

Bass distortion matters

Revisiting this issue, I think there is something missing from the above explanations.

The ear's effective frequency 'response' or sensitivity can be objectively described by what are termed "equal-loudness contours" (https://en.wikipedia.org/wiki/Equal-loudness_contour) which show in particular how the threshold of hearing - the sound pressure required to be just audible - rises rapidly at low frequencies.

The importance of low distortion at very low frequencies can be deduced from the form of these equal-loudness contours. The normal average threshold of hearing at 20 Hz is around 70 dB SPL (which is about the typical level of normal conversation). With increasing frequency this threshold drops rapidly.

The contours (measured in loudness units of 'phon') can be seen to have an initial slope of 80 dB/decade or 24 dB/octave at low frequency, low volume levels. This means that if the 40 Hz 2nd harmonic of a 20 Hz fundamental tone is 24 dB lower in level, which corresponds to **6%** 2nd harmonic distortion (not untypical of the average woofer), then it will sound **equally** as loud as the fundamental ! The 3rd harmonic distortion would have to be around 40 dB down, i.e. **1%**, just to sound *less* loud than the 20 Hz fundamental.

The curves become a little less steep at higher loudness levels but the same general analysis applies. It all points to low bass distortion being a significant factor. When the fundamental frequency sound pressure level needs to be above a certain threshold to even become audible it should not be masked by its higher frequency distortion products if accurate reproduction is the goal. Small loudspeakers in particular will almost entirely substitute surplus