Journal of Basic and Applied Engineering Research
p-ISSN: 2350-0077; e-ISSN: 2350-0255; Volume 3, Issue 1; January-March, 2016, pp. 51-55

http://www.krishisanskriti.org/Publication.html

Combating Air Pollution: Exploring the solutions and analysis of the Challenges

Jyoti Malik[1], Ragini Singh[2] and Sushma Bhardwaj[3*]

[1,2,3]Sri Aurobindo College University of Delhi
E-mail: [1]funfriends.jyoti@gamil.com, [2]ragini9995@yahoo.com, [3]sushma.bhardwaj@gmail.com

Abstract—*Air pollution poses a major challenge to the world. This problem alone is the greatest cause of degradation of environment and public health. Therefore, the need has never been more pressing for smart and innovative technologies to take a stand against air pollution. . This study focuses on the various smart technologies developed at small levels across the world which can be considered at the larger scale to control pollution. CristalACTiV Titanium Dioxide is one of several technologies that curb the emission of pollutants during combustion. Electrostatic vacuum cleaner is another solution which is the first 7 meter high smog free tower which cleans 30m^{3}air/hour and uses no more energy than a water boiler. Clean Coal Technology can be used to reduce the amount of Green House Gas emitted by coal-fired plants.*

1. INTRODUCTION

World is the hapless victim in the hands of a lethal combination of pollutants from traffic emissions (Carbon Monoxide) to particulates from the burning fields across the world , as well as industrial effluents. Though it is common knowledge that air that we breathe today is not fit for human habitation and the poisonous air is ruining the health of every individual who inhabit mother Earth, especially the health of the young generation, it is extremely tragic that everybody presses a mute button, to air pollution. It is an irony that we all have enough time to discuss other insignificant topics. The green lungs of the planet are dying slowly and its inhabitants are suffering from Asthma, Lung cancer and breathing disorders in alarming proportions, a malice which has come to plague the world.

2. A TRUTH NOBODY WANTS TO HEAR

2.1. Statistics of Pollution Level

Air pollution isn't just a threat to our health, but it is also damaging our environment. Toxic air pollutants and the chemicals that form acid rain and ground-level ozone can damage crops, trees, wildlife, lakes and other bodies of water. Those pollutants can also harm fish and other aquatic life by polluting the water source [1].

From 1990 to 2013 reductions in emissions of all air pollutants was recorded. The biggest fall was reported for sulphur oxides (SO_x) which between 1990 and 2013 decreased by 86.7 %, followed by non-methane volatile organic compounds (NMVOCs) which declined by nearly 60 %. Nitrous oxides (NO_x) stood at 53.5 % of their 1990 levels (a decrease of roughly 46.5 %); while the smallest decrease was reported for ammonia (NH_3), emissions of which fell only by 27 % by 2013 [2].

In 2013 emissions of ammonia (NH_3) in the EU-28 stood at 3 847 870 tonnes, NMVOCs at 7 004 930 tonnes, nitrogen oxides (NO_x) at 8 176 454 tonnes and sulphur oxides (SO_x) at 3 429 764 tonnes (Table 1)

Air pollution is not a problem that is limited to only one country. In fact, it is a worldwide epidemic that is much worse in some countries than in others.

Table 1: Total Emission of Air Pollutants (tonnes) [2] [9]

Country	NH3-Ammonia	NOx-Nitrogen Oxides	Non-methane volatile organic compounds	SOx-Sulphur oxides
EU-28	3847870	8176454	7004930	3429764
Germany	670849	1269182	1138241	416214
France	718133	989521	758380	218785
Italy	402230	820574	905539	145054
Sweden	52168	125915	173756	26785
United Kingdom	271309	1019674	802997	393158
Hungary	81243	120567	120400	29309
Spain	379308	812152	550801	287128
Greece	60570	238621	144765	152327

On a per capita basis, the picture looks different (Table 2) [1]. In 2013, the EU-28 average was 7.6 kg per person for ammonia (NH_3), 13.9 kg for NMVOCs, 16.2 kg for nitrous oxides (NO_x) and 6.8 kg for sulphur oxides (SO_x)[2].

