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ABATEMENT TECHNIQUES FOR AIR POLLUTION

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Abstract-* Air pollution is the introduction of chemicals, particulate matter (PM), or biological materials that cause harm or discomfort to humans and other living organisms, or cause damage to the natural environment. The substance that is solid, liquid or gas in the air that cause harm to humans and the environment is known as pollutants. These pollutants are classified into primary and secondary. This paper addressing sulphur dioxide, nitrogen oxides, carbon monoxide, carbon dioxide, volatile organic compounds, ammonia, odours, and radioactive pollutants as primary pollutants whiles particulate matter, ground level ozone and peroxyoxyacetyl nitrate were mentioned as secondary pollutants. The effects of these Pollutants on health and the environment were also included. Air pollution can be removed physically using equipment such as cyclones, scrubbers, electrostatic precipators and bag house filters for collecting the fine particulates.

Keywords: Air pollution, pollutants, abatement techniques.

I. INTRODUCTION

Air is an important natural resource providing the basis of life on earth. The air in the atmosphere provides oxygen to plants and animals by virtue of which they are able to live. It is therefore important to have good quality air for various activities. However, this is becoming increasingly difficult in view of large scale pollution caused by the industrialization of society, intensification of agriculture, introduction of motorized vehicles and explosion of the population. These activities generate primary and secondary air pollutants which substantially change the composition of air[1]. Air pollution is a problem as old as history itself. Air pollution can be defined broadly as the introduction of chemicals, particulate matter, or biological materials into the atmosphere that cause harm or discomfort to humans or other living organisms, or cause damage to the natural environment or built environment. Primary pollutants are directly emitted from a process, such carbon monoxide gas from a motor vehicle exhaust or sulfur dioxide released from industrial processes. Secondary pollutants such as ozone (O_3) and particulate matter (PM) are not emitted directly, but form in the air when primary pollutants react or interact. Air pollution statistics in urban areas are available from various sources by country or by city, but not compiled globally. Air pollution maps and monitoring information are available from various internet sources. It is essential that the hazardous impacts from environmental pollution are regularly reported and monitored. Of the various kinds of pollution, the air pollution has attracted high priority in respect of environmental regulation since the environmental damage due to such pollution mostly affects human well-being directly by way of adverse health effects on the population exposed to it. Air quality has deteriorated in most large cities in India, a situation driven by population growth, industrialization and increased vehicle use. Integrated air quality management (AQM), which is an evaluation and monitoring tool, is a challenge to carry out in most developing countries because of the lack of information on sources of air pollution and insufficient ambient air monitoring data that is available in the public domain (TERI 2009). Gas adsorption methods are used for odour control at various types of chemical-manufacturing and food-processing facilities in the recovery of a number of volatile solvents (e.g. benzene) and in the control of VOCs at industrial facilities. Again, incineration or combustion is a very rapid way to convert VOCs and other gaseous hydrocarbon pollutants to carbon dioxide and water (ICMA, 2007). On the other hand, airborne particles can be removed physically from a polluted airstream using equipment such as cyclones, scrubbers, electrostatic precipators and bag house filters for collecting the fine particulates (ICMA, 2007). This review provides recent literature on the above equipment, sources of air pollution, effect of air pollution on health and environment and techniques for controlling air pollution. To determine the identity and tolerance level of chemical

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compounds falling within this class, pollutants must be classified and their effects studied.

II. SOURCES OF AIR POLLUTION

outlined the sources of air pollution to be the various locations, activities or factors which are responsible for the release of pollutants into the atmosphere. It is defined as pollutant to be any substance (solid, liquid or gas) in the air that can cause harm to humans and the environment [1]

A. *Primary Pollutants:*

Primary pollutants are directly emitted from processes such as ash from volcanic eruption, monoxide gas from a motor vehicle exhaust or sulphur dioxide released from factories. The class of primary pollutants includes particulate matter, certain aromatic hydrocarbons, and various compounds-particularly oxides-formed from sulfur, nitrogen, or carbon.

