Motor Cycle Emission Control in India

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By
Mr. M. K. Chaudhari
Sr. Deputy Director
The Automotive Research Association of India
chaudhari.ecl@araiindia.com
Tel: +91-20-4003858
Fax: +91-20-25434190

Introduction about ARAI
Role of ARAI

♦ First ISO-9001 R&D and Testing & Evaluation Institute in India.
  • Nodal agency:
    - Certification
    - Regulations
    - Formulation of Standards
    - Implementation of R&D Programs at National level
    - Central Motor Vehicle Rule (CMVR) Technical Committee

Role of ARAI

• Nodal agency:
  - Automotive Industry Standard Committee (AISC)
  - Member Secretary – Standing Committee on Implementation of Emission Legislations.
  - High level committees representation - for policy decision.
  - Technical support to Ministry – Govt. of India.
Role of ARAI

♦ R&D and Certification:
  ♦ Research & Development of engines, vehicles and its aggregates.
  ♦ Certification
  ♦ Formulation of Standards
  ♦ Consultancy
  ♦ Specific assignments in R&D and certification
    - Evolution of Inspection & Maintenance Programme for India.
    - Development of Emission factors.

Role of ARAI

♦ Specific assignments in R&D and certification
  - Gasoline vehicle particulate measurement.
  - Life cycle prediction.
  - Noise and Vibration.
  - Gasoline / Diesel Engine design and development.
  - Alternate fuels – CNG, LPG, Methanol, Electric Vehicle etc.
  - Study of Adulteration of fuel.
Motor Vehicle Population in India-Fleet Composition

Two Wheelers 71% (42 million)

Three Wheelers 4% (2.37 million)

Cars, Jeeps and Taxies 13% (7.69 million)

Buses 1% (0.59 million)

Goods Vehicles 5% (2.96 million)

Others (Tractors, Trailors and miscellaneous) 6% (3.55 million)

Indian Two Wheeler Industry

- Second largest manufacturer in the world – next to China
- Has grown over 3 times during past 10 years
- During Year 2002-2003 domestic sales was 5.1 million
- Current year 2003-2004 expect to cross 5.6 – 5.8 million
In India, 85% of vehicles are having engine capacity less than 125 cc, whereas in Europe (35%), Japan (31%) and US (7%).
Progress Through Research

Two-Wheeler industry category share trend

<table>
<thead>
<tr>
<th>Year</th>
<th>Category share %</th>
</tr>
</thead>
<tbody>
<tr>
<td>92-93</td>
<td>27.5</td>
</tr>
<tr>
<td>93-94</td>
<td>25.9</td>
</tr>
<tr>
<td>94-95</td>
<td>22.5</td>
</tr>
<tr>
<td>95-96</td>
<td>22.7</td>
</tr>
<tr>
<td>96-97</td>
<td>22.1</td>
</tr>
<tr>
<td>97-98</td>
<td>20</td>
</tr>
<tr>
<td>98-99</td>
<td>16.3</td>
</tr>
<tr>
<td>99-00</td>
<td>15.1</td>
</tr>
<tr>
<td>00-01</td>
<td>15.1</td>
</tr>
<tr>
<td>01-02</td>
<td>14.8</td>
</tr>
<tr>
<td>02-03</td>
<td>14.5</td>
</tr>
</tbody>
</table>

Product Segments (2002-03 Sales)

- **Motorcycle**: 76%
- **Scooter**: 17%
- **Moped**: 7%

ARAII | Progress Through Research

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**ARAII** | Progress Through Research
Usage Pattern in India

- Quite different from many other countries
  - more a utility and family oriented vehicle
  - small business people and farmers conduct their business carrying materials and loads
  - limited usage for leisure and sport
- Initial cost and fuel economy are highest priority.
- Should be rugged and robust.
- Engine displacement, mostly around 100 cc.
- During last 12 – 18 months, higher displacement engines upto 175cc being introduced.