Table 2: Emissions of Air Pollutants Per Capita (in kg) [2] [9]

Country	NH3	NOX	NMVOC	SOX
EU-28	7..6	16.2	13.9	6.8
Germany	8.3	15.8	14.1	5.2

France	11.0	15.1	11.6	3.3
Italy	6.7	13.7	15.2	2.4
Sweden	5.5	13.2	18.2	2.8
United Kingdom	4.2	16.0	12.6	6.2
Hungary	8.2	12.2	12.2	3.0
Spain	8.1	17.4	11.8	6.1
Greece	5.5	21.7	13.2	13.9

2.2. Health Impacts of Air Pollution

Despite major gains in lowering pollution throughout the European Union, some major metropolitan cities like London, Beijing and Delhi are currently suffering from some of the worst air quality they've ever seen. A study by the World Health Organization reported in National Geographic News states that air pollution in China is related to around 656,000 deaths every year throughout the country. The same report by the World Health Organization states that an average of 2 million people is killed worldwide every year due to air pollution. In India, almost half of all monitored cities have above-average or critical levels of particulate matter pollution below 10 micrometres [3] [6].

There is substantial body of contemporary epidemiologic research that has explored health effects of particulate air pollution at levels common to contemporary cities in the developed world. Observed health effects of inhaled particulate pollution include: increased incidence of respiratory symptoms, decreased lung function, increased hospitalizations and other health care visits for cardiopulmonary disease, increased respiratory morbidity as measured by absenteeism from work or school or other restrictions in activity, and increased cardiopulmonary disease mortality. Health effects are observed at levels common to many U.S. and Canadian cities, including levels well below current U.S. National Ambient Air Quality Standards. There is no clear evidence of a safe threshold level. Many studies observe that health effects increase monotonically with pollution levels, often with a near-linear dose-response relations [3] [6].

Most air pollution deaths are caused by tiny particles that can be inhaled deep into the lungs. These cause heart attacks and strokes, which account for three-quarters of the 3.3 million annual deaths, with lung cancer and respiratory diseases responsible for the rest [7]. Outdoor air pollution has been officially classified as carcinogenic by the cancer arm of the World Health Organisation. The International Agency for Research on Cancer (IARC) said air pollution from traffic and industrial fumes was a definite cause of lung cancer and also linked to bladder cancer. The recent data present on WHO suggest there were 233,000 deaths from lung cancer caused by air pollution around the world in 2010 [8].

3. ORGANISATIONS WORKING FOR POLLUTION CONTROL

3.1. Environmental Protection Agency(EPA)

EPA implements a range of techniques to manage environmental impact, from building new, high-performance structures to improving the energy.

A Technology program launched by EPA i.e. SmartWay Technology Program has expanded to allow trailer aerodynamic verification through multiple testing pathways. This technology Program verifies fuel savings from aerodynamic devices and low rolling resistance tires that can be used on 53-foot box dry van and refrigerated in long-haul operations. “SmartWay-verified” devices are the verified individual devices or combinations of devices that are tested using SmartWay’s robust protocols. These test protocols create consistent, comparable fuel-savings estimates under high-speed cruise conditions for long-haul tractor-trailers.

In 2015, EPA finalized the use of expanded testing-verification pathways to include an enhanced track test, wind tunnel testing, coast down testing, and computational fluid dynamics (CFD). If trailer aerodynamic devices demonstrate fuel savings in SmartWay testing, they are identified as SmartWay-verified and are listed, along with SmartWay-verified low-rolling resistance tires, on the SmartWay website’s technology verification page [12].

Table 3: Comparison of Financial Load in Different Fiscal Year [10]