1) Sulfur Dioxide:

Sulfur dioxide (SO_2) is the most common and harmful sulfurous pollutant. The annual emission of sulfur dioxide by industrialized countries is in excess of 80 million tons[4]. This toxic gas respects few substances; it has deleterious effects on humans, animals, plants, and many minerals. Sulfur dioxide molecules are capable of attaching themselves to the larger aerosol molecules, enabling a deeper penetration into the lungs than with the gas alone [5]. Exposures of low concentration or short duration causes plant leaves to yellow then whiten. Higher concentrations can kill plant cells. Plants with thin leaves, such as alfalfa, cotton, and certain grains, are particularly susceptible to absorption of sulfur dioxide.

2) Nitrogen oxides (NO_x):

Nitrogen dioxides are emitted from high temperature combustion. Nitrogen dioxide is a chemical compound with the formula NO_2. It is one of the several nitrogen oxides. It is a reddish-brown toxic gas which has a sharp, biting odor characteristic and is one of the most prominent air pollutants.

3) Carbon monoxide (CO): It is a colorless, odorless, nonirritating but very poisonous gas. It is a product of incomplete combustion of fuel such as natural gas, coal or wood. Vehicular exhaust is a major source of carbon monoxide.

4) Carbon dioxide (CO_2):

Is a colorless, odorless, nontoxic greenhouse gas associated with ocean acidification, emitted from sources such as combustion, cement production and respiration processes.

5) Volatile Organic Compounds (VOCs):

VOCs are important outdoor air pollutant. They are often divided into separate categories of methane (CH_4) and non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to increasing global warming. Other hydrocarbon VOCs are also significant greenhouse gases via their role in creating ozone and in prolonging the life of methane in the atmosphere although their effect vary depending on local air quality. In addition, within the NMVOCs, the aromatic compounds such as benzene, toluene and xylene are suspected carcinogens and may lead to leukemia through prolonged exposure. 1, 3-butadiene is another dangerous compound which is often associated with industrial uses.

6) Ammonia (NH_3):

It is emitted from agricultural processes. Ammonia is a compound with the formula NH_3 and normally considered as a gas with a pungent odour characteristic. Ammonia contributes significantly to the nutritional needs of terrestrial organisms by serving as a precursor to foodstuffs and fertilizers. It is also, either directly or indirectly as a building block for the synthesis of many pharmaceuticals. Further it is known to be both caustic and hazardous.

7) Odours:

Odours emanate from slaughterhouses, breweries, bio-industries, textile industries, coffee roasting plants, yeast and alcohol factories, sewage treatment works, solid waste composting works among others. VOCs and H_2S have been identified as the major odour stimuli in sewer pipes and aerobic wastewater treatment plants [6]. Other odorous molecules include organic sulphides, mercaptans, ammonia, inorganic and organic amines, and organic acids, aldehydes and ketones.

8) Radioactive Pollutants:

These are produced by nuclear explosions, war explosives and natural processes such as radioactive decay of radon.

B. Secondary Pollutants:

Particulate matter is formed from gaseous primary pollutants and compounds in photochemical smog. Smog is a kind of air pollution and the word 'smog' is derived from smoke and fog. Classic smog results from large amounts of coal burning in an area caused by a mixture of smoke and sulphur dioxide. Moreover, modern smog does not usually come from coal but from vehicular and industrial emissions which are acted on in the atmosphere by ultraviolet light from the sun to form secondary pollutants that also combine with the primary emissions to form photochemical smog.

Ground level ozone (O_3) is formed from NO_x and VOCs. Ozone (O_3) is a key constituent of certain regions of the stratosphere commonly known as the ozone layer. The layer undergoes photochemical and chemical reactions which drive many of the chemical processes that occur in the atmosphere by day and night. More importantly, high concentrations at abnormal level brought about by human activities largely through the combustion of fossil fuel constitute a pollutant and

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hence a smog, Peroxyacetyl nitrate (PAN) is similar to NO_X and VOCs as described above.

