Standards For Environmental Protection In India

R Ranjith Kumar, G Elavarasan, M Kannan, D Karthikeyan

Abstract: There is a critical situation waiting for our future generation about the consumption of all the resources of globe to produce electricity that our planet took billions of years to create. Over a short duration of shut down or an on-demand power source to supplement a renewable energy system, crude oil based engine-driven generators can provide a viable technological solution. The ICE generator is a mature technology that has been employed with great success the world over. Indeed, it is arguable that this success and the ubiquitous nature of the technology have led directly to many of the environmental crises facing our planet today. Nevertheless, the disadvantages of the engine-driven generator are many, and in some applications, it is the appropriate technology for the job. Even today, the major power source of automobile is crude oil based ICE which are need to be changed gradually by an alternative source of energy. By taking EURO emission standard as reference Central Pollution Control Board in India has implemented Bharat emission standards and it is updating its regulation in regular interval of time. In this paper, a complete review of various stages of Bharat emission standards and the reason for making the emission rules and regulations stringent in recent times were discussed in this paper.

Index Terms: Bharat stage, BS VI emission, Emission standards, Environmental Protection, Euro Norms, Indian emission norms, Pollution.

1. INTRODUCTION

CURRENTLY, there are more than 1.2 billion automobiles present in the road which are the basic sources of pollution and crude oil consumption. So, it is necessary to monitor and regulate the various emissions of Automobile. It is noted that the certain harmful gases were formed as a byproduct due to the variation in the engine combustion process and were released to the atmosphere through the exhaust pipe causes serious effect to the human health; they were Hydrocarbons (HC), Nitrogen Oxides (NO), Carbon monoxide (CO) & Particulate Matter (PM). Apart from these byproducts, as a result of perfect combustion Carbon Dioxide is produced in the engines and this is one of the major greenhouse gases which lead to global warming. To control the release of these harmful exhaust gases into the environment various countries have initiated and implemented different pollution standards to the Automobile manufacturers according to the vehicle type in order to keep the air quality clean. For example, Environmental Protection Agency (EPA) in United States government, European Union Research Organization (EURO) in Europe has framed strict rules for the vehicles to limit the toxic exhaust emissions releasing into the environment. The EURO emission standards that were adopted in the European countries and Tier Emission standards were adopted in USA. The Air (prevention and control of pollution) Act was initially enacted to regulate the air pollution in 1981 and the Environment (Protection) Act of 1986 by the government of India paved the way to regulate the motor vehicle emission in India. Followed
by this India have initiated to follow certain emission standards through the Motor vehicles act of 1988, which allows the government to implement the emission standards. Emission standards for petrol vehicles from 1991 and for diesel vehicles from 1992 and started to follow EURO emission standards as a reference from the year 2000. The Auto fuel policy of 2003 have described about the timeline for the implementation of the various stages of emission standards in all over India and the implementation of emission standards in selected cities and the rest of the country. The Indian emission standard India 2000 (BS I) is taken from EURO 1 emission standards as a reference, BS II from EURO II, BS III from EURO III, BS IV from EURO IV, BS V from EURO V and BS VI from EURO VI. The supreme court of India have ordered to stop the selling of BS-IV vehicle by the end of March 2020 and planning to implement BS-VI emission standards nationwide from April, 2020. The emission standard value of various categories of were discussed in this journal based upon the values provided in the Central Pollution Control Board, Ministry of Environment forest and climate change, Government of India and Emission standards, India from Dieselnet. The major emissions like CO,HC,NOx and PM data were collectively compiled and the graphs were generated for the understanding purpose, However, the other exhaust emissions like sulphur, Ozone, benzene and soot formation in the Gasoline Direct Injection(GDI) were not discussed in this paper. The CO2 formation as a result of perfect combustion is also a major greenhouse gas that has to be reduced from the automobiles and also the amount of fuel consumption should also be reduced.

