CSE critique

Centre for Science and Environment comments on the CPCB's recently released *Study of Exhaust Gases from Different Fuel-based Vehicles for Carbonyls and Methane Emissions*

We have reviewed the recently released study from the Central Pollution Control Board and ICAT -- *Study of the Exhaust Gases from different fuel based vehicles for Carbonyls and Methane Emissions*. CPCB has made a valuable effort to generate emissions data on unregulated toxic emissions as well as methane emissions from different combination of vehicle and fuels (diesel, petrol, LPG, CNG, bio-diesel and ethanol etc). However, there are some discrepancies and missing links in the study that lead to misleading policy conclusions. In order to prevent wrong and damaging interpretation of this study and to get good policy action from this study we would like to propose an immediate review of this study to address these concerns. Here are our key observations related to the study.

1. The study must explain and justify the selection of toxics considered for the study. Why has it left out more toxic and important cancer causing compounds that other governments prioritise based on their unit risk factors?

The study has not explained the basis on which it has selected a few carbonyl compounds and why it has not considered those toxics that have higher toxicity and cancer potency. There are numerous toxic compounds in vehicle exhaust. But globally governments use unit risk factors (This means *the number of excess cancer cases per million people per microgramme per cubic meter concentration of toxic air contaminants exposed over a 70 year period*) that are assigned to each toxin to indicate their relative toxic or cancer risks. Accordingly they prioritise them. For instance, as the table below indicates that acetaldehyde has much lower unit risk than other air toxic such as 1,3-Butadiene and benzene. But CPCB-ICAT study has not rationalised selection of compounds on that basis. An earlier ARAI-MOEF-CPCB study to generate emissions factors for vehicles has considered the key groups of toxics – aldehydes (formaldehydes and acetaldehydes), benzene, 1,3-Butadiene, and PAHs.

Particulate emissions have not been included in this study. But diesel particulates are listed as toxic air contaminant in the US. The unit risk factor for diesel particulate matter is 300 – much higher than the toxics considered for this study. But the study has not put any caveat on that. It is extremely misleading that the CPCB lists diesel as the "best fuel" and CNG as the "worst" without putting caveat about the very high toxic risk of diesel particulate matter. CPCB must indicate the unit risk factors of all the compounds they have considered for the study must also add more important toxins for comparison. This selective omission of more toxic compounds and diesel PM from the list is very misleading and breeds suspicion.

It is important to consider all the relevant air toxics if any ranking of fuels is done. CPCB cannot rank fuels as best and worst on the basis of only partially selected air toxic.

Table: Toxic Air contaminant (Unit Risk Factors)

Toxic Air Contaminant	Unit Risk/Million People	Detection limit (ppb)
Acetaldehyde	2.7	0.10
Benzene	29	0.05

1,3-Butadiene	170	0.04
Carbon Tetrachloride	42	0.02
Chromium, Hexavalent	150,000	0.06 (in nanogram)
Para-Dichlorobenzene	11	0.30
Formaldehyde	6	0.10
Methylene Chloride	1	0.10
Perchloroethylene	5.9	0.01
Diesel particulate matter	**300**	**N/A**

Note: Unit Risk represents the number of excess cancer cases per million people per micrgramme per cubic meter TAC concentration over a 70 year lifetime exposure
A diesel particulate matter unit risk value of 300 is used as a reasonable estimate in the "Risk Reduction Plan to reduce Particulae Matter Emissions from Diesel Fuelled Engines an vehicles (ARB, October 2000)
Source: California Air Resource Board

2. For all other fuel segments like diesel and petrol the study has taken OEM vehicles. But for the CNG segment it has considered only old retrofitted CNG vehicles. Why? It is very strange that this study published in 2010 has chosen to ignore the OEM vehicles on CNG and LPG and have considered only retrofitted vehicles. As you would know both bus and car manufacturers are now producing CNG and LPG models. Nearly all city bus projects are based on new dedicated models. Delhi has already taken a decision not to retrofit buses. Also OEM car models on gaseous fuels have multiplied in the recent years. Yet the study states, "For Compressed Natural Gas (CNG), retro-fitment engines have been used due to **unavailability** of dedicated engine in the market." (Pg 43). This is inexplicable.

CPCB has today justified in a media report that the reason for selecting retrofitted vehicles for the study is the dominance of retrofitted cars in the Indian market. But the report cites unavailability of OEM models as the reason. If dominance of the retrofitted cars in the market is the key reasons then by that logic why has the study used diesel fuel with 10 ppm sulphur content to test Euro III diesel vehicles when 10 ppm sulphur diesel is not available in the Indian market? Indian diesel currently has 350 ppm sulphur and ony 13 cities have 50 ppm sulphur diesel. .

