Prevention of Air Pollution at the very Generation & its Purification: A Review

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Abstract

Air pollution being the major concern of consideration rising from a long before comes suddenly into limelight as the country breaks its own records every year and getting degraded with a blot of being having most polluted cities in the world. It is now should be taken as the prime need of country to curb pollution and emission standards.

A Review on "Prevention of air pollution at the very generation and its purification" sums up from the very beginning and delineate about its source, of its kinds, the ways of measuring it with different devices and about different pollutants. It also presents the information about the national ambient air quality Standards (NAAQ) and the standards regards by world health organization and other countries which demands a huge need of improvement and cut-off in emissions. It further describes The tools and techniques of how it can be reduced Being in continuity it also tells about the ways of getting fresh air at our homes by use of air purifiers and air cleaners at industries too. There is a severe concern of outdoor purification which is in environment being released by sources can be controlled anti-smog guns. Being an optimistic at the end of discussion it is also explained in terms of social and Economic aspects to achieve it and the data available on internet comes up with positive outcomes in cost-benefit analysis and decrement in mortality rate.

Keywords: Air Pollution, Air Quality Standards, Economic & Social Benefits, Health Benefits, Indoor Purification, Outdoor Purification, Pollutants,

1. INTRODUCTION

THE planet earth yet only known to humans for existence of living beings having complex and integrated systems ever developed over the time span of millions of years having un-imaginable capabilities and capacities. By the continuity of development humans known as the most sophisticated living being with highly developed brain has incessantly working to do things more efficiently with the ease of more complexity involved to get more comfort.

But to being in the bright gaudy light apprehension we have developed malady and self-harming consequences for our own. The concern of not because of humans beings and other living
Beings and it will not effect if the human population will double only we have to suffer for space but the stupidest things we are doing with fundamentals which are essentials for our existence will ruin out ourselves. It is well said on the planet earth everything is going well except the human activities and the mindsets of "not to change" we having. You must be agreeing. The world is suffering from other kinds of pollutions but at least we have some filtration process for them, people are not really conscious about what they are inhaling minute to minute basis not less than poison and causing several diseases and disorders.

People who can afford might be having water purifiers in their house and sound proof rooms at industries, work places and at home but even a few people do not have air purifiers at their homes and even govt.'s of countries are not much critical to this potential need of the hour. The report describes from the very beginning to the future impacts to start the journey with disciplined initiatives.

2. LITERATURE SURVEY

2.1Scope work and exclusions

The literature review for this report includes appraisal of reports, research papers and books from the esteemed organization. The material reviewed concerned with the air pollution causes, its effects to living being health and the future reforms can be taken to keep the car on track. The literature review explores the literature regarding the costs & benefits of the upcoming norms. The review will not explore the emission standards for stationary I.C. Engines generally used as power back-up in industries and construction projects. This review also excludes the driving test cycles used for measurement of emissions.

2.2 Review

Bansal G. & Bandivadekar [1]

The report gives overview of India's emission standards in the past and future prospects. It justifies the lag between the Euro and Indian standards by citing low per capita income and ill effects of standards on development growth.

The HKU scholar hub [2]

This research paper describes from the very beginning about air pollution, diseases, sources mortality rates and air quality guidelines with the estimated curves and graphs.

Sarath K. Guttikunda & Dinesh Mohan [3]

Heading with "Re-fueling road transport for better air quality in India" this research paper, in order to maintain a balance between the energy demand, growing on-road emissions, and overall air quality in the cities, there is a need to implement and enforce Bharat-5 standards (equivalent of Euro-V) nationwide by 2015.

Bert Brunekreef, Stephen T Holgate [4]

In this review, the evidence for adverse effects on health of selected air pollutants were discussed.

Burki, Talha Khan [5]

The paper has concluded that the present generation of diesel cars on the road in Europe produce, on average, more than twice as much nitrogen oxides per kilometer driven as heavy goods vehicles and buses. The report by the International Council on Clean Transportation (ICCT) was soon followed by the news that London had, on January 5, already surpassed European Union emissions thresholds for nitrogen dioxide (the component of nitrogen oxides that is harmful to human health) for the entire year.