III.EFFECT OF AIR POLLUTION ON HEALTH

Air pollution's impacts are both direct and indirect. Direct impacts include health, damage of materials and ecosystems, and poor visibility. Less direct impacts include 'acid rain' which results from chemicals being released into the atmosphere. Changes in human behavior also result from air pollution, such as inhabitants of heavily polluted urban areas relocating or tourists staying away from polluted cities. The main indirect impact is climate change. The biomass and fossil fuels that cause air pollution also have caused the warming of the earth's atmosphere resulting from the release of greenhouse gases (GHGs). Therefore, air pollution has many and diverse impacts.

IV. AIR POLLUTION IMPACTS ON RESPIRATORY HEALTH

In 2012 alone, 7 million deaths in the world were attributable to the combined effects of ambient (3.7 million) and household (4.3 million) air pollution (WHO, 2015). Ischemic heart disease is at the forefront in this ranking of causes, and COPD, lower respiratory infections, lung cancer are also amongst the top five causes of deaths worldwide. Ambient air pollution has been identified as the fifth biggest cause of mortality in India (Lim et al., 2012) India registered an increase of about 12% in the number of deaths and about 3% in years of life lost between 2005 and 2010. Figure 1 shows the alarming increase in the death toll in India over the period from 2005 to 2010 i.e 72000 more deaths. Figure 2 gives the disease-wise percentage distribution of deaths attributable to ambient particulate matter pollution in India.

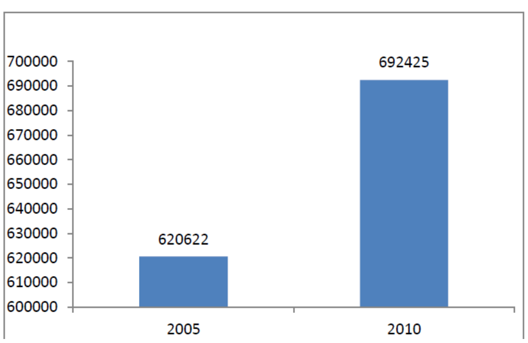

Fig1: Total deaths from ambient PM and ozone pollution in India

Source: OECD (2014)

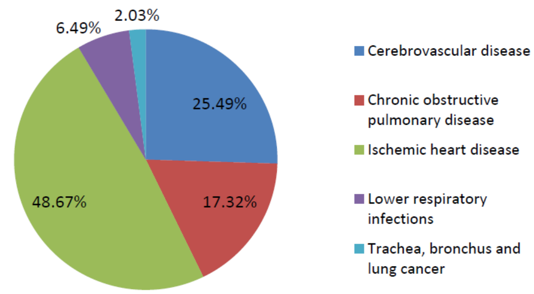

Fig 2: Percentage distribution of deaths from ambient PM pollution in India

Source: Lim et al, (2012)

There are many studies across the world and also in India to prove that outdoor and indoor air pollution is a serious environmental risk factor that causes or aggravates acute and chronic diseases. Pairing city-level air pollution measures with child level data from the National Family Health Survey (2005-06) for six cities in India shows that an increase in ambient air pollution significantly increases child morbidity [9]. The six cities considered in the city were Chennai, Delhi, Hyderabad, Indore, Kolkata and Nagpur. The study found that a rise in ambient air pollution significantly increases the likelihood of a child suffering from cough and fever in the past week. However, the type of cooking fuel used at home is not significantly related to child morbidity after accounting for ambient air pollution and other child- and household-level control variables. Thus, while bad air is bad for child health, ambient air pollution is a more significant determinant of the child health outcomes. A significant correlation between the two child morbidity outcomes – fever and cough. Controlling citywide air pollution could significantly lower child morbidity, and should receive greater emphasis in urban planning and infrastructure development.

V. ABATEMENT TECHNIQUES FOR CONTROLLING AIR POLLUTION

From the viewpoint of industry it makes good sense to ameliorate the air pollution problem. Reducing the level of emitted particles during the industrial processes helps keep plant damage at a minimum. In addition, efficient cleaning equipment which effectively removes contaminants from the air will prevent this matter from finding its way back into the work areas. This feature is of importance in industries having high quality control standards. Also, materials recovered from Emissions may prove a valuable source from which to reclaim usable material. Further, the fine dust or organic matter which might be found in pollutants are dangerously conducive to fire

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and explosion. Efficient removal of these contaminants can greatly reduce this hazard. Finally, efficient cleansing of the air may enable this air to be recirculated into the work areas[10]

A) Control of particulates:

Airborne particles can be removed from a polluted air stream by a variety of physical processes. The common types of equipment for collecting fine particulates include cyclones, scrubbers, electrostatic precipitators and bag house filters. Electrostatic precipitators and fabric-filter bag houses are often used at power plants and the principles behind cyclones, scrubbers, electrostatic precipitators and bag houses as air-cleaning equipment [3] are presented below.