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2 BHARAT STAGE STANDARDS

Table 1 shows the history of emission standards implementation in various stages in India. As both the state and central government have to cooperate for the implementation of the emission standards and also the necessity in the various regions of the country the emission standards were implemented in various stages. Initially the emission standards were implemented for gasoline vehicles from 1991 and for diesel vehicles in 1992 . Later from the year 2000 India have started to follow the EURO emission standards, and Bharat Stage I (EURO 1) emission standard was implemented nationwide from the same year. BS II emission standard emission standard were implemented in three stages from 2001 to 2005 and BS III emission standards were implemented in two stages from 2005 to 2010 in order to cover whole nation. The National auto fuel policy 2003 have framed out the road map for the implementation of BS IV type emission standards upto the year 2010 and later the auto fuel policy was updated by Mr.Prahlal Joshi,chairman , the standing committee on Petroleum and Natural gas on May,2015 to made the recommendations to implement the emission standards up to the year 2025. The BS V emission

standards were initially proposed to implement from the year 2015. Because of the updated Auto fuel vision policy and poor air quality in India especially in the National Capital Region (NCR), Gwalior in India accounts for 176µg/m3 of PM and it is known that the PM level of more than 36 µg/m3 will have high risk of mortality.

TABLE 1

IMPLEMENTATION OF STANDARDS

Standard	Date	Implemented Region
BS-I (India 2000)	2000	Nationwide
BS-II	2001	NCR*, Mumbai, Kolkata, Chennai
BS-II	2003.04	NCR*, 11 cities#
BS-II	2005.04	Nationwide
BS-III	2005.04	NCR*, 11 cities#
BS-III	2010.04	Nationwide
BS-IV	2010.04	NCR*, 13 cities^
BS-IV	2015.07	Above plus 29 cities mainly in the states of Haryana, Uttar Pradesh, Rajasthan and Maharastra
BS-IV	2015.1	North India plus bordering districts of Rajasthan (9 States)
BS-IV	2016.04	Western India plus parts of South and East India (10 States and Territories)
BS-IV	2017.04	Nationwide
BS-V	Skipped	Skipped Nationwide
BS-VI	2020.04	Nationwide

*National Capital Region (Delhi)

#Mumbai, Kolkata, Chennai, Bangalore, Hyderabad, Secunderabad, Ahmedabad, Pune, Surat, Kanpur and Agra

^Above cities plus Solapur and Lucknow. The program was later expanded with the aim of including 50 additional cities by March 2015

2.1 Emission Standards for Passenger Cars

As the passenger car segments were running in large numbers in the road compared to the commercial vehicles it is necessary to monitor the emission standards for these vehicles. Figure 1, 2, 3 & 4 shows the maximum allowable emissions for passenger cars in India. It shows that there is a massive decrease in the emission standards from 1990's to 2020 emission standards. From the figure 1, It is clear that the CO emission standards were initially recommended of about 27.1g/km in 1991 and 12.4 g/km in the year 1996 and later the value was reduced up to 1g/km in BS VI emission standards.

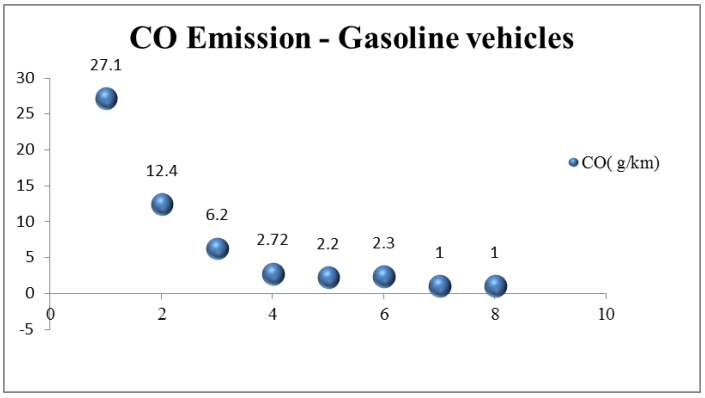

Fig. 1*. Maximum Allowable CO emission from passenger cars powered by petrol according to various emission standards of India.*

From the figure 2, It is clear that the CO emission from diesel powered vehicles were initially recommended as 17.3g/km in 1991 and a major decrease is observed in 1996 of about 5g/km. The recommended value of BS VI emission standard is 0.5g/km.