3. POLLUTION [2]

Pollution is the introduction of contaminants into the natural environment that causes adverse change. Pollution can take the form of chemical substances or energy, such as noise, heat or light. Pollutants the components of pollution, can be either foreign substances/energies or naturally occurring contaminants. Pollution is often classed as point source or nonpoint source. A unwanted existence of something that deteriorate the purity simply causes the reason of pollution in any substance.

3.1 Automobiles

Automobiles being the major part as liable to air pollution contribute almost 25-30% to make the air even worst. Automobiles consist of prime movers, commercial vehicles, cars (4w), motorcycles (2w), off road vehicles such as tractors and JCB's playing major part to pollute the air.

3.2 Industrial sector

Major sources of air pollution in India include industries, Power sector, residential (domestic sector) and transport sector. Unwanted existence of something that deteriorates the purity simply causes the reason of pollution in any substance.

3.3 Illegal Burning

The most stupid thing human beings are doing is polluting air just to get extract from tires. To get the extract of iron and steel it is being burnt globally and contains densely harmful gases. "Two to three billion scrap tires are in landfills and stockpiles across the United States, and approximately one scrap tire per person is generated every year.

3.4 Conventional kitchens

A large section of our country's population, nearly 75 per cent of rural and 22 per cent of urban households, still uses biomass for daily cooking. An estimated 80 per cent of the residential energy in India comes from biomass, and much of it is burnt in traditional cook- stoves or chulhas.

3.5 Air quality standards

To maintain quality air Govt. has prescribes some standards to limit the liquid, solid and gaseous stuff which is present in the exhaust air. So many agencies and communities and organizations have given their standards

Table 3.2 Causes of Air Pollution

Air pollution	Sectors
Particulate matter, dust, SPM, SPRM	Abrasion, stone mining, fuel combustion in automobiles, civil construction, mining power station
Oxides of sulphur	Powerhouse, smelters, coal and fossil fuel combustion, acid plants, refining process, petroleum and natural gas industries
Oxides of Nitrogen	Refining of petroleum, combustion of fuel, Natural gas, oil and coal, acid manufacturing
Hydrogen sulphide	Petroleum industry, waste water treatment, tanneries, oil refineries
Hydrocarbon	Motor vehicles, refuse burning, combustion of coal, natural occurrence
Hydrogen fluoride	Glass and ceramics, cement factories, steel, Al industries, phosphate fertilizer plants, brick plants
Carbon mono- oxide	Metabolic activity, fuel combustion, auto mobile exhaust
Ozone	Photochemical reactions, storm centers
Lead	Automobile exhaust
Mercury	Pesticides, paints, laboratories
Organic solvents	Paints, pesticides, cooking, cosmetics
Chlorine	Petroleum refineries, glass industry, plastic incineration, scarp burning, accidental spills
Ammonia	Spillage of anhydrous ammonia, leaks and breakdown in industries

Like: NAAQ, EPA and WHO. Here are some tables of standards as follows.

3.5.1 National Ambient Air Quality Standards

Standards given by NAAQ are simply a copied version of standards of European countries. NAAQ is following its standard which were not renewed after 18Dec. 2009 and it's been more than 8 years there is no change to be at safe position. AS follows here is comparable data from other agencies to get conscious toward the need of the hour.

3.6.2 Standards by Environment Protection Agency

Environment Protection Act, 1986 is an act of the Parliament of India. In the wake of the Bhopal Tragedy, the Government of India enacted the Environment Protection Act of 1986 under Article 253 of the Constitution. Passed in March 1986, it came into force on 19 November 1986.It has 26 sections. The purpose of the Act is to implement the decisions of the United Nations Conference on the Human Environments. They relate to the protection and improvement of the human environment and the prevention of hazards to human beings, other living creatures, plants and property.

3.5.3 Standards prescribed by WHO

World health organization has recently updated its standards of air pollution which has the minimal values when compared to the other countries standards. The World Health Organization (WHO) is a specialized agency of the United Nations that is concerned with international public health. It was established on 7 April 1948 headquartered in Geneva, Switzerland. The WHO is a member of the United Nations Development Group. Its predecessor, the Health Organization, was an agency of the League of Nations.

