Prediction And Control Of Transmission Loss To Improve Motorcycle Muffler Sound

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Prediction and control of motorcycle engine noise under combustion load

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Requirements of Automotive Muffler

- Attenuate engine exhaust noise
- Provide low back pressure
- Meet pass by noise
- Space constraint
- Cost

Exhaust sound is important for motorcycles

Measures of performance of muffler

- Transmission Loss
- Insertion Loss
- Noise reduction
Transmission Loss

- Transmission loss (TL) is the ratio between acoustical power incident and power transmitted downstream of muffler into anechoic termination.

\[ TL = 10 \cdot \log_{10} \left( \frac{W_{in}}{W_{tr}} \right) \]

- TL can be predicted from known physical parameters of muffler.
- It is a property of a “muffler only” so used as a design criteria.
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Gas flow inside muffler

Exhaust Gas from engine

Perforated Baffle
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Gas flow inside muffler

Flow from Volume 1 to Volume 3
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Volume mesh for header pipe

Perforations

Volume 1

Volume 2

Volume 3
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Volume mesh for different regions of muffler
Volume mesh for different regions are imported in COMSOL

Unit pressure at inlet

Plane wave radiation condition is applied to both inlet and outlet boundaries
Continuity Boundary Condition

Perforations on pipe and baffle

Inputs required:
1. Area Porosity - holes fraction of the boundary surface area
2. Baffle/Pipe thickness
3. Hole Diameter
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**Transmission Loss of Muffler**

- Noise levels for the existing muffler at engine idling condition were recorded in testing.
- Increase in noise levels at low frequencies was desired.
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**Modified Muffler**

Pipe length increased
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**TL Comparison: Existing v/s Modified**

- With modified muffler, transmission loss at low frequencies is reduced 10 dB.
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Tail pipe noise measurement

SPL Comparison: Existing v/s Modified

- With modified muffler, desired increase in noise levels at low frequencies is achieved
Transmission loss for a muffler of single cylinder motorcycle engine is predicted using COMSOL. Based on analysis results, modifications in muffler can be carried out in the design stage to achieve desired noise levels.

This approach results in savings in terms of cost and reduction in product development time.
THANK YOU
APPENDIX

Simple Expansion Chamber

Test results

Expansion Chambers with extensions

Test results

Analysis results match well with the test results
APPENDIX

Expansion Chambers with Walls and Extensions

Test results

Mufflers with Flush Eccentric Inlet and Outlet Pipes

Test results

Analysis results match well with the test results
APPENDIX

Mufflers with Flow Reversal

Test results

Analysis results match well with the test results

Helmholtz Resonator

Test results

Analysis results