The study has therefore ended up comparing apples with oranges when they are not directly comparable. This is misleading. You may recall the case from California where the California Air Resources Board had first carried out tests and compared state of the art diesel buses fitted with CRT etc with conventional CNG buses without cat converters and concluded that CNG buses emit more carbonyl and aldehydes than diesel buses. The study was repeated on CNG buses fitted with after treatment systems and they found significant reduction in the toxic emissions.

Nonetheless, emissions data of retrofitted vehicles are also important to guide policy action on retrofitment. Retrofitment – if not done well, wear and tear of the old vehicles, often absence of proper cat converters – can lead to unstable and high gaseous emissions. The study should have given proper policy guidance on the merit of promoting dedicated vehicles, and enforcing stringent quality audits for proper retrofitment and in-use monitoring. The study has not done that.

Moreover, the CPCB-ICAT study is completely silent on the vintage and age of the retrofitted vehicles selected for the tests. Nor has it given any detail regarding the presence or the status of the aftertreatment devices in the vehicles. This is a serious lapse as that would determine the emissions as well as comparability. It is misleading that a CRDI powered Euro III diesel car fitted with oxicat is compared with a retrofitted CNG car of unknown vintage and model year to conclude that diesel is best and CNG is worst -- and that too without any caveat to diesel particulate emissions.

The study should be modified to separate out the retrofitment vehicles and not club them with OEM vehicles. Additionally, data should be generated for OEM vehicles as well.

3. Why has the study clubbed methane which is a greenhouse gas with toxics? Also why has the study not considered other prominent and dominant greenhouse gas emissions like CO2 to compare the fuels?

The study has not explained why it has combined air toxics with only one warming gas methane. Urban air quality regulators do not regulate methane as it is not considered a toxic gas. This is a global warming gas. If CPCB is interested in assessing greenhouse gas emissions from vehicles then it should have included carbon-dioxide (CO2), black carbon, N2O etc. CO2 is the most dominant GHG emissions. To stand the scientific scrutiny CPCB should separate out methane from the toxic compounds. Methane emissions can be high from the CNG vehicles but comparison of warming potential of different vehicle-fuel systems can be evaluated based on the range of dominant greenhouse gases like CO2 etc to arrive at a conclusion. The study needs to justify this clearly.

4. Why has the study not mentioned the actual composition of the fuels used for testing the vehicles, especially when the study takes note of the fact that changes in the fuel parameters has bearing on the unregulated emissions?

The study shows that the toxic emissions increase in petrol cars from BSII to BS III level. The study explains this on the basis of literature survey that attributes the increase to the reduction in aromatics, olefins etc in petrol fuel. Similarly, improvement in cetane number and reduction in sulphur levels (reference fuels as per regulations have very low sulphur) have been cited as the reasons for increase in emissions from BSII to BSIII diesel cars.

But the study has not analysed the fuel properties or mentioned the control strategies. The study only mentions specifications of reference fuels which is not adequate. There is no information on actual oxygen or aromatic content of the fuels used for testing. How can you then correlate the changes with the changes in fuel composition? Globally studies have been carried out on the influence of oxygen, aromatics, olefins and sulphur on aldehydes emissions. And these studies show that it might be possible that aldehydes are more dependent on oxygenates than on aromatics or sulphur content. Studies show oxygen content can also be a very critical parameter regarding aldehydes. Higher aromatics content can also lead to some increase in aldehydes. Sulphur may not show any significant influence. In fact global studies show that higher sulphur content can typically increase emissions from petrol cars due to harmful effect on the three-way catalysts. But the study has not explained any of this. It has also not drawn any policy conclusion from this aspect of their result or suggested any control strategy.

5. Comparison of fuels is misleading:

This study in its conclusion finally compares and ranks fuels based on tailpipe emissions from vehicles. If the objective of the study is to compare fuels and not vehicle technology

and their levels then it should have done a lifecycle analysis of fuels by looking at the upstream and downstream emissions of the fuels as is done globally.

