DML basics and material graph

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Abstract

Distributed Mode Loudspeaker (DML) : results from some tests about efficiency

Contents

1 Introduction

This paper shows the results of some tests made on DML to understand what leads the efficiency.

2 Academic and technical background

The DML is said to have the property of a SPL that decreases with the distance slower than a classical cone loudspeaker.

For the efficiency the litterature like Kerem Ege's thesis [1] or the patent Heron's patent WO1992003024A1 [2] shows it is related to the Young modulus E of the material and its density ρ independantly of the thickness thank to the parameter R.

$$R = E/\rho^3$$

3 Measurements

The measurements were done in a living room by feeding the panel with a pink noise with a limited bandwidth (200Hz to 5kHz).

The levels were measured with an UMIK1 USB mic connected to laptop running under Linux Manjaro with REW. The mic calibration file according to the frequency was used but the absolute level was not calibrated.

For comparison (ie in the evaluation of the SPL according to the distance)a small Visation FRS8 8cm cone full range in a 1.2l closed box is used.

4 SPL according to the distance

The SPL according to the distance was measured for 3 panels

- PWD3 : 3mm poplar plywood 1.2 x 0.45m (2 sets of measures)
- XPS20 : 20mm XPS 1.2 x 0.6m
- canvas : 0.41 x 0.31m

And the Visaton FRS8 (2 sets)

See the table and graph below.

Conclusion : the SPL decreases more slowly with DML than with a cone speaker

	level SPL dBA					
distance (m)	PWD3	XPS20	FRS8	FRS8 (2)	canvas	PWD3 (2)
0,25	45	53	45	45	45	43
0,5	40,5	50	40	40	40	40
1	38	46	35	35	37	37
2	35,5	44	32	32	34	34

Figure 1: SPL versus distance - table

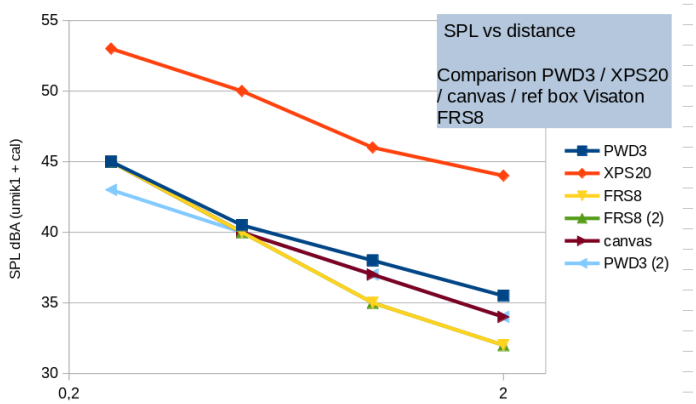

Figure 2: SPL versus distance - graph

5 Efficiency versus dimensions

The XPS 9mm (Depron) panel was divided several times in 2 parts starting from 0.6 x 0.8m then 0.6 x 0.4 then 0.3 x 0.4 and so one.

Conclusion : the bandwith changes with the area not the efficiency.

6 Efficiency versus thickness and material

Several panels of different material, dimensions and thickness keeping the distance fixed (1m).

The weight of the panels was measured to determine their density.

The Young modulus was estimated from different sources (web or previous tests). This might be a source of error in the evaluation of R.

The graph of $log(R)$ versus the SPL was done. The points of the graph are quite nicely aligned showing 3 areas :

- high density on the right with acrylic
- mid density with the plywood
- low density with PS

Conclusion : the efficiency is driven by E/ρ^3

An simple euristic can even be extracted : $Eff = 83 + 5.log(R)$ in dB... no proof it works or at least no ideas of the limitations.

An other paper relates the efficiancy to form ration of the panel. Even if not described here (where are my notes?). It was not seen.

μ	D/μ3	log10(D/μ3)	heuris-tic	SPL dB/1W/1m	SPL	material	weight	W	L	h	rho	E	D
0,365	82,54	1,917	92,6	93,6	56,6	EPS 20mm	0,175	0,6	0,8	0,02	18	6	4,00
0,773	21,62	1,335	89,7	93	56	XPS 20mm	0,58	0,6	1,25	0,02	39	15	10,00
0,254	44,40	1,647	91,2	92	55	XPS 9mm	0,122	0,6	0,8	0,009	28	12	0,73
0,125	53,97	1,732	91,7	88	51	XPS 5mm	0,06	0,61	0,79	0,005	25	10	0,10
1,599	4,95	0,695	86,5	86,2	49,2	plywood 3mm		0,45	1,2	0,003	533	9000	20,25
5,465	4,59	0,662	86,3	84,3	47,3	Plywood 10m	2,35	0,5	0,86	0,01	547	9000	750,00
2,793	2,20	0,343	84,7	84,1	47,1	Plywood 4mm	0,61	0,39	0,56	0,004	698	9000	48,00
1,336	0,11	-0,965	78,2	79,7	42,7	Acrylic ?	0,935	0,7	1	0,001	1336	3100	0,26

Figure 3: SPL versus material - table

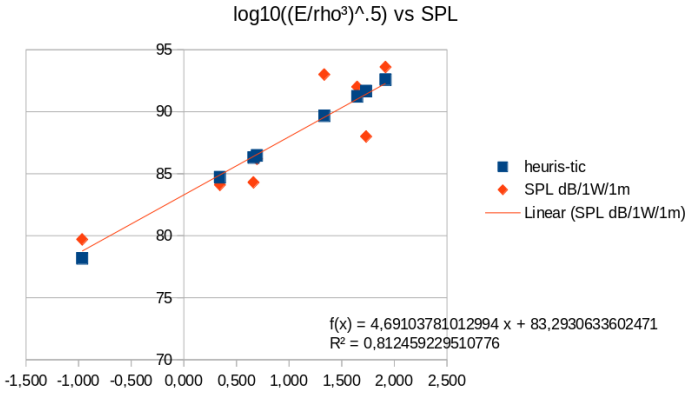

Figure 4: SPL versus material - graph

References

[1] K. Ege, "La table d'harmonie du piano – études modales en basses et moyennes fréquences," PhD thesis, 2009. Available: https://www.researchgate.net/publication/41663333_La_table_d%27harmonie_du_piano_-_Etudes_modales_en_basses_et_moyennes_frequences

[2] K. H. Heron, "Panel-form loudspeaker." Google Patents, 1992. Available: https://patents.google.com/patent/WO1992003024A1/fi%20US4325121.pdf