1) Cyclones:

A cyclone (Figure. 3) removes particulates by causing the dirty air stream to flow in a spiral path inside a Cylindrical chamber. Dirty air enters the chamber from a Tangential direction at the outer wall of the device forming a vortex as it swirls within the chamber. The larger Particulates because of their greater inertia move outward and are forced against the chamber wall. Slowed by Friction with the wall surface, they then slide down the wall into a conical dust hopper at the bottom of the cyclone. The cleaned air swirls upward in a narrower Spiral through an inner cylinder and emerges from an Outlet at the top and accumulated particulate dust is periodically removed from the hopper for disposal. Cyclones are best at removing relatively coarse particulates. They can routinely achieve efficiencies of 90 percent for particles larger than about 20 µm (0.0008 inch). However, cyclones are not sufficient to meet stringent air quality standards. They are typically used as precleaners and are followed by more efficient air cleaning Equipment such as electrostatic precipitators and baghouses.

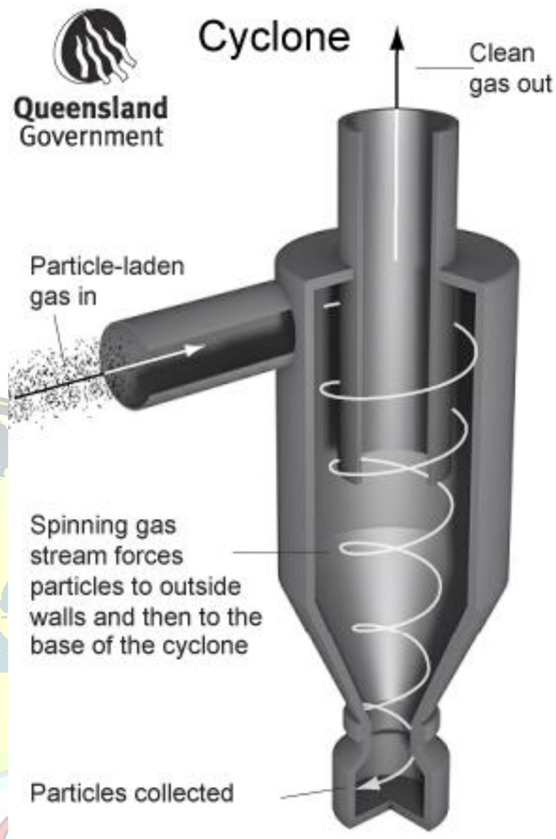

Fig 3. Diagram of a cyclone (Adapted from DEHP, 2011)

2) Scrubbers:

Wet scrubbers trap suspended particles by direct contact with a spray of water or other liquid. In effect, a scrubber washes the particulates out of the dirty airstream as they collide with and are entrained by the countless tiny droplets in the spray. Several configurations of wet scrubbers are in use. In a spray-tower scrubber, an upward-flowing airstream is washed by water sprayed downward from a series of nozzles. The water is recirculated after it is sufficiently cleaned to prevent clogging of the nozzles. Spray-tower scrubbers can remove 90% of particulates larger than about 8 µm (0.0003 inch). In orifice scrubbers and wet-impingement scrubbers, the air and droplet mixture collides with a solid surface. Collision with a surface atomizes the droplets reducing droplet size and thereby increasing total surface contact area. These devices have the advantage of lower waterrecirculation rates and they offer removal efficiencies of about 90 percent for particles larger than 2 µm (0.00008 inch). Venturi scrubbers are the most efficient of the wet collectors achieving efficiencies of more than 98% for particles larger than 0.5 µm (0.00002 inch)

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in diameter. Scrubber efficiency depends on the relative velocity between the droplets and the particulates. Venturi scrubbers achieve high relative velocities by injecting water into the throat of a venturi channel (a constriction in the flow path) through which particulate-laden air is passing at high speed.

