Simple and Double Tuned Expansion Chamber Simulations

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Overview

- MSC Actran is used to model a simple expansion chamber and double tuned expansion chamber.
- Ideas for improving the lower frequency attenuation of the double tuned expansion chamber are considered assuming that the total volume is not increased.
Case 1 Simple Expansion Chamber SEC

Temperature: 20 °C

Unit: mm
Case 1 SEC FEM Simulation

Transmission Loss (dB) vs. Frequency (Hz)
Case 2 DTEC

Vibro-Acoustics Consortium
Case 3 DTEC with Wall Thickness

Unit: mm

Vibro-Acoustics Consortium
End Correction Calculations

End Corrections (all dimensions in m)

\[ l_0 = d_{duct} \left( a_0 + a_1 \left( \frac{d_{exp}}{d_{duct}} \right) + a_2 \left( \frac{t_w}{d_{duct}} \right) + a_3 \left( \frac{d_{exp}}{d_{duct}} \right)^2 + a_4 \left( \frac{d_{exp}t_w}{d_{duct}} \right) + a_5 \left( \frac{t_w}{d_{duct}} \right)^2 \right) \]

- \( a_0 = 0.005177 \)
- \( a_1 = 0.0909 \)
- \( a_2 = 0.537 \)
- \( a_3 = -0.008594 \)
- \( a_4 = 0.2616 \)
- \( a_5 = -5.435 \)

Corrected Lengths

- \( L_a = \frac{L}{4} - l_0 \)
- \( L_b = \frac{L}{2} - l_0 \)
- \( L_c = L - L_a - L_b \)

Example

- \( d_{duct} = 5 \text{ cm} \)
- \( d_{exp} = 50 \text{ cm} \)
- \( t_w = 4 \text{ mm} \)
- \( l_0 = 1.36 \text{ cm} \)
End Correction used in SIDLAB

- End Correction, $l_e$

$$l_e = \frac{8d_{duct}H(\alpha)}{6\pi}$$

$$H(\alpha) = \begin{cases} 0.875(1 - \alpha)(1.371 - \alpha) & 0.5 < \alpha < 1 \\ 1 - 1.238\alpha & 0 < \alpha < 0.5 \end{cases}$$

$$\alpha = \frac{d_{duct}}{d_{exp}}$$
MSC Actran Simulation Comparisons

Case 1 - SEC
Case 2 - DTEC
Case 3 - DTEC (thickness included)
Overview

• Actran simulations are used to model a simple expansion chamber and double tuned expansion chamber.
• Ideas for improving the lower frequency attenuation of the double tuned expansion chamber are considered assuming that the total volume is not increased.
Case 4 DTEC with Extended QWT
Case 4 DTEC with Extended QWT
Case 4 DTEC with Extended QWT

![Graph showing transmission loss in dB vs frequency for Case 4 with MSC Actran and SIDLAB.]
Case 5 DTEC with Truncated QWT
MSC Actran Simulation Comparisons

- Case 2 - DTEC
- Case 4 - DTEC with Extended QWT
- Case 5 - DTEC with Truncated QWT

Transmission Loss (dB) vs. Frequency (Hz)
Case 6 DTEC with QWT and HR Tight
Case 7 DTEC with QWT and HR Wide
MSC Actran Simulation Comparisons

Case 2 - DTEC
Case 6 - DTEC with QWT and HR Tight
Case 7 - DTEC with QWT and HR Wide
Case 7 DTEC with QWT and HR Wide
Summary

• FEM simulation is necessary to tune a DTEC.
• Alternative configurations may be used to improve the low frequency performance.