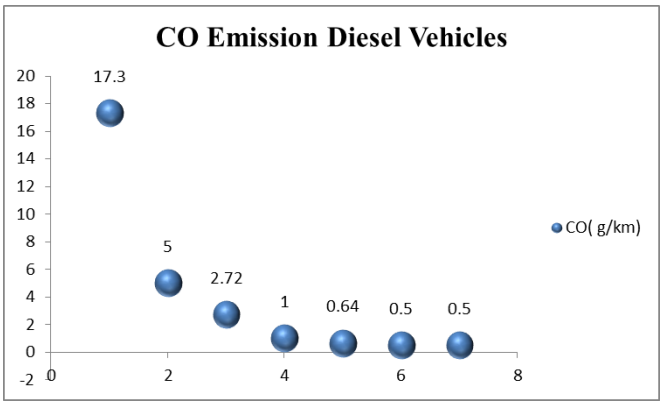

Fig. 2*. Maximum Allowable CO emission from passenger cars powered by diesel according to various emission standards of India*

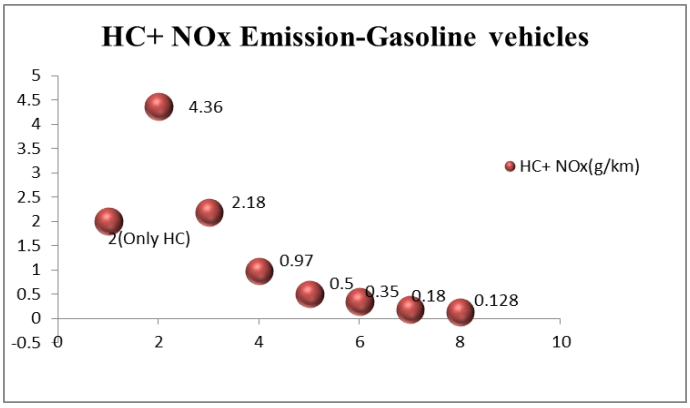

Fig.3*. Maximum Allowable HC+NOx emission from passenger cars powered by petrol according to various emission standards of India.*

From the figure 3, In the early 1991 norms Only HC emission was considered to regularize, NOx emissions were not considered by the government to regularize, but in 1996 NOx was also considered for reduction. It is also seen from the graph that the emission standards of HC+NOX were constantly reduced from 4.36g/km in 1996 to 0.128g/km in BS VI emission standards. From the figure 4, It is clear from the graph that for the HC+NOx emission standards, the initial recommended value was 2.7g/km in 1992 and the upcoming BS VI recommended value was only 0.17g/km. The graph also shows that there is the strictness in the amount of allowable emission from the vehicles.

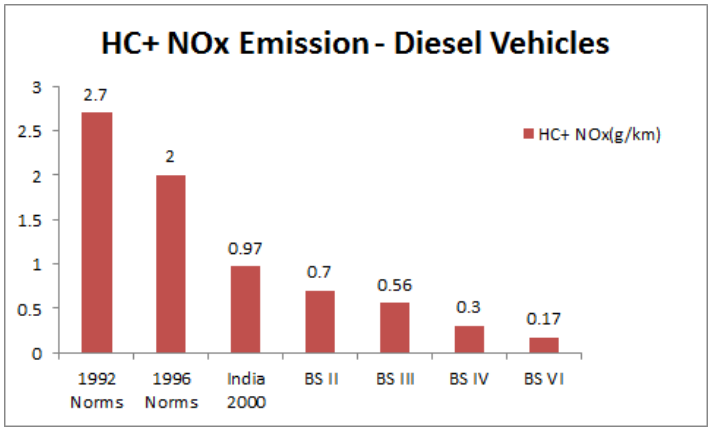

***Fig.4**. Maximum Allowable HC+NOx emission from passenger cars powered by diesel according to various emission standards of India.*