3) Electrostatic precipitators:

Electrostatic precipitation is a commonly used method for removing fine particulates from airstreams. In an electrostatic precipitator (Figure 4), particles suspended in the airstream are given an electric charge as they enter the unit and are then removed by the influence of an electric field. The precipitation unit comprises baffles for distributing airflow, discharge and collection electrodes, a dust clean-out system and collection hoppers. A high DC voltage (as much as 100,000 volts) is applied to the discharge electrodes to charge the particles, which then are attracted to oppositely charged collection electrodes on which they become trapped. In a typical unit, the collection electrodes comprise a group of large rectangular metal plates suspended vertically and parallel to each other inside a boxlike structure. There are often hundreds of plates having a combined surface area of tens of thousands of square metres. Rows of discharge electrode wires hang between the collection plates. The wires are given a negative electric charge whereas the plates are grounded and thus become positively charged.

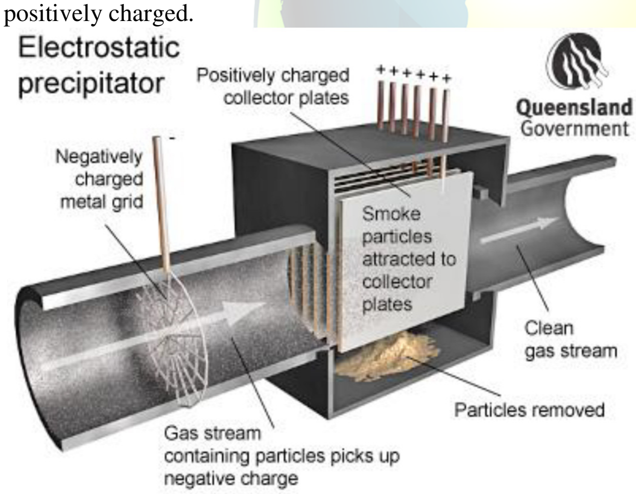

Fig. 4. Diagram of an electrostatic precipator (Adapted from DEHP, 2011)

Particles that stick to the collection plates are removed periodically when the plates are shaken, or "rapped." Rapping is a mechanical technique for separating the trapped particles from the plates which typically become covered with a 6-mm (0.2-inch) layer of dust. Rappers are either of the impulse (single-blow) or vibrating type. The dislodged particles are collected in a hopper at the bottom of the unit and removed for disposal. An electrostatic precipitator can remove particulates as small as 1 µm (0.00004 inch) with an efficiency exceeding 99 %. The effectiveness of electrostatic precipitators in removing fly ash from the combustion gases of fossil-fuel furnaces accounts to their high frequency of use at power stations.

4)Bag house filters:

One of the most efficient devices for removing suspended particulates is an assembly of fabric filter bags commonly called a bag house. A typical bag house (Figure 5) comprises an array of long, narrow bags - each about 25 cm (10 inches) in diameter - that are suspended upside down in a large enclosure. Dust-laden air is blown upward through the bottom of the enclosure by fans. Particulates are trapped inside the filter bags while the clean air passes through the fabric and exits at the top of the bag house.

