

If one presumes that the speaker's job is to reproduce the music as opposed to be part of its production (as in a guitar amp etc), then one can look at it from the perspective of the speaker deviating from an ideal device where what goes in = what comes out. Also, fwiw, while the THD figure may be identical on two totally different sounding amplifiers, they will still be very different if looked at a more appropriate way. It was after all the marketing of solid state electronics which caused the use of distortion measurement's to be "an indicator" (as a marketing tool) of "goodness" in the market place. In the case above, one would typically find one amp (the good sounding one) having higher levels of mostly 2nd and 3rd (low order) harmonics vs the "bad" sounding one having more orders but all lower level. The issue is obviously THD % does not track audibility but it is an easy thing for the sales staff to point to as a sales tool. The ideal "perfect radiator" allows the driver to act as if only the motor and suspension were acting on it. In that case (ignoring the low cutoff), one finds flat response up to the point the inductive roll off is reached and then it rolls off at 6 dB/oct. Also, if one examines energy vs time, one finds the distribution is also that set by the motor etc. In real life, one finds the radiator is much "more" than what is ideal. For one, a real driver is often operated through the range where it is an acoustically small point source into the range where it has some directivity. This is somewhat problematic as the driver's directivity causes a shift in the acoustic phase which is not exhibited in its amplitude, that is it is Non-minimum phase and is a shift in time of origin. In order to make the on axis response flat in the face of increasing directivity (with increasing frequency), it is necessary to roll off the input power through proper choice of L_e and internal absorption in the radiator. In the "directivity" range (the frequency range where the driver is larger than about $1/3 \lambda$ in diameter) the velocity of the force propagating in the material must be kept low, ideally keeping pace with the acoustic pressure from the center. The higher into the directivity range the driver is used, the more critical and eventually show stopping these factors become. Fold into this the factor that as soon as the driver departs significantly from "piston operation" it is in semi controlled breakup and it is a tough design challenge in every way. At the top end, the modes become so complex and chaotic that the response is a series of spikes and then rolls off as the radiator is nearly fully decoupled from the motor. It is the fact that all of these cannot truly be balanced in a driver much larger than a headphone and you see why multi-way speakers are the norm. A hidden problem in breakup in general is that if one has a peak in the raw response, that peak represents a frequency selective "acoustic gain". Some times the peaks can be large and while the way of dealing with them is to place the brake up above low pass crossover, this does not really fix all of the problem. Lets say one has some big break up peaks around 3KHz in the woofers response. You use a steep crossover at say 1.5KHz, problem gone right? When operating the driver at sub-multiples of 3KHz, the acoustic gain is still present, it amplifies the distortion product at that frequency by that amount. For example, at 1KHz (in band, well below crossover), the 3rd harmonic is amplified by the amount of that peak at 3KHz. In the systems range there is going to be a frequency where each harmonic, 2nd, 3rd, 4th 5th and so on is amplified by the magnitude of that peak at 3KHz. This is yet another way the cone material can significantly alter the "sound" or flavor of a driver without having different "in band" response measurements. The bottom line might be that the best radiator has the best trade off of stiffness, sound velocity, damping and of course cost. All of this is why radiators can be made out of paper made in a washing machine with "secret ingredients, possibly from the cat box", wood soaked in sake, plastic, metal exotic or just plane

Jane pulp. None are "ideal" in every way, over the entire frequency range, all have significant trade offs, especially the wider the frequency range is. So complex are all of these factors that even with modern computing power, the best examples of great full range drivers were made by mostly by trial and error by "driver engineer artists". Hope this helps a tad. Tom Danley