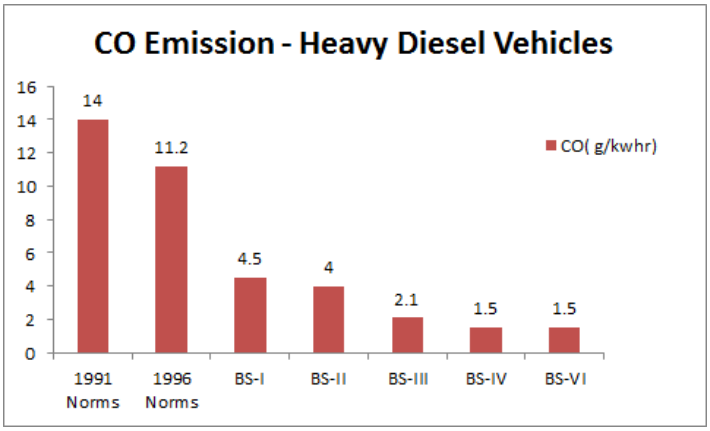

***Fig. 5**. Maximum Allowable CO emission from Heavy Diesel Vehicles according to various emission standards of India.*

2.2 Emission Standards for Heavy Diesel Vehicles

The operating variables in the diesel engines is also responsible for the various emission formation and this was clearly explained by Cenk Sayinet al. Diesel engines are known for their high torque and also the diesel engine will have the maximum efficiency while working in the full load conditions. Because of this diesel engines are suitable for the heavy duty vehicles like trucks and busses. As the engine is large the amount of fuel consumption is higher which leads to the various kind of efficiency, especially the PM and NOX emissions will be higher in diesel engine vehicles compared to petrol engine powered vehicles. The various emissions from the Heavy Diesel Vehicles and its maximum allowable limits were shown in the figures 5,6 & 7. From the figure 5, It is clear that the maximum allowable CO emission from Heavy diesel vehicles were constantly reduced from 14g/kwhr in 1991 Norms, and 4.5g/kwhr in BS I emission standard and later it was reduced to 1.5g/kwhr in BS VI norms. NOx emission ormation will be more in diesel engines compared to petrol engines, because of the high working temperatures in the diesel engines. From the figure 6, It is clear that the maximum allowable HC emission from Heavy diesel vehicles were constantly reduced from 18g/kwhr in 1991 to 0.46g/kwhr in BS VI emission standards. Also the maximum allowable NOx emission from Heavy diesel vehicles was constantly reduced from 3.5g/kwhr in 1991 to 0.16g/kwhr in BS VI emission standards. The graph also shows that there is a stringent rule in the amount of allowable emission from the vehicles. Particulate emission while inhaled will cause serious of problems like asthma, acute respiratory infection and conjunctivitis. From the figure 7, It is clear that the maximum allowable PM emission from Heavy diesel vehicles were constantly tightened from 0.36g/kwhr in 1991 to 0.01g/kwhr in BS VI emission standards. It is because of the adverse effect of PM in the environment.

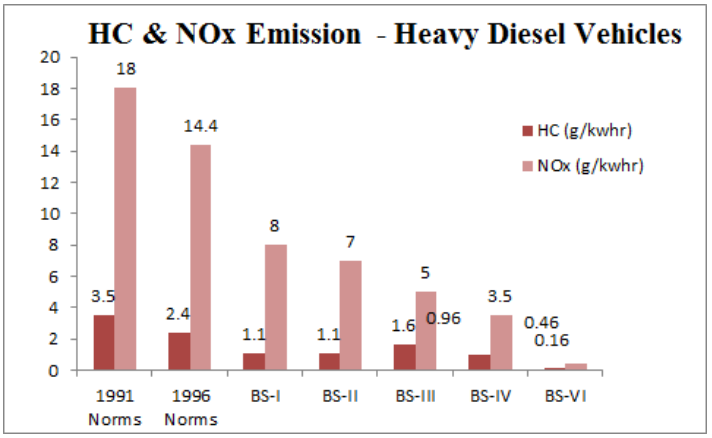

***Fig. 6**. Maximum Allowable HC and NOx emission from Heavy Diesel Vehicles according to various emission standards of India.*