MARKET TRENDS

- Customer preference to 4 stroke engines as against 2 strokes (higher fuel efficiency)
- Currently, percentage of 4 strokes to 2 strokes 75 : 25
- By year 2005, expect only small percentage 2 strokes to continue in production
Motor Vehicle Emission Control Programmes in India

- Formulation of Standards for new and in-use vehicles.
- Ensure appropriate emission control technologies through vehicle design – type approval.
- Compliance at production level quality – Conformity of Production (COP)

Motor Vehicle Emission Control Programmes in India......

- In-use vehicles emission control.
  - I&M programme
  - On road checks
  - Retrofitment – CNG / LPG
- Framing the specifications of fuel quality in line with emission legislation.
- Traffic Management.
EMISSION REGULATIONS

- Two wheelers constitute 70-75% of vehicle population on Indian roads
- Hence, considered a major contributor to atmospheric pollution
- Since year 1991, emission regulations for 2 wheelers been made more and more stringent over the years

Indian Emission Norms for 2 Wheelers

- For Ref. Mass 170 kg
- * Only for HC
- ** As per Mashelkar Committee Report

<table>
<thead>
<tr>
<th>Year</th>
<th>CO (g/km)</th>
<th>HC+Nox (g/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1991**</td>
<td>14.25</td>
<td>8.5*</td>
</tr>
<tr>
<td>1996</td>
<td>4.5</td>
<td>3.6</td>
</tr>
<tr>
<td>2000</td>
<td>2.0</td>
<td>2.0</td>
</tr>
<tr>
<td>2005**</td>
<td>1.5</td>
<td>1.5</td>
</tr>
<tr>
<td>2008**</td>
<td>1.0</td>
<td>1.0</td>
</tr>
</tbody>
</table>

* For Ref. Mass 170 kg; ** As per Mashelkar Committee Report
Indian Emission Norms for 3 Wheelers - Petrol

- For Ref. Mass 170 kg
- * Only for HC
- ** As per Mashelkar Committee Report

Indian Emission Norms for 3 Wheeler - Diesel

- For RM of 350 kg
- * Only for HC
- ** As per Mashelkar Committee Report
Progressive Reduction of Indian Emission Norms: 2 Wheelers (Both 2 and 4 stroke)

![Graph showing CO and HC + NOx emissions reduction from 1991 to 2005.]

EMISSION REGULATION APRIL 2005 (BS II)

<table>
<thead>
<tr>
<th>CO</th>
<th>HC + Nox</th>
<th>Test Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.5 gm/Km</td>
<td>1.5 gm/Km</td>
<td>IDC</td>
</tr>
</tbody>
</table>

- Conformance of Production (COP) allowance of 20% available so far is withdrawn
- Durability of 30,000kms or D.F. of 1.2 is enforced
- Practically, this means tightening regulation of year 2000 by 50%
Emission Regulation April 2008/2010 (BS III-Proposed)

<table>
<thead>
<tr>
<th>CO</th>
<th>HC + Nox</th>
<th>Test Cycle</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0 gm/Km</td>
<td>1.0 gm/Km</td>
<td>IDC</td>
</tr>
</tbody>
</table>

- Very sophisticated lean-burn engines need to be developed
- New technologies like Variable intake systems, Electronic engine management, 3-way catalyst systems, Electronic fuel injection etc may need to be introduced

Deterioration Factors in India

<table>
<thead>
<tr>
<th>Category of Vehicles</th>
<th>Gasoline</th>
<th>Diesel</th>
</tr>
</thead>
<tbody>
<tr>
<td>CO</td>
<td>1.2</td>
<td>1.10</td>
</tr>
<tr>
<td>HC+NOx</td>
<td>1.2</td>
<td>1.0</td>
</tr>
<tr>
<td>PM</td>
<td>---</td>
<td>1.20</td>
</tr>
</tbody>
</table>

Deterioration factors became applicable for gasoline and diesel vehicles (fitted with catalytic converter) from 1st December 2002.

or

30,000 km Durability for 2-W and 3-W
Indian Driving Cycle

**FEATURES:**
- Based on the heterogeneous traffic pattern in major cities in India.
- Derived from the real world operating condition.
- All category of the vehicles, even mopeds are capable of following cycle.
Comparison of IDC and ECE 40 Cycle

