Controlling toxic air pollutants in Indian metros in the new millennium

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Abstract

The current set of diesel vehicles on Indian roads emits inordinate amounts of particulate matter, NOX, and sulphur dioxide. Of highest concern are the fine, respirable particles of sizes 10 and 2.5 microns (PM 10 and PM 2.5) which are highly carcinogenic and carry toxic heavy metals with them. It is time to set standards to particularly address PM 10 and PM 2.5 emissions. The answer may lie in control technologies such as particulate traps, oxidation catalysts, and NOX catalytic controls.

Further, given the poor maintenance of vehicles in India, there is a tendency to pollute more as they get older. One solution could be in mandatory periodic fitness certification for all such vehicles.

This paper attempts to highlight developments taking place around the world concerning the influence of various additives on the emission behavior and characteristics of the vehicles.

1 Introduction

The imposition of Euro-I and Euro-II norms has not come a day too soon. A petrol driven 4-wheeler which adheres to Euro-II norms, depending upon its engine capacity, would emit 2 to 3 times less carbon monoxide and 3 to 4 times less hydrocarbons and nitrogen oxides than the currently stipulated levels.

Its diesel counterpart, on the other hand, depending upon the gross vehicle weight, would be required to meet emission norms that compared to present levels, are 1.2 to 2.0 times stricter for carbon monoxide and double this value for nitrogen oxides (NOX). Notably, the first time in India, emission norms would also be set for particulate matter (Bose, Gupta [10]).
Present status of vehicular traffic and vehicular pollution in India

At present, there are nearly 50,000,000 vehicles in India and annual production is about 5,000,000 units. This means that 90% of the vehicles on roads run on older technology. According to a World Bank Report, 20% of poorly maintained vehicles in India emit about 60% of the pollutants. The government has realized the hazards of vehicular emissions and is now doing its bit to crack down on pollution. The recent intervention of the Hon. Supreme Court regarding the implementation of emission laws at Delhi, will also result in a quick reduction in the time required to improve the quality of air. (Rebello [4]).

Recently, a special drive conducted against polluting vehicles by the Motor Vehicles Department of Maharashtra in Mumbai found 1012 taxis, 1198 trucks and 128 tankers emitting pollutants in excess of the prescribed limits. The registration of these vehicles has been suspended for 3 months.

However, this alone will not suffice the situation. Fuels and engines should go hand in hand. An important pre-requisite for clean air is the availability of better fuel. High octane and cetane numbers, more stable and adulteration free fuel should be introduced. The government should concentrate on improving the quality of fuel. According to a report of Central Pollution Control Board of India (CPCB), the vehicular pollution in Delhi which contributed 64% of the total pollution, decreased for the first time in this decade and it came down from 7.47 lakh tones in 1995-96 to 6.66 lakh tones this year, the reduction of lead content in petrol from 0.58 gm/liter to 0.15 gm/liter, the introduction of unleaded petrol for new cars from 1995 and the supply of only unleaded petrol to all vehicles from February 2000 have reduced the lead content in vehicular exhaust by more than 60%. Sulphur content in diesel oil was reduced to 0.5% in 1996, thereby reducing sulphur dioxide emissions. They still need to be brought down to match Euro-III norms. The level of benzene continues to be a cause of concern. This is due to the fact that benzene content in unleaded petrol will be reduced from 5% to 3% by 2000. In Europe and the United States, the acceptable limit is 1%. Benzene, a carcinogen, can cause a lung disease which makes breathing very difficult. Lung transplantation is the only cure for this disease, and can’t be performed in India. The unleaded petrol in Delhi has a benzene content of 5%, when the existing refineries can provide petrol with 2.5 to 3.0% benzene. (Prasad,[11]).

The oil industry has already spent around Rs. 5600 crores in diesel hydro desulphurization (DHDS) units. Indian Oil has spent Rs. 1776 crores to supply low sulphur diesel across the country by July-August last year. The introduction of unleaded petrol in the Delhi has certainly made a difference to Delhi’s air. The observance of Euro norms will also help. But this is only a total package of measures that will make a lasting difference. This should include traffic management, discouraging the use of personalized mode of transport, the scrapping of old vehicles, handling adulteration and improving technology. There are no short cuts to clean air.
3 Vehicular pollution load in Indian major cities

The estimated vehicular emission load in major Indian cities is shown in the Table 1.