FISCAL YEAR	ENACTED BUDGET	WORKFORCE
FY 2015	$8,139,887,000	TBD
FY 2014	$8,200,000,000	15,408
FY 2013	$7,901,104,000	15,913
FY 2012	$8,449,385000	17,106
FY 2011	$8,682,117,000	17,359
FY 2010	$10,297,864,000	17,278
FY 2009	$7,643,674,000	17,049
FY 2008	$7,472,324,000	16,916
FY 2007	$7,725,130,000	17,072
FY 2006	$7,617,416,000	17,355
FY 2005	$8,023,483,000	17,495
FY 2004	$8,365,420,000	17,611
FY 2003	$8,078,703,000	17,741
FY 2002	$8,078,813,000	17,590
FY 2001	$7,832,211,000	17,558
FY 2000	$7,562,811,000	17,726
FY 1999	$7,590,352,000	18,110
FY 1998	$7,363,046,000	17,739
FY 1997	$6,799,393,000	17,152
FY 1996	$6,522,953,000	17,082
FY 1995	$7,240,887,000	17,508
FY 1994	$6,658,927,000	17,106
FY 1993	$6,892,424,000	17,280
FY 1992	$6,668,853,000	17,010
FY 1991	$6,094,287,000	16,415

3.2 Centres for Disease Control and Prevention

CDC's fight against environmental-related respiratory illnesses, including asthma is led by the Air Pollution and Respiratory Health Branch of the National Centre for Environmental Health, Centres for Disease Control and Prevention (CDC) which is based on the study of indoor and outdoor air pollution.

CDC's asthma program focuses on three main activities:

Surveillance: Collection and analysis of data on an ongoing basis to understand the prime 3 Ws i.e. when, where, and in whom asthma occurs;

Implementing interventions scientifically proven: ensuring that scientific information is utilized in public health practices and programs to reduce the burden of asthma; and

Establishing and maintaining partnerships: Ensuring that all stakeholders have the opportunity to be involved in developing, implementing, and evaluating local asthma control programs.

The same methodology of research-based intervention conducted in partnership with international, national, and local partners is applied to CDC's work in preventing carbon monoxide poisoning, studying the health effects of exposure to forest fire smoke, and investigating human health effects of poor air quality.

3.2.1 Surveillance

In conjunction with the National Centre for Health Statistics and the National Centre for Chronic Disease Prevention and Health Promotion, the Air Pollution and Respiratory Health Branch supports a number of major asthma data collection efforts, including: collection of state-level adult asthma prevalence rates for detailed subgroups in 50 states, 3 territories (Puerto Rico, Guam, and the Virgin Islands), and the District of Columbia, through the Behavioural Risk Factor Surveillance System Survey;

collection of data on asthma attacks, asthma management, days of work or school lost, emergency room visits, and hospitalizations due to asthma through the National Health Interview Survey; and collection of asthma management and control data through development of a National Asthma Survey. This survey is currently implemented as a state-based call-back survey through the behavioural Risk Factor Surveillance System.

3.2.2 Interventions

CDC's National Asthma Control Program was created in 1999 to support the goals and objectives of Healthy People 2010.

CDC funds state health departments in 23 states to develop asthma control plans that include disease tracking, intervention, and occupational components. Additionally, CDC partners with major non-governmental agencies such as the American Lung Association, the Asthma and Allergy Foundation of America, and the Allergy and Asthma Network/Mothers of Asthmatics to support asthma control activities such as adult educational programs and addressing asthma control through school health programs.[13]

3.2.3 Budget and workforce

CDC's FY2014 budget is $6.9 billion.

As of 2008, staff numbered approximately 15,000 (including 6,000 contractors and 840 Commissioned Corps officers) in 170 occupations. Eighty percent have earned bachelor's degrees or higher; almost half have advanced degrees (a master's degree or a doctorate such as a PhD, D.O., or M.D.). CDC job titles include engineer, entomologist, epidemiologist, biologist, physician, veterinarian, behavioural scientist, nurse, medical technologist, economist, public health advisor, health communicator, toxicologist, chemist, computer scientist, and statistician.

In addition to its Atlanta headquarters, the CDC has other locations in the United States and Puerto Rico. Those locations include Anchorage; Cleveland; Cincinnati; Fort Collins; Hyattsville; Morgantown; Pittsburgh; Research Triangle Park; San Juan, Puerto Rico; Spokane, Washington; Detroit; and Washington, D.C. The CDC also conducts the Behavioural Risk Factor Surveillance System, the world's largest, on-going telephone health survey system.

The CDC offers grants that help many organizations each year bring health, safety and awareness to surrounding communities throughout the entire United States.