- ECE 40 Driving Cycle
  - One Cycle: 195 sec
  - Total Cycle (4 nos): 780 sec

- Indian Driving Cycle
  - One Cycle: 108 sec
  - Total Cycles (6 nos): 648 sec

Comparison of emissions from a 2-Wheeler on ECE40 and IDC cycles

<table>
<thead>
<tr>
<th>2-Wheeler -4-stroke vehicle</th>
<th>2-Wheeler -4-stroke vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Capacity: 125 cc</td>
<td>Engine Capacity: 133 cc</td>
</tr>
<tr>
<td>ECE 40 IDC</td>
<td>ECE 40 IDC</td>
</tr>
<tr>
<td>CO, g/km</td>
<td>CO, g/km</td>
</tr>
<tr>
<td>2.74</td>
<td>1.34</td>
</tr>
<tr>
<td>HC, g/km</td>
<td>HC, g/km</td>
</tr>
<tr>
<td>0.49</td>
<td>0.86</td>
</tr>
<tr>
<td>Nox, g/km</td>
<td>Nox, g/km</td>
</tr>
<tr>
<td>0.31</td>
<td>0.39</td>
</tr>
<tr>
<td>HC+Nox, g/km</td>
<td>HC+Nox, g/km</td>
</tr>
<tr>
<td>0.8</td>
<td>1.25</td>
</tr>
<tr>
<td>CO2,g/km</td>
<td>CO2,g/km</td>
</tr>
<tr>
<td>43.44</td>
<td>32.52</td>
</tr>
<tr>
<td>Cal. FC, km/l</td>
<td>Cal. FC, km/l</td>
</tr>
<tr>
<td>48.29</td>
<td>63.74</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>2-Wheeler -4-stroke vehicle</th>
<th>2-Wheeler -2-stroke vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Capacity: 115 cc</td>
<td>Engine Capacity: 64 cc</td>
</tr>
<tr>
<td>ECE 40 IDC</td>
<td>ECE 40 IDC</td>
</tr>
<tr>
<td>CO, g/km</td>
<td>CO, g/km</td>
</tr>
<tr>
<td>1.51</td>
<td>0.9</td>
</tr>
<tr>
<td>HC, g/km</td>
<td>HC, g/km</td>
</tr>
<tr>
<td>0.69</td>
<td>1.03</td>
</tr>
<tr>
<td>Nox, g/km</td>
<td>Nox, g/km</td>
</tr>
<tr>
<td>0.25</td>
<td>0.26</td>
</tr>
<tr>
<td>HC+Nox, g/km</td>
<td>HC+Nox, g/km</td>
</tr>
<tr>
<td>0.94</td>
<td>1.29</td>
</tr>
<tr>
<td>CO2,g/km</td>
<td>CO2,g/km</td>
</tr>
<tr>
<td>41.69</td>
<td>25.74</td>
</tr>
<tr>
<td>Cal. FC, km/l</td>
<td>Cal. FC, km/l</td>
</tr>
<tr>
<td>51.48</td>
<td>78.26</td>
</tr>
</tbody>
</table>
Comparison of emissions from a 3-Wheeler (Diesel) on ECE40 and IDC cycles

<table>
<thead>
<tr>
<th></th>
<th>3-Wheeler -Diesel vehicle</th>
</tr>
</thead>
<tbody>
<tr>
<td>Engine Capacity</td>
<td>416cc</td>
</tr>
<tr>
<td>CO, g/km</td>
<td>ECE 40: 0.26 IDC: 0.2</td>
</tr>
<tr>
<td>HC, g/km</td>
<td>ECE 40: 0.07 IDC: 0.05</td>
</tr>
<tr>
<td>Nox, g/km</td>
<td>ECE 40: 0.42 IDC: 0.42</td>
</tr>
<tr>
<td>HC+Nox, g/km</td>
<td>ECE 40: 0.49 IDC: 0.47</td>
</tr>
<tr>
<td>CO2, g/km</td>
<td>ECE 40: 94.24 IDC: 70.17</td>
</tr>
<tr>
<td>Cal. FC, km/l</td>
<td>ECE 40: 28.53 IDC: 37.75</td>
</tr>
<tr>
<td>PM, g/km</td>
<td>ECE 40: 0.1 IDC: 0.05</td>
</tr>
</tbody>
</table>

GLOBAL HARMONISATION OF STANDARDS

- Indian automotive industry identified 76 ECE standards for adoption, out of which, 24 relate to 2 wheeler industry
- By year 2005, expect good progress to align with many ECE standards
Alternative Fuel Policy

Introduction of 5% ethanol mix in Gasoline
– effective early 2003 – notified by Govt.