Table 1: Vehicular pollution loads (tons per day)

<table>
<thead>
<tr>
<th>NAME OF CITY</th>
<th>PARTICULATES</th>
<th>SO2</th>
<th>NOX</th>
<th>CO</th>
<th>HC</th>
<th>TOTAL</th>
</tr>
</thead>
<tbody>
<tr>
<td>AHMED-ABAD</td>
<td>2.95</td>
<td>2.89</td>
<td>40.00</td>
<td>179.14</td>
<td>67.75</td>
<td>292.73</td>
</tr>
<tr>
<td>BANGALORE</td>
<td>2.62</td>
<td>1.76</td>
<td>26.22</td>
<td>195.36</td>
<td>78.51</td>
<td>304.47</td>
</tr>
<tr>
<td>CALCUTTA</td>
<td>3.25</td>
<td>3.65</td>
<td>54.69</td>
<td>188.24</td>
<td>43.88</td>
<td>293.71</td>
</tr>
<tr>
<td>CHENN-AI</td>
<td>2.34</td>
<td>2.02</td>
<td>28.21</td>
<td>143.22</td>
<td>50.46</td>
<td>226.25</td>
</tr>
<tr>
<td>DELHI</td>
<td>10.30</td>
<td>8.96</td>
<td>126.46</td>
<td>651.01</td>
<td>249.57</td>
<td>1046.30</td>
</tr>
<tr>
<td>HYDER-ABAD</td>
<td>1.94</td>
<td>1.56</td>
<td>16.84</td>
<td>126.17</td>
<td>56.33</td>
<td>202.84</td>
</tr>
<tr>
<td>JAIPUR</td>
<td>1.18</td>
<td>1.25</td>
<td>15.29</td>
<td>51.28</td>
<td>20.99</td>
<td>89.99</td>
</tr>
<tr>
<td>KANPUR</td>
<td>1.06</td>
<td>1.08</td>
<td>13.37</td>
<td>48.42</td>
<td>22.24</td>
<td>86.17</td>
</tr>
<tr>
<td>LUCKNOW</td>
<td>1.14</td>
<td>0.95</td>
<td>9.68</td>
<td>49.22</td>
<td>22.50</td>
<td>83.49</td>
</tr>
<tr>
<td>MUMBAI</td>
<td>5.59</td>
<td>4.03</td>
<td>70.82</td>
<td>496.92</td>
<td>108.21</td>
<td>685.57</td>
</tr>
<tr>
<td>NAGPUR</td>
<td>0.55</td>
<td>0.41</td>
<td>5.10</td>
<td>34.99</td>
<td>16.32</td>
<td>57.37</td>
</tr>
<tr>
<td>PUNE</td>
<td>2.39</td>
<td>1.28</td>
<td>16.20</td>
<td>162.24</td>
<td>73.20</td>
<td>255.31</td>
</tr>
<tr>
<td>GRAND TOTAL</td>
<td>35.31</td>
<td>29.84</td>
<td>422.88</td>
<td>2299.21</td>
<td>809.96</td>
<td>3624.20</td>
</tr>
</tbody>
</table>

SOURCE: (M. Ganesan, [6])

4 Route to fuel economy lubes: latest developments

Globally efforts are being made to reduce carbon dioxide (CO-2) emissions and conserve resources by cutting fuel consumption. In the US, direct pressure is put on the auto-makers through the Environmental Protection Agency's corporate average fuel economy requirements. In Japan, there is a requirement that fuel consumption must be reduced by 7 % to 11 % depending on vehicle size by the year 2000.

In Europe, the emphasis has been on reducing CO-2 emissions and energy use by taxation rather than regulation. About half the countries within the European Union (EU) have, to some extent, adopted this approach. The European Auto-
makers Association (ACEA) has taken a prominent role - perhaps with the encouragement of the civil servants - by calling on its members to make a commitment to cut CO-2 emissions by up to 25%. ACEA has asked for a passenger car CO-2 emissions target of 140 g/km by 2008.
ACEA's oil sequences are the performance standards for European lubricants and provide a market minimum levels for service-fill engine oils. They are set after consultations-usually lengthy-with the automotive, oil and additive industries. The current sequences came into March 1998 and continued the existing trend toward longer drain intervals, higher overall performance, and reduced emissions. But for the first time, they also contained fuel economy categories for passenger car gasoline engines and passenger car light duty van diesel engines. The standards were based on attaining a 2.5% improvement over the performance levels of a Society of Automotive Engineers (SAE) 15 W - 40 reference oil tested in a Mercedes M 111 W engine.

4.1 Germany tests: A status report

Germany is one EU member state that has made a specific effort to tackle CO-2 emissions via the fuel efficiency route. Its government has offered two levels of tax incentives for passenger cars to achieve CO-2 emissions of 120 or 90 g/km. The recently announced LUPO is being marketed as a “3-liter or SL” car because it can travel 100 km on 3 liters of fuel-about 78 mpg in the U.S. Its 1.2 liter, turbo-charged, three-cylinder diesel engine and other fuel-efficient features have received considerable technical praise.

Germany has not extended the tax incentives to the truck market. HD vehicle operators tend to be self-regulating in that they will buy the vehicle with the lowest fuel consumption.

4.2 United Kingdom encouraging energy efficiency

The United Kingdom (UK) announced a raft of new reforms to encourage energy efficiency within the country, including a proposal to be introduced in 2002-under which business car drivers will be taxed on a percentage of the car's price, varying with the vehicle's CO-2 emissions rate.

Climate change is recognized as one of the most significant environmental threats facing the world. For the same environmental reasons, the UK government has also been particularly zealous in the application of escalating fuel taxes. So far, visible disapproval among its citizenry has been restricted to demonstrations by truck operators. Elsewhere in Europe, road related taxation does not appear to be biting as hard or perhaps it is aimed at a "greener" and more tolerant public-as in Germany, Austria and Scandinavia. (Adlington, [5]).