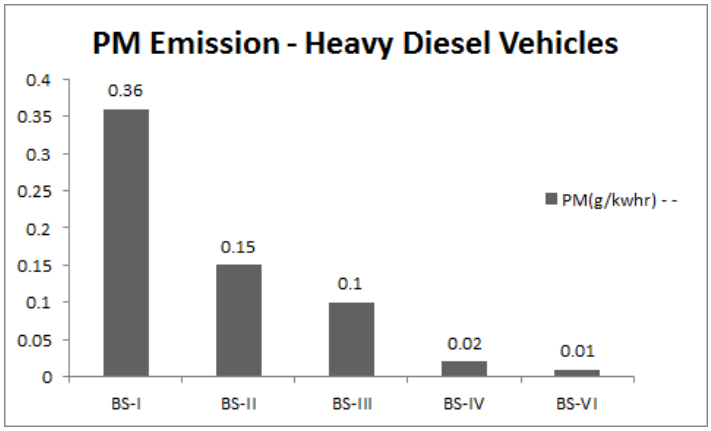

***Fig. 7**. Maximum Allowable PM emission from Heavy Diesel Vehicles according to various emission standards of India.*

2.3 Emission Standards for 2&3 Wheeled Vehicles

The emission standard for 2 and 3 wheeled vehicles were initially implemented in the year 1991 for 2 wheel gasoline and diesel powered vehicles and 3 wheel gasoline and diesel powered vehicles. The new emission standard BS VI will be implemented from April 2020. As it is not possible to equip after treatment devices like catalytic convertors in these type of vehicles, most of the changes were done in the combustion process and pre-treatment techniques to reduce the engine

emissions. However for the 2 wheeled vehicles operating under GDI conditions a certain amount of PM will be generated by the engine and the maximum limits for that PM is 4.5mg/km and for Non Methane Particulate Matter is 68mg/km. Figure.8 shows tightening of emission standards from the initial stage to the upcoming emission standards, CO emission is also a major source of pollutant to the environment, From the figure.8 it is clear that, the emission standards were regularly checked from the beginning value of about 30g/km in 1991 norms to 4.5 g/km in 1996 norms and the proposed value for the upcoming BS VI emission standard is 1g/km.

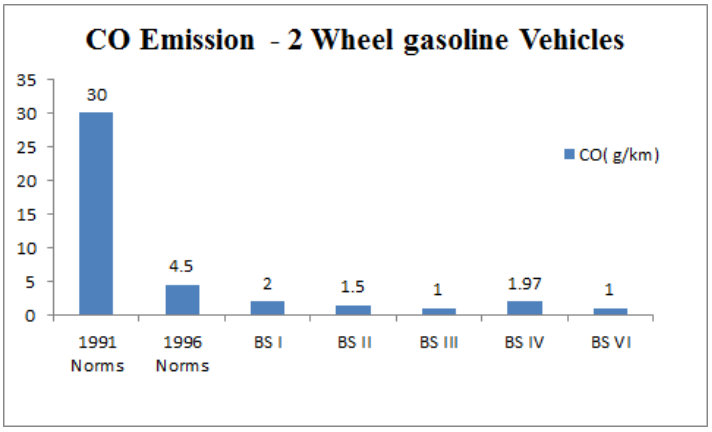

***Fig. 8**. Maximum Allowable CO emission from 2 wheeled gasoline powered vehicles according to various emission standards of India*

Figure.9 shows that the CO emission for gasoline powered 3 wheeled vehicles is also checked properly from the starting value of about 30g/km in 1991 norms to the upcoming recommended value of 0.44g/km in BS VI emission standards.

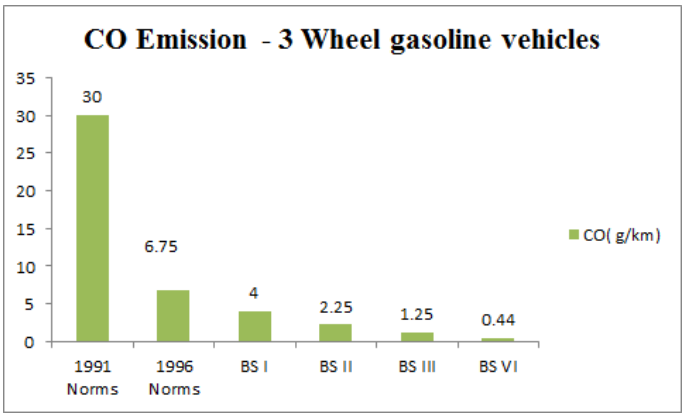

***Fig. 9**. Maximum Allowable CO emission from 3 wheeled gasoline powered vehicles according to various emission standards of India*

Figure.10 shows the maximum allowable emission of HC and NOX emission from the gasoline powered 2 wheeled vehicles. It observed from the figure that the regulations were only considered for HC emission only during the 1991 emission norms of about 12g/km and later NOX emissions were also considered to regulate along with HC emissions in 1996 for about 3.6g/km(combined) and for the BS VI emission standards it is 0.16g/km.