Trend to encourage use of gaseous fuels
- CNG (Compressed Natural Gas)
- LPG (Liquefied Petroleum Gas)

CNG/LPG regulations (safety/emissions) firmly in place

Alternative Fuels - ARAI Contribution

♦ Formulation of safety code of practice and standards.
♦ Testing and evaluation of AFV.
♦ Design and development of AFV conversion kits for
  - CNG/LPG for 3-wheelers
  - LPG for 2-wheelers and gensets
♦ Innovative design of pumpless lubrication system for 2-stroke engines
♦ Conversion of 2-stroke 3-wheeler on M-85.
NOISE NORMS

- The current method for measurement of Pass-by Noise is in line with Directive 97/24/EC. (in force from 28th September 2001.)
- The Next Stage Noise Norms have been notified for implementation from 1st January 2003.

<table>
<thead>
<tr>
<th>Type of Vehicle</th>
<th>Current Norms</th>
<th>Next Stage (w.e.f. Jan 2003)</th>
<th>ECE Norms</th>
</tr>
</thead>
<tbody>
<tr>
<td>Two Wheelers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt; 80 cc</td>
<td>80(petrol)</td>
<td>75</td>
<td>75</td>
</tr>
<tr>
<td>80 – 175 cc</td>
<td>82(diesel)</td>
<td>77</td>
<td>77</td>
</tr>
<tr>
<td>&gt; 175 cc</td>
<td>80</td>
<td>80</td>
<td>80</td>
</tr>
<tr>
<td>Three Wheelers</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>&lt;175 cc</td>
<td>82(petrol)</td>
<td>77</td>
<td>80</td>
</tr>
<tr>
<td>&gt;175 cc</td>
<td>85(diesel)</td>
<td>80</td>
<td>80</td>
</tr>
</tbody>
</table>

In-use Vehicle Emission Study conducted by ARAI
In-use Vehicle Emission Study conducted by ARAI

2W - 2 Stroke In-Use Vehicle Tested (After Servicing)

- CO Limit
- HC+NOX Limit

2 W - 4 Stroke In-Use Vehicles Tested (Before Servicing)

- CO Limit
- HC+NOX Limit
**In-use Vehicle Emission Study conducted by ARAI**

**2 W - 4 Stroke In-Use Vehicles Tested**

(After Servicing)

- **CO Limit**: 14.25
- **HC+NOx Limit**: 8.5

<table>
<thead>
<tr>
<th>Year</th>
<th>CO (g/km)</th>
<th>HC+NOx (g/km)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Pre-1991</td>
<td>8.27</td>
<td>54%</td>
</tr>
<tr>
<td>1991-1996</td>
<td>6.59</td>
<td>70%</td>
</tr>
<tr>
<td>1996-2000</td>
<td>6.10</td>
<td>54%</td>
</tr>
<tr>
<td>2000</td>
<td>4.5</td>
<td>72%</td>
</tr>
</tbody>
</table>

Sample Size:
- Pre-1991=8 nos.
- Post 2000=3 nos.
In-use Vehicle Emission Study conducted by ARAI

In-Use 2 wheeler 2-Stroke Mass HC+Nox Data

- Before servicing
- After servicing
- Limits
- %age improvement

Sample Size:
- Pre-1991=6 nos.
- 1991-96=14 nos.
- post 2000=3 nos.

Mass HC+Nox (g/km)

0.0  1.0  2.0  3.0  4.0  5.0  6.0  7.0  8.0  9.0  10.0


4.85  3.96  3.43  2.08
27%  34%  18%  17%

2.67  2.82  1.73

In-use Vehicle Emission Study conducted by ARAI

In-Use 2 wheeler 4-Stroke Mass CO Data

- Before servicing
- After servicing
- Limits
- %age improvement

Sample Size:
- Pre-1991=1 no.
- 1991-96=5 nos.
- post 2000=4 nos.