5 Automobile exhaust emissions and quality of fuel: A direct relationship

Generally, engine oil manufacturers have been active to point out how they can alleviate the motorist's financial discomfort. High-quality, low-viscosity products-such as SAE OW - 40 Mobil 1-have been marketed with claims of economy improvements of up to 6% against standard mineral oil. SAE 15 W - 40 engine oils have been favored in Europe for many years. But if engine manufacturers are
going to meet Association des Constructeurs Europeans d'Automobiles (ACEA) -
European Auto makers Association's proposed CO-2 limits, they will be
demanding even greater fuel efficiency from oils in the marketplace and more
will be recommending SAE 5W - 20, 0W-30 and 5W-30 grades. Oil formulators
will have to re-balance additive components, and enhanced friction modification
will be required to maintain performance from both new and aging oil.

It seems that European vehicle manufacturers - through ACEA - have
successfully added CO-2 emissions and fuel economy limits to the engine oil
performance standards they already set. Meanwhile, national governments stand
on the fuel efficiency moral high ground, providing support and encouragement
with taxation regimes.

6 NOX - reducing air membranes: a clean alternative to
exhaust gas recirculation

An air separation membrane - a clean alternative to exhaust gas recirculation
(EGR) - successfully cut nitrogen oxides (NO-2) from a light duty diesel by up to
30 %, without the excess particulates, corrosion, and lube oil degradation
problems of EGR. In tests at Argonne National Laboratory (ANL), with matching
funds from the U.S. Department of Energy, for the Partnership for a New
Generation of Vehicles (PNGV) Programs, Compact Membrane Systems (CMS)
proved that a prototype non-optimized "nitrogen-enriched-air (NEA) membrane
air separator could cut NOX up to 30%, with about 3.5% fuel penalty and no
detriment to engine performance.

According to CMS, the membrane has no direct effect on engine oils. It only
affects the air entering the combustion chamber. EGR, in contrast, is known to
contribute to lubricant contamination. By substituting the NEA air-enrichment
technology for EGR, then, the problems of such contamination can at least
theoretically be avoided altogether.

In the tests at ANL, researchers measured NOX, particulates (PM),
hydrocarbons (HC), carbon monoxide (CO), power output, and fuel consumption.
They showed that the NEA outperformed EGR on NOX reduction at higher
speeds and loads, whereas EGR showed slightly better NOX reduction at lower
engine speeds. PM emissions were similar for both NEA and EGR, although the
same engine with neither EGR nor NEA had higher PM emissions at low engine
speed, but lower PM emissions at higher engine speed. HC and CO emissions
were similar for both NEA and EGR.

7 Discussions

A Center for Science and Environment has recommended a ban on use of diesel
vehicles. Diesel exhaust contains 10-100 times more particles than petrol. Also,
these are carcinogenic. Yet, diesel accounts for 2/3 of the total fuel consumption
in the transport sector. More diesel cars are being made in India because of the
price differential vis-à-vis petrol. Brazil, Taiwan and Egypt have banned diesel
vehicles.
A standards based approach is the main component of control programs in the U.S. and Europe. Economists tend to be skeptical of the impact that standards will have. They will certainly reduce the quantity of emissions per mile driven for given type of vehicles, but will only affect new sources; considerable time delays exist before such standards permeate the whole fleet.

There is no uniquely best instrument for all circumstances. It is probably desirable to select a range of instruments, and operate these in a flexible manner. However, a good incentive system is a simple, transparent system and so it is important to avoid over-elaboration and excessive complexity in the chosen set of policy instruments.

8 Conclusions

The time has also come to shift part of the air pollution debate to the prevailing fuel quality standards. The oil refineries still produce diesel with high levels of sulphur, and leaded petrol is even now a reality. Moreover, fuel adulteration is rampant. For vehicles to conform to Euro-I and Euro-II norms, it is imperative that petrol and diesel adhere to specific fuel properties. Substituting lead in petrol by oxygenates such as methyl tertiary butyl ether would boost its octane value and reduce the emissions of toxic substances such as benzene, toluene, and xylene.

Further, increased use of clean substitute fuels such as oxygenated blends, compressed natural gas, and propane in captive fleet vehicles (buses, taxis, 3-wheelers) should be vigorously promoted. Thus, the crucial role of oil refineries in improving air quality cannot be overstated. The solution, thus, lies in collaboration among the automotive and oil companies. Notably the European Program on Emission, Fuels and Engine Technology has amply recognized this view, which addresses the vehicle and fuel system as a whole. The need of the time is to adopt the same in all metros in India towards cleaner environment.

Emission warrantees are being offered for the first time in India by the automobile industry. They are the highest offered on two-wheelers anywhere in the world. Vehicular emissions have been receiving the highest consideration and priority by the automobile manufacturers in India. The emission warranty announced is a pioneering step by the automobile industry and reflects its proactive approach towards controlling air pollution and environment management. This itself proves that India is now moving towards a more technology driven and environmentally conscious automobile industry.

9 References