The CDC operates the Public Health Associate Program (PHAP), a two-year paid fellowship for recent college graduates to work in public health agencies all over the United States. PHAP was founded in 2007 and currently has 159 associates in 34 states.[14]

4. HEALING STEPS: COMBATING AIR POLLUTION

There is an incredible global effort to implement known pollution abatement technologies on key sources of this non-carbon pollution.

4.1. CristalACTiV

CristalACTiV Titanium Dioxide curbs the emission of pollutants during combustion. In electrical power generation plants, selective catalytic reduction, utilising ultrafine titanium dioxide (TiO2) as a DeNOx catalyst, has been demonstrated to remove over 90 percent of the NOx generated by the combustion of coal, gas or other fossil fuels to produce electricity. TiO2 acts as a catalyst to convert the harmful gases into harmless nitrogen and water vapour. This technology has been available for up to 30 years and has been demonstrated to be very effective. The technology is beginning to be used more widely to reduce the level of pollutants generated when producing electricity.

CristalACTiV photocatalytic TiO_2 uses the sun's energy to break down pollutants. In this way, all of us could play a role in improving air quality. Through broad implementation of CristalACTiV technology a city could, in theory, clean itself of a significant percentage of its pollution, as the surface exposed to the atmosphere removes the pollution out. Mexico has taken photo catalytic coatings to its heart, with a number of major projects designed to lower air pollution and improve public health being trialled on public buildings and infrastructure.

New facilities in Saudi Arabia are being constructed with many photo catalytic-treated surfaces. In addition to the benefits of reduced pollution, treated surfaces are self-cleaning, which improves aesthetics and helps to reduce maintenance cost. [15]

The financial load of setting up the CristalACTiV photolytic TiO_2 is estimated to be around €1084.114 (Table 3).

Table 3: Estimated Financial Load [11]

Tube Painting	€118.850
Tube Lighting	€760.040
Labour for Wiring	€ 59.888
Fixation of Connectors	€ 56.736
Tube Light energy cost	€ 7.600
Tube Cleaning cost	€ 81.000
Total	€1084.114

4.2. Electrostatic Vacuum Cleaner

A massive vacuum cleaner set in the middle of a Rotterdam park is sucking all the smog out of the air. The Smog Free Tower, is a collaboration between Dutch designer Daan Roosegaarde Delft Technology University researcher Bob Ursem, and European Nano Solutions, a green tech company in the Netherlands. The metal tower, nearly 23 feet tall, can purify up to 1 million cubic feet of air every hour. To put that in perspective, the Smog Free Tower would need just 10 hours to purify enough air to fill Madison Square Garden.

It does this by ionizing airborne smog particles. Particles smaller than 10 micrometres in diameter (about the width of a cotton fibre) are tiny enough to inhale and can be harmful to the heart and lungs. Ursem, who has been researching ionization since the early 2000s, says a radial ventilation system at the top of the tower (powered by wind energy) draws in dirty air, which enters a chamber where particles smaller than 15 micrometre are given a positive charge. Like iron shavings drawn to a magnet, the positively charged particles attach themselves to a grounded counter electrode in the chamber. The clean air is then expelled through vents in the lower part of the tower, surrounding the structure in a bubble of clean air. Ursem notes that this process doesn't produce ozone, like many other ionic air purifiers, because the particles are charged with positive voltage rather than a negative [16].

While neither Roosegaarde nor Ursem would disclose the cost of the tower, the filters they have developed range in price from €1,600 to more than €118,000[17].

4.3. Clean Coal Technology

Coal-fired power plants play an important role in providing energy at low prices. However, coal-fired plants do emit carbon dioxide (CO2), a greenhouse gas (GHG) into the atmosphere, and efforts are underway to improve coal's environmental performance so we can take full advantage of this plentiful resource.

Clean coal technology' describes a new generation of energy processes, some currently available and others being developed, which have the ability to sharply reduce air emissions and other pollutants. As a government-run department, the Centres for Disease Control and Prevention awards over 85 percent of its annual budget through these grants to accomplish its ultimate goal of disease control and quality health for all.