Mass CO (g/km)

0.0  2.0  4.0  6.0  8.0  10.0  12.0  14.0  16.0


1.88  4.53  4.5  1.47
-29%  50%  75%  24%

2.43  2.28  1.29  1.11

ARAII Progress Through Research
...In-use Vehicle Emission Studies conducted by ARAI

Before v/s After Maintenance Idle CO Emission for in-use 2- & 4-Stroke 2W Vehicles - ARAI In-House Study

Note: The limits shown are as per the revised PUC norms
Before v/s After Maintenance Idle HC Emission for in-use 2- & 4-Stroke 2W Vehicles - ARAI In-House Study

<table>
<thead>
<tr>
<th></th>
<th>2 Stroke Vehicles</th>
<th></th>
<th>4 Stroke Vehicles</th>
<th></th>
</tr>
</thead>
<tbody>
<tr>
<td>Max.</td>
<td>17940</td>
<td>Max.</td>
<td>17430</td>
<td></td>
</tr>
<tr>
<td>43% above 9000ppm limit</td>
<td></td>
<td>18% above 9000ppm limit</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Avg.</td>
<td>9299</td>
<td>Avg.</td>
<td>7215</td>
<td></td>
</tr>
<tr>
<td>6000ppm limit, post-2000</td>
<td></td>
<td>4500ppm limit, post-2000</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Min.</td>
<td>2341</td>
<td>Min.</td>
<td>3760</td>
<td></td>
</tr>
<tr>
<td>before maint</td>
<td></td>
<td>after maint</td>
<td>386</td>
<td></td>
</tr>
<tr>
<td>after maint</td>
<td></td>
<td></td>
<td>336</td>
<td></td>
</tr>
</tbody>
</table>

Note: The limits shown are as per the revised PUC norms

ARAI Study on In use vehicle emissions - Conclusions derived

- There is definite improvement in mass emission due to maintenance
- Fuel consumption improvement is a complimentary benefit
- Higher in-use vehicle emissions are mainly contributed due to improper tuning of carburetor and spark plug settings
- Even older vehicles if properly maintained produce lower emissions
- New technology vehicles if not maintained properly could give higher emissions
Retrofitment of Catalytic Converter

- In-use vehicle emissions can be significantly reduced by retrofitment of catalytic converters especially for 2- and 3-wheelers which form the majority of vehicle population in India

- Issues
  - Who will carry out the retrofitment?
  - Design of catalytic converter
  - Assessment of efficiency of catalytic converters on in-use vehicles
  - Model based/ engine capacity based/year of manufacture based
  - Non-OEM catalytic converter evaluation procedure
  - Economic incentives for fitment of catalytic converters

Pollution Under Control (PUC) System in India

- Pollution Under Control
  - Idle CO Emission Test for gasoline vehicles
  - Free Acceleration Smoke test for Diesel vehicles
- No Safety related checking on Private in use vehicles
The Present PUC system - Issues

- Test procedures and norms have not changed since introduction
- PUC Center operators are not trained
- Equipment not maintained / calibrated
- Proper test procedure not followed
- No well defined criteria for authorizing/registering PUC Center
- No auditing of PUC Center
- Lack of centralized agency for co-ordination
- The number of vehicles undergoing PUC test is very small due to absence of control mechanism to identify vehicles escaping PUC
- No analysis of the data collected
- Existing system is prone to tampering

PUC Idle CO Test Procedure - Issues

Idle CO check:

- Proper extension pipes especially for 2&3 wheeler vehicles are not used
- Chances of leakages in the system leading to low readings
PUC Free Acceleration Smoke Test - Issues

- Smoke readings differ with warming up of the vehicle. It is very difficult to achieve the specified 10 km warming up in the field to get the consistent readings.

- The free acceleration test is a transient test. (raising the speed from idling to max rpm). The smoke readings may vary depending on the way the accelerator pedal is pressed by various operators.

- There is a complaint in the field that the smoke readings at different PUC centers do not match.