4. Tools and Techniques for reduction

4.1 Indoor Purification

At very first we are looking at the devices can be used to keep the air clean at homes and at work places named as "air purifiers."

As per the requirement we can classify further air purifiers into mainly three categories: -

4.1.1 Industrial Air Purifiers

1. Ambient air cleaners
2. Dust collectors
3. Mist eliminators
4. Fume extractions
5. Replacement filters

4.1.2 Commercial Air Purifier

1. Smoke eaters
2. Medical & hospital purifiers
3. Clean room equipment
4. Replacement filter & cells

4.1.3 Home Purifiers

1. Whole house air purifiers
2. Replacement filters

4.2 Chemistry behind Air Purifiers

We have seen kinds of air purifiers that can be used at industrial levels to keep the low emission levels as well to keep the work force healthy and vigorous. At indoor levels there are so many varieties available of air purifiers. We are looking here the chemistry behind the air purifiers used at indoor levels for outdoor levels there is further description in continuity.

There are so many ways an air purifiers can work that is made according to the need specified. So, that is how we see the chemistry of air purifiers, which is as follows: -

4.2.1 Filters

Some air purifiers clean the air by passing it through a filter that removes particles. These are sometimes called air cleaners. In households, these filters are usually part of the heating or cooling system. A filter housing is installed between the air return duct and the furnace. The filter cartridge slides into this housing, so all air flowing into the furnace is filtered. Not only does this remove contaminants from the air, it prevents damage to the furnace due to dust and dirt build-up. Filters can also be placed into the air return vents in each room of a house. Typical materials include foam, cotton, fiberglass or synthetic fibers.

4.2.2 Ionizing Purifier

These air purifiers use a method called corona discharge to create charged molecules called ions. Most atoms in the air have a neutral charge -- they have the same number of negatively-charged electrons as positively-charged protons. The corona discharge is a small but intense electrical field. Molecules passing through it will pick up an additional electron, giving the molecule a negative charge, or it may have an electron knocked off of it, giving it a positive charge. Larger particles in the air, such as dust or other contaminants, are more likely to be ionized because they make larger targets for the electrons as they pass through the corona discharge.

4.2.3 Ozone generators

An ozone generator works much like an ionizing purifier, but it is designed to alter molecules of oxygen and turn them into ozone, a molecule made up of three oxygen atoms. Oxygen in the atmosphere exists as dioxygen, a molecule made up of two oxygen atoms. When these molecules are exposed to a corona discharge or UV light, some of the dioxygen molecules split into separate oxygen atoms (free oxygen). While most of this oxygen recombines into dioxygen, some of the atoms form ozone.

Manufacturers of these devices claim that the ozone deodorizes and disinfects the air. Many also claim other health benefits from the presence of ozone. However, there is strong evidence that ozone does not accomplish air purification.

4.2.4 Adsorbents

Many purifiers incorporate an adsorbent material to take care of odors, fumes and chemicals in the air. Adsorption (not absorption) is the process of one substance being trapped on the surface of another substance. The most common adsorbent is activated charcoal, which is extremely porous and has many microscopic "nooks and crannies" to trap passing molecules. Larger particles are simply stuck in

the many pores in the charcoal. Electrostatic attraction draws some substances into the pores.

4.2.5 UV Light

Ultraviolet radiation renders certain micro-organisms sterile (and harmless). Some air purifiers feature a UV light that bathes the air as it passes through, eliminating the potential harm of airborne bacteria and viruses.

4.2.6 Cyclone separators

A cyclone separator is a separation device that uses the principle of inertia to remove particulate matter from flue gases. In these separators, dirty flue gas enters a chamber containing a vortex, similar to a tornado. Because of the difference in inertia of gas particles and larger particulate matter, the gas particles move up the cylinder while larger particles hit the inside wall and drop down. This separates the particulate matter from the flue gas, leaving cleaned flue gas.