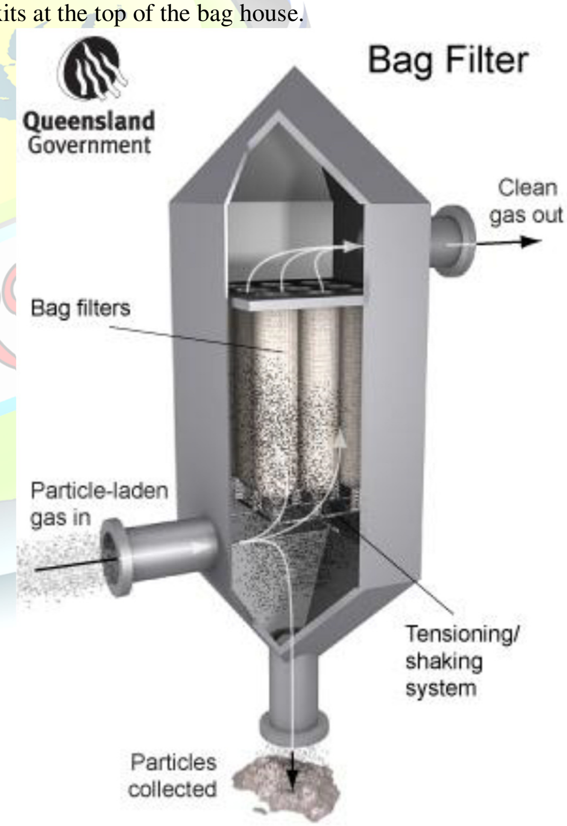

Fig 5. Diagram of typical bag filter (Adapted from DEHP, 2011)

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A fabric-filter dust collector can remove nearly 100% of particles as small as 1 µm (0.00004 inch) and a significant fraction of particles as small as 0.01 µm (0.0000004 inch). Fabric filters however, offer relatively high resistance to airflow and they are expensive to operate and maintain. Additionally, to prolong the useful life of the filter fabric the air to be cleaned must be cooled (usually below 300 °C or 570 °F) before it is passed through the unit and cooling coils are needed for this purpose which add to the expense. Also, certain filter fabrics for example those made of ceramic or mineral materials can operate at higher temperatures. Several compartments of filter bags are often used at a single bag house installation. This arrangement allows individual compartments to be cleaned while others remain in service. The bags are cleaned by mechanical shakers or by reversing the flow of air and the loosened particulates are collected and removed for disposal.

5) Packed bet wet scrubber:

A common type of packed scrubber is the counter current tower. After entering the bottom of the tower, the polluted airstream flows upward through a wetted column of light which is chemically inactive packing material. The liquid absorbent flows downward and is uniformly spread throughout the column packing thereby increasing the total area of contact between gas and liquid. Thermoplastic materials are most widely used as packing for counter current scrubber towers. These devices usually have gas removal efficiencies of 90–95%. Co-current and cross-flow packed scrubber designs are also used for gas absorption. In the Co-current design, both gas and liquid flow in the same direction - vertically downward through the scrubber. Although not as efficient as counter current designs, Co-current devices can work at higher liquid flow rates. The increased flow prevents plugging of the packing when the airstream contains high levels of particulates while Co-current designs also afford lowered resistance to airflow and allow the cross-sectional area of the tower to be reduced. The cross-flow design in which gas flows horizontally through the packing and liquid flows vertically downward can also operate with lower airflow resistance when high particulate levels are present. In general, scrubbers are used at fertilizer production facilities to remove ammonia from the airstream, at glass production plants to remove hydrogen fluoride, at chemical plants to remove water-soluble solvents such as acetone and methyl alcohol and at rendering plants to control odours. Sulfur dioxide in flue gas from fossil-fuel power plants can be controlled by means of an absorption process called flue gas desulfurization (FGD). FGD systems may involve wet scrubbing or dry scrubbing. In wet FGD systems, flue gases are brought in contact with an absorbent which can be either a liquid or slurry of solid material. The sulphur dioxide dissolves in or reacts with the absorbent and becomes trapped in it. In dry FGD systems, the absorbent is dry pulverized lime or limestone and once absorption occurs, the solid particles are removed by means of bag house filters. The dry FGD systems, compared with wet systems, offer cost and energy savings and easier operation, but they require higher chemical consumption and are also limited to flue gases derived from the combustion of low-sulphur coal. FGD systems are also classified as either renewable or non-renewable (throwaway), depending on whether the sulphur that is removed from the flue gas is recovered or discarded. Non-renewable FGD systems produce a sulphur-containing sludge residue that requires appropriate disposal but renewable FGD systems require additional steps to convert the sulphur dioxide into useful by-products like sulphuric acid.