Free Acceleration Smoke Vs Oil temp & Warm up distance
Free Acceleration Smoke Vs Oil Temperature

![Graph showing the relationship between smoke in K/(m) and oil temperature in degrees Celsius. The graph illustrates data for Engine 1, Engine 2, Engine 3, and Engine 4.]

**Proposed Revisions in Smoke Meter Specifications**

- Oil temperature and engine rpm measurement built into the smoke meter.
  - Oil temperature above 60°C will be used as an indication of engine warm-up.
  - Engine rpm will be measured to ensure consistency of operation.

- Smoke meter to identify the initial 6 flushing cycles based on the rpm measurement.

- Software will ensure the repeatability of the maximum rpm achieved for each acceleration within ±300 rpm for 4 Wheelers and ±500 rpm for 3 wheelers.

- The smoke meter will provide the indications to assist the user for operation of the accelerator pedal.
2-Stroke 2/3-Wheelers: White Smoke

- It is a known fact that 2-stroke vehicles emit white smoke
- No control of visible pollutants from such vehicles in India

Issues
- Equipment to be used- Common partial flow diesel smoke meters may not be suitable
- Full Flow in-line smoke meters are used in Thailand and Taiwan
- Detailed study needs to be carried out for to assess the feasibility and for deciding the cut points

### PUC Tests – Revised Norms from 1st October 2004

<table>
<thead>
<tr>
<th>Sr. No.</th>
<th>Vehicle Type</th>
<th>Present Norms</th>
<th>Proposed Norms</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>CO % HC ppm</td>
<td>CO % HC ppm</td>
</tr>
<tr>
<td>1</td>
<td>2&amp;3 wheeler (2/4 –stroke) (vehicles manufactured on and before 31/3/2000)</td>
<td>4.5 -</td>
<td>4.5 9000</td>
</tr>
<tr>
<td>2</td>
<td>2&amp;3-wheeler (2-stroke) (vehicles manufactured after 31st March 2000)</td>
<td>4.5 -</td>
<td>3.5 6000</td>
</tr>
<tr>
<td>3</td>
<td>2&amp;3 wheeler (4-stroke) (vehicles manufactured after 31st March 2000)</td>
<td>4.5 -</td>
<td>3.5 4500</td>
</tr>
<tr>
<td>4</td>
<td>Bharat Stage II compliant 4-wheelers</td>
<td>3.0 -</td>
<td>0.5 750*</td>
</tr>
<tr>
<td>5</td>
<td>4-wheelers other than Bharat Stage II compliant</td>
<td>3.0 -</td>
<td>3.0 1500*</td>
</tr>
<tr>
<td>6</td>
<td>Diesel Vehicles</td>
<td>65 HSU (2.45m⁻¹)</td>
<td>65 HSU (2.45m⁻¹)</td>
</tr>
</tbody>
</table>

* For CNG Vehicles, NMHC=0.3HC; For LPG Vehicles, RHC=0.5HC
**Enhanced PUC system**

- Revision Idle emission norms based on the year of vehicle manufacture.
- Introduction of idle HC emission standards
- Introduction of idle CO and HC emission norms for CNG / LPG vehicles
- Will have improved test methods for gasoline and diesel vehicles
- Four gas analyzer to check any exhaust gas dilution
- Measurement of Engine oil temperature and engine rpm for repeatable and consistent smoke readings

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**Enhanced PUC system**

- Improved equipment operating conditions
  - Compulsory AMC for min 5 yrs.
  - Annual renewal based on AMC verification
  - Training of PUC center operators by equipment suppliers and institutionalize the complete system
  - Calibration of equipment three times per year
  - Communication capability with computer for data transfer and storage
**ARAI Developed loaded test for 2 Wheelers**

- **Dynamometer** (simple rollers with flywheels)
- **Driving cycle display**
- **PC** and software to estimate mass emissions
- **4 gas analyser for raw exhaust**

**ARAI Developed Loaded test**

- **Driving Cycle Display**
- **2W Load Devel**
**Comparison of Certification results with Proposed System for CO – 2 Wheelers**

Comparision - Certification vs Estimated Mass Emission (CO g/km)

\[ y = 1.0928x + 0.0245 \]

\[ R^2 = 0.9529 \]