4.2.7 Fabric Filters

Fabric filters are one fairly simple method that can be used to remove dust from flue gases. In some gases they can also remove acidic gases if they utilize basic compounds. This method simply uses some sort of fabric - generally felt is used as a woven cloth would allow dust to make its way through is placed so that flue gasses must pass through it before exiting the smokestacks. When the gas passes through, dust particles are trapped in the cloth.

4.2.8 Scrubbers

Scrubbers are a type of system that is used to remove harmful materials from industrial exhaust gases before they are released into the environment. These pollutants are generally gaseous, and when scrubbers are used to specifically remove SOx it is referred to as flue gas desulfurization. There are two main types of scrubbers, wet scrubbers and dry scrubbers. The main difference is in the type of material used to remove the gases. By removing acidic gases from the exhaust before it is released into the sky, scrubbers help prevent the formation of acid rain.

4.3 Outdoor Purification

4.3.1 Selective Catalytic Reduction System [6]

Selective Catalytic Reduction (SCR) is an advanced active emissions control technology system that injects a liquid-reductant agent through a special catalyst into the exhaust stream of a diesel engine. The reductant source is usually automotive-grade urea, otherwise known as Diesel Exhaust Fluid (DEF). The DEF sets off a chemical reaction that converts nitrogen oxides into nitrogen, water and tiny amounts of carbon dioxide (CO2), natural components of the air we breathe, which is then expelled through the vehicle tailpipe.

SCR technology is designed to permit nitrogen oxide (NOx) reduction reactions to take place in an oxidizing atmosphere. It is called "selective" because it reduces levels of NOx using ammonia as a reductant within a catalyst system. The chemical reaction is known as "reduction" where the DEF is the reducing agent that reacts with NOx to convert the pollutants into nitrogen, water and tiny amounts of CO2. The DEF can be rapidly broken down to produce the oxidizing ammonia in the exhaust stream. SCR technology alone can achieve NOx reductions up to 90 percent.

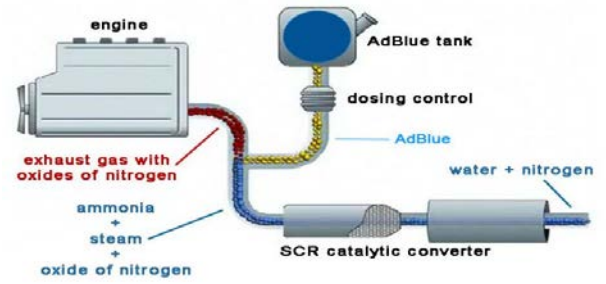

Fig. 4.3.1 SCR

Chemistry

An SCR system uses a metallic or ceramic wash-coated catalyzed substrate, or a homogeneously extruded catalyst, and a chemical reductant to convert nitrogen oxides to molecular nitrogen and oxygen. In mobile source applications, an aqueous urea solution (AdBlue) is the preferred reductant.

The three common NOx reduction reactions are:

$$1\ NH_3 + 4\ NO + O_2 \rightarrow 4N_2 + 6\ H_2O \quad (1)$$

$$2\ NH_3 + NO + NO_2 \rightarrow 2\ N_2 + 3\ H_2O \quad (2)$$

$$3\ NH_3 + 6\ NO_2 \rightarrow 7\ N_2 + 12\ H_2O \quad (3)$$

4.4.2 Diesel Exhaust Filter (DEF)

One unique aspect of a vehicle or machine with an SCR system is the need for replenishing Diesel Exhaust Fluid (DEF) on a periodic basis. DEF is carried in an onboard tank which must be periodically replenished by the operator based on vehicle operation. For light-duty vehicles, DEF refill intervals typically occur around the time of a recommended oil change, while DEF replenishment for heavy-duty vehicles and off-road machines and equipment will vary depending on the operating conditions, hours used, miles traveled, load factors and other considerations. Diesel Exhaust Fluid (DEF) is a non-toxic fluid composed of purified water and automotive grade aqueous urea. DEF is available with a variety of storage and dispensing methods. Storage options consist of various size containers such as bulk, totes and bottles or jugs.

