Expansion-Chamber Muffler Transmission Loss

Transmission loss of a simple expansion-chamber muffler from the pipe and chamber diameters and chamber length, with the peak loss and pass frequencies.

Method: Plane-wave transmission loss of a simple expansion chamber

Input parameters

Unit system: SI

Parameter	Value	Unit
Inlet and outlet pipe diameter	50.000	mm
Chamber diameter	200.00	mm
Chamber length	300.00	mm
Frequency	250.00	Hz
Gas temperature	20.000	°C

Calculated results

Parameter	Value	Unit
Area ratio	16.000	
Speed of sound	343.23	m/s
Transmission loss at the frequency (dB)	17.927	
Peak transmission loss (dB)	18.096	
First pass frequency (zero loss)	572.05	Hz
First frequency of peak loss	286.03	Hz

Notes for this case

• A sudden enlargement reflects sound back towards the source. For a chamber of area ratio m and length L the plane-wave transmission loss is TL = 10 $\log_{10}$[1 + ¼(m − 1/m)² $\sin^2$(kL)], with k = 2πf/c. It peaks where the chamber is an odd number of quarter wavelengths long and falls to zero where it is a whole number of half wavelengths (f = nc/2L). The formula holds below the chamber's first cross mode, about 1.84c/(πd_2); real mufflers combine chambers, tubes and absorbent to fill the pass bands. Air properties are used for the speed of sound.

Formula and method

$$TL = 10\log_{10}\left[1+\frac{1}{4}\left(m-\frac{1}{m}\right)^2\sin^2 kL\right],\quad m=\left(\frac{d_2}{d_1}\right)^2,\quad k=\frac{2\pi f}{c}$$

Variables

d_1	Inlet and outlet pipe diameter	m
d_2	Chamber diameter	m
L	Chamber length	m
f	Frequency	1/s
T	Gas temperature	K
m	Area ratio	-
c	Speed of sound	m/s
TL	Transmission loss at the frequency (dB)	-
TL_{max}	Peak transmission loss (dB)	-
f_p	First pass frequency (zero loss)	1/s
f_{pk}	First frequency of peak loss	1/s

Method and standards

Expansion chamber.

Assumptions and limits

- Plane waves; no flow or absorption; rigid walls.

References

Plane-wave transmission loss of a simple expansion chamber

Report details

Report reference	FCC-RPK4-R6M3 (the same inputs always give the same reference)
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Release checks	3 reference cases of this calculator, computed independently, are checked on every release

Results are for engineering estimation. Verify critical designs against the referenced standards and your own data.

This calculator online

https://calc.firecad.com/instrumentation/vibration-noise/expansion-chamber-muffler

Open this case on calc.firecad.com →

Reopens the calculator with the inputs of this report.