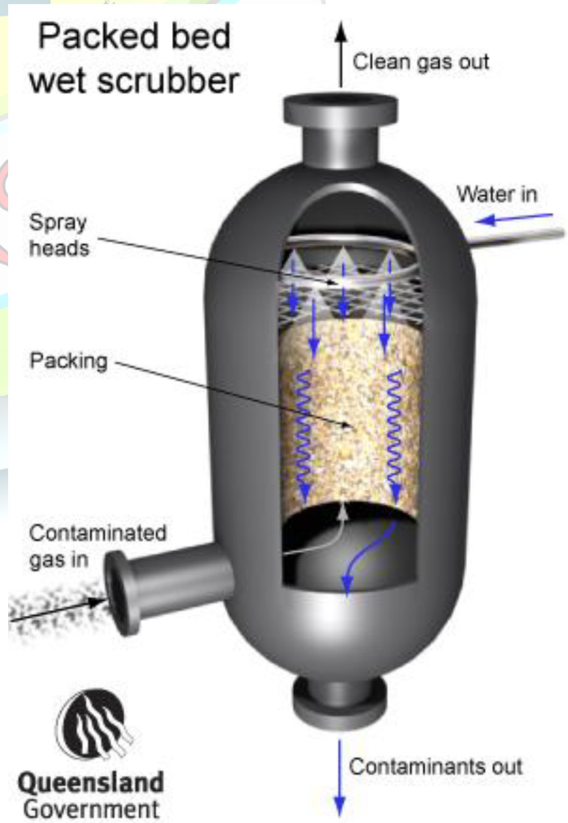

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Fig 6. Diagram of packed wet scrubber (Adapted From DEHP, 2011)

VI.CONCLUSION

This work has attempted to survey the types, sources, and health effects of air pollution and possible abatement techniques. There can be no doubt that conscientious application of existing abatement methods would produce a significant reduction in air pollution, both in the short run and the more distant future. Industrial and governmental research teams are taking rapid strides toward the development of new pollution control techniques with greater efficiency at lower costs. Industry is not unresponsive to this problem, and it is probable that public indignation would eventually compel big business to reduce contamination arising from its plants and products. But the problem, having reached emergency proportions in many areas, is immediate. Only through effective legislative action at all levels of government is need in time to avert even more serious hazards to health and comfort.

REFERENCES

[1]. Kaifi, M.A. (2011) Role of Agriculture in Air Pollution. PIMS Arid University, Rawalpindi,16pp.

[2]. TERI (The Energy and Resources Institute). 2009. GREEN India 2047 Renewed: Looking Back to Change Track. New Delhi: TERI

[3]Inkomati Catchment Management Agency ICMA (2007) Techniques for controlling air pollution. http://www .inkomaticma.co.za. Accessed on August, 22, 2012.

[4]. Katz, *Some Aspects of the Physical and Chemical Nature of Air Pollution,* AIR POLLUTION 97, 101 (1961).(PA SUP)

[5]. 10. Heimann, *Effects of Air Pollution on Human Health,* AIR POLLUTION 159, 164 (1961). (PA SUP)

[6]. Smet, E. and H. Van Langenhove (1998) Abatement of volatile organic sulphur compounds in Odorous emissions from the bio-industry. *Biodegradation 9*, 273– 284.

[7]. Lim SS, Vos T, Flaxman AD, Danaei G, Shibuya K, Adair- Rohani H, et al (2010). A comparative risk assessment of burden of disease and injury attributable to 67 risk factors and risk factor clusters in 21 regions, 19902010: a systematic analysis for the Global Burden of Disease Study 2010. Lancet 2012; 380: 222460.

[8]. OECD (2014), The Cost of Air Pollution: Health Impacts of Road Transport, OECD Publishing.

[9]. Ghosh A. and Mukherjee A (2010). Air Pollution and Child Health in Urban India. Indian Statistical Institute : New Delhi. India

[10]. AM. Foundrymen's Soc., Foundry Am Pollution Control Manual 26 (1956).

[11]. DEHP (2011) Controlling air pollution. http:// www. ehp. qld.gov.au/air/pollution/controlling.html. Accessed on August, 22, 2012.

[12]. WHO. (2014). Burden of disease from the joint effects of Household and Ambient Air Pollution for 2012. Geneva: World Health Organisation.