Figure 4.4.2.1(a) DPF location

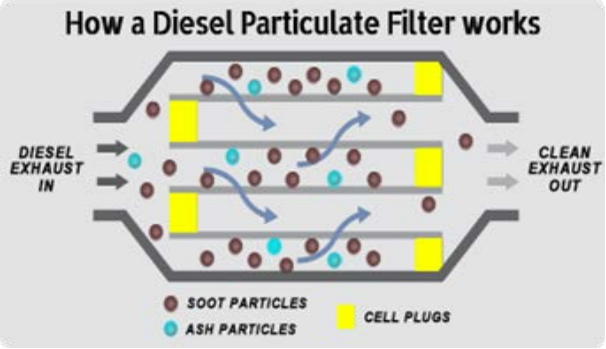

Fig. 4.4.2.2(b) DPF

4.4.4 Exhaust Gas Recirculation System

Exhaust gas recirculation (EGR) is a nitrogen oxide emissions reduction technique used in petrol/gasoline and diesel engine. EGR works by recirculating a portion of an engine's exhaust gas back to the engine cylinders. This dilutes the O2 in the incoming air stream and provides gases inert to combustion to act as absorbents of combustion heat to reduce peak in-cylinder temperatures. NOx is produced in a narrow band of high cylinder temperatures and pressures.

Gases re-introduced from EGR systems will also contain near equilibrium concentrations of NOx and CO; the small fraction initially within the combustion chamber inhibits the total net production of these and other pollutants when sampled on a time average. Most modern engines now require exhaust gas recirculation to meet emissions standards. Chemical properties of different fuels limit how much EGR may be used. For example methanol is more tolerant to EGR than gasoline.

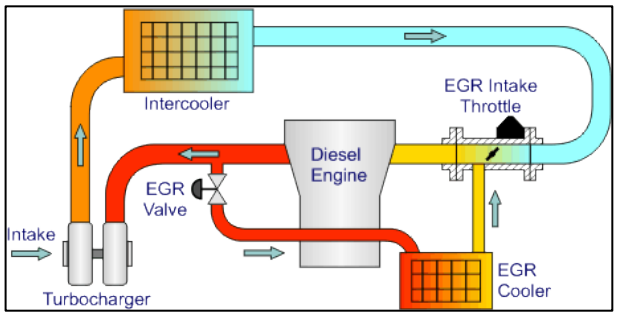

Figure 4.4.4 EGR

5 Social & Economic Impacts [1], [2], [3]

In Social and economic impacts I want your attention on the adversity the human being is suffering with the help of supporting data that even shown what will happen if corrective action will not be taken. Further in, we will look at with the help of supportive data after implementing the corrective actions.

5.1 Before implementing

1. As Delhi reels under smog cover, we bring the story of a one-stop shop that is helping residents fight against toxic pollutants.

2. As winter sets in, the national capital is in the news again. Since the start of this week, the city has been covered with a thick blanket of smog as pollution levels breached permissible standards. Schools have remained closed for the week — a measure taken by the government to protect children from deteriorating air quality. News reports highlight that the sale of air purifiers has doubled since the dust blanket engulfed the city.

3. One such brand that has witnessed a high turnout in sales this week is Nirvana Being, which offers a range of premium quality masks and other anti-pollution products. Jai reveals that this week, the sales of masks have gone up from 300 per day to over 10,000 this week.

4. Outdoor air pollution could cause 6 to 9 million premature deaths a year by 2060 and cost 1% of global GDP – around USD 2.6 trillion annually – as a result of sick days, medical bills and reduced agricultural output, unless action is taken, according to a new OECD report.