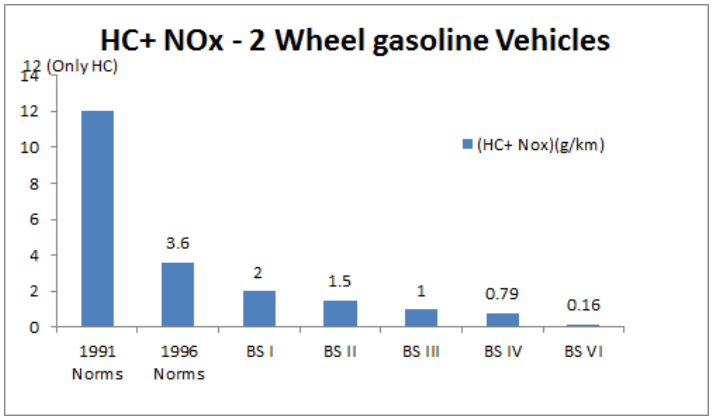

***Fig. 10**. Maximum Allowable HC + NOx emission from 2 wheeled gasoline powered vehicles according to various emission standards of India*

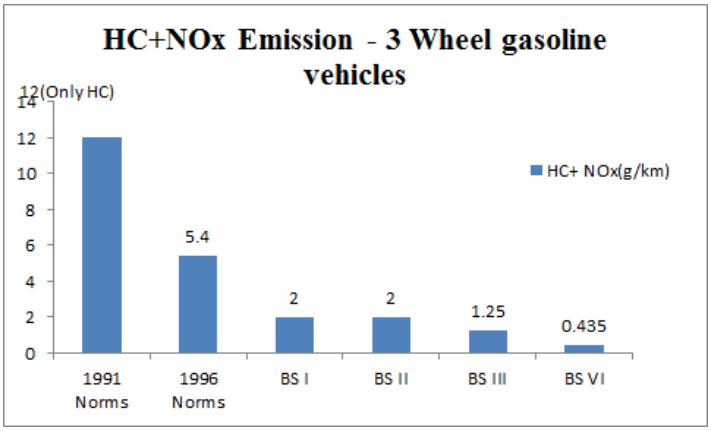

***Fig. 11**. Maximum Allowable HC + NOx emission from 3 wheeled gasoline powered vehicles according to various emission standards of India*

3 ENVIRONMENTAL IMPACTS

The air quality has also become an important political agenda of the country in order to keep the environment clean and this also have become a great challenge for the automobile manufacturers to meet the new emission standards framed by the government. There are many ways that the emission from the diesel engines is formed and technologies were developed for its control to meet the required emission standards. There are different testing procedures for the various running conditions of the vehicle were followed by various countries for the calculating the vehicle exhaust emissions. The government of India has the air quality standards for various pollutant, For example the ambient level of NO2 in the residential area should be 80µg/m3, PM10 it should be less than 100µg/m3 and for CO it is 4mg/m3. The automobile manufacturers must concentrate on the reducing of such harmful emissions with the new technologies, the existing technologies like the On Board Diagnosis, 3-way Catalytic Convertor, Diesel Particulate Filter, Charcoal Canister etc. should be properly installed in all the vehicles and should be serviced properly in regular intervals by the Automobile manufacturers. The use of alternative fuels like Compressed Natural Gas, Non-Edible Oils and Liquefied Petroleum Gas also become the immediate solution for the pollution problem. Most of the cities in India have already crossed the safety air quality standards recommended by the WHO, It is necessary to maintain the clean air quality in the environment for the betterment of all

living beings.

4 CONCLUSION

Harmful emissions were released to the environment from various sources, among these the Automobiles are the major contributors of releasing toxic gases into the atmosphere. It is necessary to regularize the automobile emission standards in a certain time interval regularly and stringent the rules for maximum allowable harmful emissions from it. As India is one of the largest automobile markets in the world the the air quality of the environment was affected continuously because of the large number of automobiles. So, it is necessary to monitor and implement strict rules like BS VI emission standards for the automobile emissions to keep the environment pollution under control.

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