Circulating fluidised-bed (CFB) technology is an existing available technology, already being used to burn coal and other fuels to produce energy in a clean way. Unlike conventional steam generators that burn the fuel in a high-temperature flame, CFB technology does not have burners or a flame within its furnace. CFB uses fluidisation technology to mix and circulate fuel particles with limestone as they burn in a low temperature combustion process. The limestone captures the sulphur oxides as they are formed, while the low-burning temperature minimises the formation of nitrogen oxides. The fuel and limestone particles are recycled over and over back to the process, which results in high efficiency for burning the fuel, capturing pollutants, and for transferring the fuel's heat energy into high-quality steam to produce power. Carbon capture and storage (CCS) means separation and capture of CO_2 from fossil fuel-fired power plants and the recovery of a concentrated stream of that CO_2 that can be transported by pipeline and stored, in either an underground formation, or the sea bed. Most research efforts are focused on systems for capturing CO_2 from coal-fired power plants because they are the largest stationary sources of CO_2.CCS technologies include post-combustion (captures CO_2 from power plant flue gases), pre-combustion (widely used in fertilizer manufacturing and in hydrogen production without any CCS) and oxy-fuel combustion (still in the demonstration phase, but showing great potential because recycling the flue gas through the boiler concentrates the CO_2 level in the flue gas, making it easier to separate the CO_2.)[18]

The project's initial 2006 price tag of $1.8 billion has risen to $5.2 billion. The energy it produces will cost more than $6,800 per kilowatt, compared with $5,500 for nuclear energy and $1,000 for a modern natural gas plant. Kemper's ratepayers will thus see a 22 percent increase in their utility bills [19].

5. CONCLUSION

The smog which hangs in the early morning hours silently screams the disaster. The Government, civic organisations and the people as such, are ignoring the sinister writing on the wall- we are playing with our own health. The death dance has begun. I exhort all like -minded people to put their heads together and save our polluted and over crowded cities from peril, before it is too late. Let us wake up to real issues rather than waste our time and energy into indulging in communal polarisation and religious hatred.

REFERENCES

[1] http://www3.epa.gov/airquality/peg_caa/concern.html

[2] http://ec.europa.eu/eurostat/statistics-explained/index.php/Air_pollution_statistics

[3] Bates DV.Environmental health risks and public policy. Seattle, WA:University of Washington Press, 1994.

[4] C. Arden Pope IHl, Economics Department, Brigham Young University, Provo, Utah 84602 USA.

[5] David V. Bates,2Department of Health Care and Epidemiology, University of British Columbia, Vancouver, British Columbia V6T 1Z3, Canada

[6] Mark E. Raizenne, 3Environmental Health Center, Health Canada, Tunney's Pasture, Ottawa, Ontario, KlA OL2, Canada.

[7] http://www.theguardian.com/environment/2015/sep/16/more-people-die-from-air-pollution-than-malaria-and-hivaids-new-study-shows

[8] http://www.ncbi.nlm.nih.gov/pmc/articles/PMC1566387/pdf/envhper00508-0105.pdf

[9] EEA, also available at Eurostat (env_air_emis)

[10] EPA's budget and spending.

[11] Dr. Christoph Maria2010 Ravesloot C.M., McIntyre R., Maltby J., Catalytic Tunneling, Designstudy Maastunnel renovation with catalytic paint and corresponding PowerLED lighting, City of Rotterdam The Netherlands in: Conference readings: Transport Research Arena Europe 2010, Brussels

[12] http://www3.epa.gov/smartway/forpartners/documents/aerodynamic/420f15006.pdf

[13] http://www.cdc.gov/nceh/airpollution/about.htm

[14] https://en.wikipedia.org/wiki/Centers_for_Disease_Control_and_Prevention#Budget_and_workforce

[15] http://www.theneweconomy.com/business/cristals-smart-technologies-help-to-reduce-air-pollution

[16] http://www.wired.com/2015/09/tower-purifies-million-cubic-feet-air-hour/

[17] http://www.engineerlive.com/content/22603

[18] http://www.theguardian.com/sustainable-business/2015/sep/19/worlds-first-smog-filtering-tower-on-tour-daan-roosegaarde-air-pollution

[19] http://www.bloomberg.com/bw/articles/2014-05-15/clean-coals-true-price