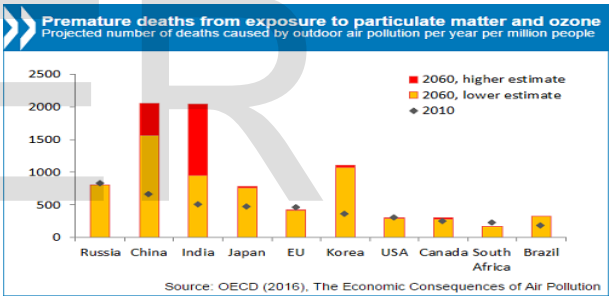

Fig. 5.1.1 Premature deaths from exposure to particulate matter and ozone

The biggest rises in mortality rates from air pollution are forecast in India, China, Korea and Central Asian countries like Uzbekistan, where rising populations and congested cities mean more people are exposed to power plant emissions and traffic exhaust. Premature death rates are forecast to be up to three times higher in 2060 than in 2010 in China and up to four times higher in India. Death rates are seen stabilising in the United States and falling in much of Western Europe thanks in part to efforts to move to cleaner energy and transport. [5]

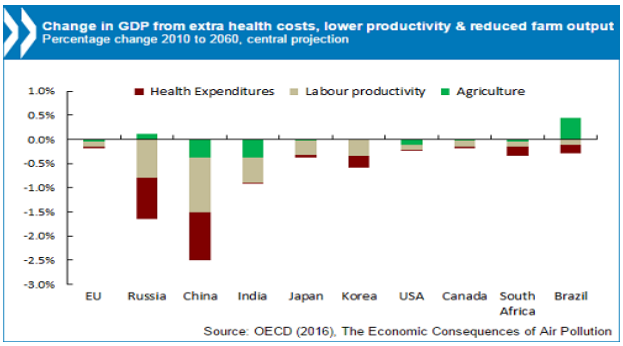

Fig. 5.1.2 Change in GDP from extra cost(s)

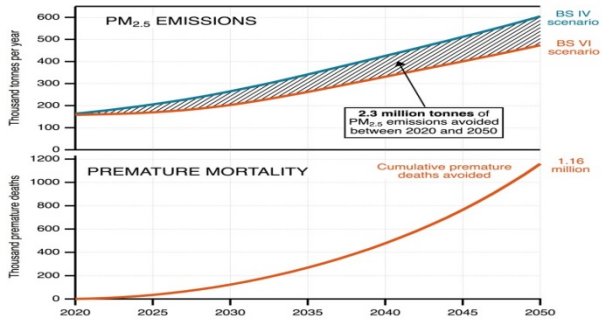

Fig. 5.2.1.1 Decrement in premature mortality

Air pollution in India is estimated to kill 1.5 million people every year; it is the fifth largest killer in India. India has the world's highest death rate from chronic diseases and asthma according to the WHO. In Delhi, poor quality air damages irreversibly the lungs of 2.2 million or 50 percent of all children.

In November 2017, in an event known as the great smog of Delhi, the air pollution spiked far beyond acceptable levels. Levels of PM2.5 and PM 10 particulate matter hit 999 micrograms per cubic meter, while the safe limits for those pollutants are 60 and 100 respectively.

Low visibility has resulted in accidents across the city, notably a 24 vehicle pile-up on the Yamuna express highway.

5.2After implementing [4]

5.2.1 Benefits

There are significant health and economic benefits associated with cleaner fuels and vehicles. Lower emissions of carcinogenic fine particulate matter (PM2.5) are especially important in reducing mortality and morbidity associated with ambient air quality. Studies supported by the World Health Organization (WHO) have detailed links between increases in ambient PM2.5 levels and mortality.

5.2.1.1 Health benefits

Studies have looked at the relationship between fuel sulfur and public health. An important study in Hong Kong detailed the health benefits of fuel sulfur reduction. It found that five years after Hong Kong lowered fuel sulfur content to a maximum of 5,000 ppm in 1990, annual all-cause mortality fell 1–2%. While this may seem minimal, it represents the benefits of only sulfur reduction in fuels. If low-sulfur fuels are used as an impetus for stricter emission standards, the benefits are substantially higher.

The decline in PM emissions envisioned by the Alternate scenario leads to a quantifiable reduction in premature mortality. Using a methodology, WHO calculated avoided premature deaths up to 1.16 million associated with adult (over age 30) cardiopulmonary disease and lung cancer, and child (under age 5) respiratory infections under the implementation of BS-VI scenario in India's 337 largest cities.

