) determine the bandwidth including the low frequency cutoff (of optimum efficiency, not frequency), and the driver/back chamber combination determine the lowest usable frequencies produced. There are natural limits to these combinations, of course, but bear with me for the sake of this discussion...

Mouth-area size - there are some considerations at play - first, the nominal low frequency cutoff that the bass horn flare rate is intended to have, and THEN the size of the horn mouth (which is dependent on the channel cross-section at the throat, the overall pathway length and then on the radiating sphere [or fraction thereof] that it is intended to operate in). Needless to say, a low frequency bass horn needs a large mouth; larger than most of the so-called horn mouths out there. There are two types of undersized horn mouths that we typically see, one being a foreshortened variety (simply undersized for the Lc of the flare rate)and the other being a quarter-wave tube with an accompanying flare of some sort, sort of a resonating port with a slightly wider frequency response albeit somewhat "peaky" when compared to a full-sized horn with an optimum mouth size for its placement.

With a rear-loaded application, this is covered up somewhat by the output of the direct radiator. In the case of a front-loaded horn, it's a bad design choice because there is nothing to cover it up or otherwise fill it in.

The actual wave LENGTH of low frequencies actually has little to do with the size of a horn mouth - the PLACEMENT (or radiating angle that it operates into) is the controlling consideration and the combination of the frequency and the radiating angle then determine the proper area of the horn mouth. Even so, the area size of the mouth is typically rendered much, much smaller than the wavelength itself by the number of reflecting surfaces and the attendant reactive/resistive quality of the horn mouth and boundary cooperation provided by the placement as well as the configuration of the horn mouth itself. Mismatches of the horn mouth area and the radiating angle it is exhausting into cause reflections travelling backward into the horn itself due to impedance mismatch with the air in the listening space and make the response "peaky".

Even extremely undersized mouths produce low frequencies for this reason, just not smoothly or at full efficiency. It just won't be "good" but it will be there. The sound-wave propagates into the room even if the room is undersized compared to the wavelength and bounces around. Few of us

have the space to allow a full 32 foot waveform to express itself without reflection but the low frequency energy is still in the room with us at the proper frequency. It is the level of efficient transfer of the waveform from the horn to the environment and overall smoothness provided by a properly executed horn that determines the quality (not the frequency) of the low frequencies. In other words, a horn can be quite a bit shorter than the actual wave LENGTH of the lowest frequency (Lc) going though it.

Even bad horn designs with too small of a horn mouth area produce low frequencies. Just not smoothly or "well". It is typical in the market to make things smaller to sell them - even while flying in the face of physics.

I suppose one could look at the output response of an undersized horn mouth as a "somewhat-tuned port with multiple smaller ports associated with it" giving multiply-peaked response across a wider bandwidth than a single properly-tuned port would (one high-efficiency peak at a given frequency).

Dana