**Comparison of Certification results with Proposed System for HC – 2 Wheelers**

Comparision - Certification vs Estimated Mass Emission (HC g/km)

\[ y = 0.5813x - 0.0087 \]

\[ R^2 = 0.9812 \]
**Comparison of Certification results with Proposed System for HC – 2 Wheelers**

\[ y = 0.991x + 0.0043 \]

\[ R^2 = 0.9772 \]

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**ARAI Developed Loaded test for 2 Wheelers**

- After extensive trials on limited no of 2 W vehicle models, a speed based signature for each vehicle model is developed to estimate mass emissions from raw continuous emission data.
- The library of signature needs to be created for all types of vehicle models.
- The data Correlation with the certification test is high.
- This test method is recommended in the Auto fuel policy report.
- ARAI can develop short test for other category of vehicles like 3 and 4 Wheelers.
Proposed Inspection and Certification System for India

Tests required to be done

- Safety Parameters evaluated
  - Visual inspection of upper body
  - Brake performance
  - Speedometer
  - Side-slip
  - Head-light
  - Noise
  - Underbody visual inspections

- Emissions testing
  - 4 gas analyzer for petrol driven vehicles (Idle Test)
  - Smoke meter for diesel driven vehicles (FAS)
Requirement from equipment suppliers

- The equipment suppliers will be required to provide 5 years of warranty for all the equipment
  - This is basically to avoid ‘fly by night’ suppliers
- 90% system up-time should be guaranteed by the operators for each of the test lanes

Present Status of I&C in India

- Two committees on I&C were formed
  - Administrative committee: to look into the administrative aspects of the I&C implementation in India
  - Technical Committee: to look into the technical aspects related to I&C
  - Both the committees have submitted draft reports
  - Both the committees will shortly be submitting final reports
Conclusions

- Indian two wheelers are unique with optimum blend of
  - utility and performance
  - fuel efficiency
  - and complying with stringent emission regulations
- Continuing to Grow at a healthy pace

Future challenges to mobility in India would be:
- To introduce new technologies
- To meet stringent emission regulations
- To be recognized as ECO-friendly (re-cyclability) and safe mode of transport by society at large

*and all this at affordable and competitive price to the customer*
Conclusions

Strategy to reduce pollution from vehicles should focus on:
- Vehicle technology upgradations along with tightening of emission norms
- Fuel Quality improvement
- Control of in-use vehicle emission by effective I/M programme
- Retrofitment of catalytic converters especially on 2- and 3-wheelers
- Use of Alternative Fuels
- Introduction of pre-mixed 2-Stroke lubrication oil for 2-Stroke vehicles
- Phasing out and replacement of old vehicles

Conclusions

The existing PUC system would be enhanced by:
- Revision of PUC norms based on the year of vehicle manufacture
- Introduction of HC norms for all types of vehicles
- Improved test method for diesel vehicles with engine rpm and oil temperature measurement
- The existing 2 gas analyzer in the field to be phased out and the 4 gas analyzer to be introduced in the PUC centers
- New PUC centers would be approved with 4 gas analyzers only
- The test data to be uploaded to a central agency for monitoring and analysis of the data
Conclusions (Contd...)

- The inspection and certification lanes to be established for emission and safety inspections
- Identify high polluting vehicles by Remote sensing device or any other gross polluter identification method
- Subject the High polluting vehicles to loaded test at I&C lanes
- Have a centralized test only centers and separate the Repair / Maintenance and certification
- Synergize the PUC system with the I & C at a later stage

Conclusions (Contd...)

- A loaded transient emission test is required for Indian conditions to accurately identify Gross polluters and represent realistic emissions from in-use vehicles.
- A suitable I / M program covering the emission and safety aspects have to be designed for Indian conditions i.e. low cost, easy to maintain, easy to operate and suitable for all vehicles including 2-wheelers.
Conclusions (Contd...)

- The ARAI developed short test for Two wheelers which has a very good correlation with certification test can be considered for immediate implementation.
- Similar loaded test can be developed for other categories of vehicles (3W, 4W gasoline and diesel vehicles).
- The existing PUC centers may be upgraded in phased manner to advanced vehicle inspection lanes for safety and emissions checks.
- Public awareness campaigns are to be strengthened.