5.2.1.2 Economic benefits

. A mortality lag was taken into account to monetize benefits. This was done because the benefits of reduced emissions would likely be seen in years subsequent to the reductions.

Therefore, we lagged annual benefits according to the following methodology:

1.30% of monetized behavior occurs in 1 yr.
2. 50% occur in Years 2-5.
3. 20% occur in Years 6-20.

5.2.1.3 Cost- Benefit analysis

Economic benefits were compared with extra costs associated with cleaner fuel production and cleaner vehicles. Per liter cost increases for BS-VI production were multiplied by projections for on-road fuel consumption in India. Similarly, clean vehicle costs per vehicle were multiplied by projected vehicle sales. The chart shows that while there are costs associated with clean fuels and vehicles, benefits far outweigh costs. Benefits continue to rise, as vehicle population increases and lower ambient PM2.5 Concentrations reduce premature mortality. On the other hand, learning and economies of scale stabilizes cost in long term.

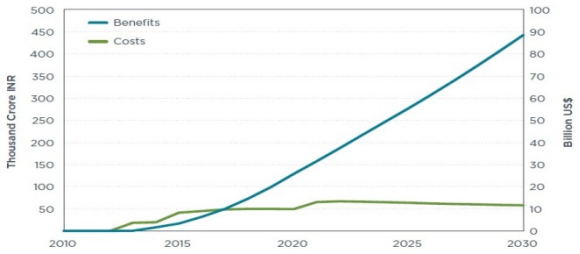

Fig. 5.2.3 Cost benefit analysis

Cumulatively from 2010-2030, fuel costs add up to $19 billion (Rs. 94,000 crore) and vehicle costs add up to $170 billion (Rs. 850,000 crore). These compare to cumulative benefits of $673 billion (Rs. 3,365,000 crore). Subtracting costs from benefits, India stands to gain a net benefit of about

$484 billion (Rs. 2,400,000 crore) by 2030 by implementing BS-VI nationwide and tightening emission standards as envisioned by the Auto fuel policy.

6. CONCLUSION

1. The end of the internal combustion engine is nearer than you think. As the world is scrambling to combat growing air pollution crisis, many countries are setting deadlines for them to take diesel and petrol cars off the road. A comprehensive zero-emission mandate together with new electric cars could make their goal achievable.

2. As it is being said the only dysfunctionality is happening is just because of humans and their mindsets. We have to change consciously to keep the planet save for our future generation, for our off-spring.

3. Diesel vehicles, being the most polluting source among motor vehicles will be the most hit. Stringent emission norms will force the manufacturers to reduce tailpipe emissions of heavy vehicles.

4. BS-VI norms also bring three - wheelers into the fold of standards, with them being heavily used for urban mobility will reduce urban air pollution. Reduced PM emissions will reduce premature deaths by respiratory and cardiovascular diseases. Avoided premature mortality leads to a stronger economy because of increased worker productivity and reduced healthcare costs, among other reasons.

5. Initial cost to enforce these technologies will be higher but can be overridden by cost paid by society.

7 REFERENCES

[1] Bansal G. & Bandivadekar, A. (2013), Overview of India's Vehicle Emissions Control Program: Past Successes and Future Prospects. http://www.theicct.org/indias-vehicle- emissions-control-program.

[2] Kamal Manaktola & Vinnie Jauhari, "Exploring consumer attitude and behavior towards green practices in the lodging industry in India", International Journal of Contemporary Hospitality Management, Vol. 19 No. 5, 2007 pp. 364-377.

[3] Bert Brunekreef& Stephen T Holgate," Air pollution and health", THE LANCET, Vol 360, October 19- 2002, pp. 1233-42.

[4] Chan-Yeung, MNW, "Air pollution and health", Hong Kong Medical Journal, 2000, volume 6 n. 4, p. 390-398.

[5] International Journal of Contemporary Hospitality Management Vol. 19 No. 5, 2007 pp. 364-377.

[6] Sarath K.Guttikunda & Dinesh mohan,May 2014," Re-fueling road transport for better air quality India", ELSEVIER Volume 68 pp.556-56