6. Wrong and contradictory conclusions drawn in the study

In some parts of the document the substantive conclusion and the data do not match. For instance, the pai charts on vehicle wise emissions data as well as the comprehensive table on emissions data in the Annexure show clearly the emissions values of various aldehyde and carbonyl compounds from diesel cars. But the conclusion section of the study mentions "Considering Diesel engine fuels, Propionaldehyde, acetone, Crotonaldehyde, Methyl ethyl ketone, n-Butyraldehyde, Methacrolein, Benzaldehyde, m-Tolualdehyde and Hexanal emissions were **absent……..**" The same paragraph further mentions – "The **aldehyde emissions are absent**…." In diesel cars (Pg 61). What can be the reason for this observation and incongruity when the data is showing clearly the emissions level from diesel cars?

What needs to be done?

We have urged and requested CPCB to recall and urgently review this study and modify it to address the concerns raised and make this study more scientifically tenable. For this review, we have suggested the following issues for CPCB's consideration:

1. It is important to consider all the relevant air toxics if any ranking of fuels is done. CPCB cannot rank fuels as best and worst on the basis of only partially selected air toxics. The study must explain the criteria and the rationale for selecting the carbonyl compounds and aldehydes considered for the study. How do these compounds compare in the toxicity levels in the whole list of toxics that are internationally considered important in vehicular emissions? Indicate the unit risk factors of these compounds and how do they compare with all other toxics from mobile source that are listed by other regulators like the USEPA and California Air resources Board etc and are accorded priority.

2. Retrofitted CNG and LPG vehicles should be treated separately in the study and not clubbed with OEM vehicles on petrol and diesel for direct comparison. Also take steps to generate emissions data for new OEM CNG and LPG vehicles. Explain the comparability of vehicles by providing the technical details in terms of their vintage, level of emissions control systems etc of the models tested, quality of fuel used.

3. Methane data should be treated separately from the air toxic.

4. If one of the objectives of this study is to compare the warming potential of the fuel-vehicle systems then provide CO2 emissions data and also generate data on other prominent greenhouse gas emissions. Only mentioning methane will not help to make the comparison on warming potential of different vehicle-fuel systems. Also it is important to mention that comparison of fuels is done based on lifecycle emissions.

4. The ranking of fuels as done in this study based on tailpipe emissions of a few unregulated emissions is very misleading. This essentially conveys that CPCB has branded CNG as the "worst" fuel and Euro II-Euro III compliant diesel fuel as the "best" fuel. No other government in the world has ever concluded that CNG is the worst fuel and Euro II - Euro III compliant diesel is the best fuel. The study should also provide a caveat on the

toxicity of diesel particulates that are classified internationally as toxic air contaminant and as probable human carcinogen.

5. Provide the details of the actual composition of the fuel parameters used for testing of the vehicles to explain the impact of the changing fuel composition on the unregulated emissions. Only mentioning fuel specification is not adequate.

6. Also review the variance with other emissions data on toxics such as those generated by the Automotive Research Association of India (ARAI). Even though different test data are expected to vary given the type of vehicles tested and test procedures but the variance in this case is huge For instance, the ARAI emissions factor for formaldehyde is 27 times higher than CPCB emissions data for BSIII diesel car. Similar variation is seen for petrol and also retrofitted CNG and LPG cars.

7. The study should also help to identify the policy recommendations on the unregulated emissions from vehicles. This is currently very weak. The study needs to recommend:

- More stringent emissions standards along with much stronger durability requirements and in-use compliance regulations for vehicles in the post 2010 roadmap: CPCB should recommend early nation-wide introduction of Euro V and Euro VI standards. Globally the thrust is on improving the efficiency and durability of the after treatment system to cut both regulated and unregulated emissions from vehicles. But this study has completely ignored the role of emissions control systems in different vehicle segments in controlling these regulations. Only in the case of diesel cars the study mentions in conclusion, “The aldehyde emissions are absent due to the improved vehicle catalytic converter technologies, location of catalytic converter and better fuel injection technologies.” (Pg 61). But this aspect has not been highlighted as part of the control strategies for other vehicle categories.

- CPCB should also recommend formaldehyde emissions standards for vehicles in the post 2010 emissions standards roadmap.

- CPCB should proritise monitoring of the key air toxics in the ambient air for proper risk management.

It is very vexing that first the key partners of the CPCB’s source apportionment study including IOC, and NEERI have started to cite the source apportionment study (yet to be released) in the public forum to claim that LPG is the most polluting fuel in our cities. And now in quick succession a second study follows from CPCB on emissions of unregulated emissions to claim that CNG is the “worst” fuel and Euro II-III diesel is the “best”. Can this withstand scientific scrutiny? Why is science being used to protect conventional diesel market and ignoring the benefit of the CNG programme? TERI-ARAI study has already shown that PM emissions from BSII diesel buses are 46 times higher than the BSII CNG buses?