On-Road Vehicle Emissions in Beijing, China: An Experimental Study Using PEMS

Speaker: Ziqianli Wang
Department of Transportation Studies
Texas Southern University

Authors

• Fengxiang Qiao, Ph.D., Assistant Professor (Corresponding Author), TSU.

• Ziqianli Wang, Graduate Research Assistant, TSU.

• Lei Yu, Ph.D., P.E. Changjiang Scholar of Beijing Jiaotong University. Professor of TSU.
Objectives

• Highlight situation of Beijing automobiles’ emission

• Evaluate vehicle emissions and fuel consumption for different time periods and roadways

• Evaluate vehicle emissions and fuel consumption for different vehicle ages and kilometerages
Outline

• Objectives
• Background
• MONTANA OEM-2100 System
• Test Plan and Data Collection Progress
• Data Processing Procedures
• Data Analysis
• Conclusions and Recommendations

Background

• China – the world’s fastest growing economy
• Beijing is the capital and the second largest Chinese city in terms of population
• Beijing is connected via road links from all directions of China

• Emission standards
  – Regulation GB-14761 - 1990’s
  – Euro 4 standards for light duty vehicles by 2008, the year of Beijing Olympics

• Unique mixed traffic system
  – Bike lanes on most of the roads
  – Millions of bicycles and mass pedestrians on streets
Transportation situation in Beijing

Many bicycles and pedestrians on streets

Bicycles travel with vehicles on the same street but in different lanes

There are special lanes for bicycles

Some people break traffic rules which is dangerous and slows traffic

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MONTANA OEM-2100 System

- Designed to measure vehicle mass exhaust emissions under actual on-road driving conditions
- Uses vehicle & engine operating data and concentrations of pollutants in exhaust gas sampled from the tailpipe

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Test Plan

Test scenario:
• Distance: 8 km, test time: 8:00 am
• Pedestrian traffic: heavy except freeway
• Bicycle lanes presents on local streets only
• This test includes local, freeway, minor arterial
• Each street use a bag to record data

Data Collection Process

• Test Collection
  – Different vehicle types
    • Heavy Duty Gas Vehicle (HDGV), Heavy Duty Diesel Vehicle (HDDV), Light Duty Gas Vehicle (LDGV), Light Duty Diesel Vehicle (LDDV), Compressed Natural Gas, Liquefied Petroleum Gas.
  – Various ages and mileages
  – Different test routes
    • Freeways, Principal arterials, Minor arterials, and Local streets.
  – Different dates and time periods
Test Plan and Data Collection Process (Cont’d)

• Collected Data
  – Vehicle emissions
    • CO, NOx, HC, CO2, PM
  – Fuel consumption
  – Vehicle activity data (Speed, Acceleration, RPM, etc.)

• Management
  – Microsoft ACCESS 2000 database
  – 280 MB
  – 5 tables

Testing Vehicles Description

<table>
<thead>
<tr>
<th>Vehicle Type</th>
<th>Number</th>
<th>Percent of test vehicles</th>
<th>Test days</th>
<th>Percent of test days</th>
</tr>
</thead>
<tbody>
<tr>
<td>LDV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>LDGV</td>
<td>34</td>
<td>65.40%</td>
<td>40</td>
<td>69.00%</td>
</tr>
<tr>
<td>LDDV</td>
<td>6</td>
<td>11.50%</td>
<td>6</td>
<td>10.30%</td>
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<tr>
<td>HDV</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>HDGV</td>
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<td>1.90%</td>
<td>1</td>
<td>1.70%</td>
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<tr>
<td>HDDV</td>
<td>4</td>
<td>7.70%</td>
<td>4</td>
<td>6.90%</td>
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<tr>
<td>Others</td>
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<td></td>
</tr>
<tr>
<td>Compressed Natural Gas</td>
<td>1</td>
<td>1.90%</td>
<td>1</td>
<td>1.70%</td>
</tr>
<tr>
<td>Liquefied Petroleum Gas</td>
<td>6</td>
<td>11.50%</td>
<td>6</td>
<td>10.30%</td>
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<tr>
<td>Total</td>
<td>52</td>
<td>100%</td>
<td>58</td>
<td>100%</td>
</tr>
</tbody>
</table>
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Data Processing Procedures

• Control data quality
  – Eliminate and interpret errors and missing data
• Summarize and clarify the database
  – Sum up for statistical overviews
• Plot emissions & fuel consumption under different testing environments
  – Spatial/temporal distributions of emissions and fuel consumption within test area
• Analyze results
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Data Analysis

• Emissions and fuel consumption
  – time of day
  – roadway types

• Spatial distribution of emissions and fuel consumption on the Five Ring Roads

• Vehicle age and mileage impacts on emissions and fuel consumption
Emissions and Fuel Consumption
Roadway Types

Spatial Distribution of Emissions and Fuel Consumption on the Five Ring Roads
Vehicle Age Impacts on Emissions and Fuel Consumption

Vehicle Mileage Impacts on Emissions and Fuel Consumption
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Conclusions

• Emissions and fuel consumption have one or two peaks for different times of day
  – Morning rush hours observe less emission than the afternoon peaks
• Roadway types affect emissions and fuel consumption
• No consistent trends observed for the relationships between emissions & fuel consumption, and the vehicle age & mileage
Recommendations

• Current database analysis expansion
  – Weather, temperature, driver behavior, traffic variations

• Establish statistical relationships between emissions and major affecting variables
  – Vehicle operating parameters, climate factors, driving factors

• It is expected that suitable vehicle emission models and air quality control standards can be established for Beijing by enriching the database

Reference


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Thanks for your time

Any question is welcome.

Email: wangz@tsu.edu