Critical Study of Snorkel Modeling Approaches In GT-POWER For Achieving Better Correlation of Predicted Noise At Air Intake Orifice of Turbocharged Engine

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Content

- Introduction
- GT-POWER Tool
- GT-POWER Engine Simulation Process Overview
- Air Intake Snorkel Modeling Approaches
- Summary
Major Automotive Noise Sources

- **Engine Noise**
  - Combustion noise
  - Mechanical noise
  - Intake noise

- Aero-dynamic Noise

- HVAC unit Noise

- Exhaust Noise

- Differential/axle Noise

- Fan Noise

- FEAD Noise

- Tire/road Noise

- Shell Noise
  - (Exhaust System)

- Gear box Noise

- Tire/road Noise
GT-POWER Process Overview for Exhaust & Intake Noise Prediction

**Input Details**
- Engine P-theta
- Valves
- Injector
- Cylinder
- Engine Crank-train
- Turbocharger
- Intake-Exhaust Manifold
- Intake system
- Exhaust system

**Step 1: Burn rate**
- Instantaneous rate of fuel consumption within the cylinder combustion process

**Step 2: CAD Modeling**
- Intake Manifold
- Exhaust Manifold
- Intake System
- Exhaust System

**Engine Calibration Parameter**
- P-Theta
- Volumetric efficiency
- Pressure and temperature
- Fuel flow rate
- Air flow rate
- Turbo-charger
- Temperature variation in Exhaust system

**Prediction Capability**
- Pressure-Temperature variation
- Pressure Drop across system
- Transmission Loss
- Un-muffled noise
- Muffled Orifice Noise
- Insertion Loss
- SPL at particular RPM
- Back Pressure
CAD modeling in GEM3D / GT-SPACECLAIM

CAD Model → GEM3D Model → GT-POWER 1D Model
Snorkel Modeling Approaches For Achieving Better Correlation of Predicted Intake Noise
GT-POWER Model Set up

Exhaust System

Intake System
Why Such Snorkel can not be modeled as Exactly as CAD?

- Complex 3D shapes must be discretized into 1D components
- Custom shaped perforated section open to environment can not be modeled
Approach 1: Direct Duct Inlet

Air Intake System

Actual Snorkel

Approach 1: GEM3D Snorkel

Air Intake Orifice 2 EO Noise: Measured Vs Predicted
Approach 2: Snorkel Direct Opening

Air Intake System: Snorkel Modeling Approach

Actual Snorkel

Approach 2: GEM3D Snorkel

Air Intake Orifice 2 EO Noise: Measured Vs Predicted

Air Intake Orifice 2 EO Noise Comparison

- Measured 2 EO Noise
- Predicted Approach 1
- Predicted Approach 2

0 dB(A)

2000 2250 2500 2750 3000 3250 3500 3750

Speed (RPM)
Approach 3: Snorkel Tapered Opening

Air Intake System: Snorkel Modeling Approach

Actual Snorkel

Approach 3: GEM3D Snorkel

Air Intake Orifice 2 EO Noise: Measured Vs Predicted

![Graph showing Air Intake Orifice 2 EO Noise Comparison]

- Measured 2 EO Noise
- Predicted Approach 1
- Predicted Approach 2
- Predicted Approach 3

Speed [RPM]

2000 2250 2500 2750 3000 3250 3500 3750

\( \text{dB(A)} \)
Approach 4: Snorkel Direct Opening with Perforated Plate

Air Intake System: Snorkel Modeling Approach

Actual Snorkel

Approach 4: GEM3D Snorkel

Air Intake Orifice 2 EO Noise: Measured Vs Predicted

![Graph showing Air Intake Orifice 2 EO Noise Comparison]
Approach 5: Snorkel Tapered Opening with Perforated Tube

Air Intake System: Snorkel Modeling Approach

Actual Snorkel

Approach 5: GEM3D Snorkel

Air Intake Orifice 2 EO Noise: Measured Vs Predicted

![Air Intake Orifice 2 EO Noise Comparison Graph]
### Summery: Air intake Snorkel Modeling Approach

<table>
<thead>
<tr>
<th>Snorkel</th>
<th>Modeling Approach</th>
<th>Accuracy Level</th>
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</thead>
<tbody>
<tr>
<td>Actual CAD</td>
<td>• Ideal snorkel Modeling&lt;br&gt;• But, can not possible due to modeling limitation</td>
<td><img src="image" alt="Green" /></td>
</tr>
<tr>
<td>Approach 1</td>
<td>• Direct duct opening to environment&lt;br&gt;• Easiest way of modeling</td>
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</tr>
<tr>
<td>Approach 2</td>
<td>• Snorkel modeled as Shell&lt;br&gt;• Short opening C/s pipe</td>
<td><img src="image" alt="Yellow" /></td>
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<tr>
<td>Approach 3</td>
<td>• Snorkel modeled as Shell&lt;br&gt;• Short opening C/s tapered pipe&lt;br&gt;• Tapered inlet C/s equivalent to perforated hole opening</td>
<td><img src="image" alt="Green" /></td>
</tr>
<tr>
<td>Approach 4</td>
<td>• Snorkel modeled as Shell&lt;br&gt;• Short opening C/s pipe&lt;br&gt;• Perforated plate added</td>
<td><img src="image" alt="Green" /></td>
</tr>
<tr>
<td>Approach 5</td>
<td>• Snorkel modeled as Shell&lt;br&gt;• Short opening C/s tapered pipe&lt;br&gt;• Tapered inlet C/s equivalent to perforated hole opening&lt;br&gt;• Perforated plate added</td>
<td><img src="image" alt="Red" /></td>
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Acknowledgment / References

- GT Suite Help
- GT Suite Examples
- GT Suite Manual
- GT Support Team
Thank You