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AIR POLLUTION CONTROL USING MEMBRANE TECHNIQUE

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ABSTRACT-*The state of the art of application of membrane techniques for air cleaning is presented. The most characteristic parameters of membrane separation of gases and vapours are described. Separation of gases and vapours has been applied practically in the industry for the following areas: removal of volatile organics from the air and from industrial waste flows, oxygen enrichment of air and vice versa and the membrane absorption process.*

Keywords: gas separation, membranes, air pollution, membrane absorption

1.INTRODUCTION

What is pollution? In general this could be defined as unwanted material. However, it is a known fact that very often, what is not desired today could be in demand tomorrow. Recycling old sand dumps is a typical example. In general pollution can be classified in two categories, namely those carried by the atmosphere and those which are mainly in liquid or solid form. The former includes air pollution and also to a greater or lesser extend noise and radioactive pollution. In this project work the accent will be on the objectives of atmospheric pollution control by pollution control device.

2.AIR POLLUTATIONS

Air pollution is the introduction of harmful substances including particulates and biological molecules into Earth's atmosphere. It may cause diseases, allergies or death in humans; it may also cause harm to other living organisms such as animals and food crops, and may damage the natural or built environment. Human activity and natural processes can both generate air pollution.Indoor air pollution and poor urban air quality are listed as two of the world's worst toxic pollution problems in the 2008 Blacksmith Institute World's Worst Polluted Places report. According to the 2014 WHO report, air pollution in 2012 caused the deaths of around 7 million people worldwide, an estimate roughly matched by the International Energy Agency

3.POLLUTANTS

An air pollutant is a substance in the air that can have adverse effects on humans and the ecosystem. The substance can be solid particles, liquid droplets, or gases. A pollutant can be of natural origin or man-made. Pollutants are classified as primary or secondary. Primary pollutants are usually produced from a process, such as ash from a volcanic eruption. Other examples include carbon monoxide gas from motor vehicle exhaust, or the sulfur dioxide released from factories. Secondary pollutants are not emitted directly. Rather, they form in the air when primary pollutants react or interact. Ground level ozone is a prominent example of a secondary pollutant. Some pollutants may be both primary and secondary: they are both emitted directly and formed from other primary pollutants

3.1Major primary pollutants produced by human activity include:

Carbon dioxide (CO_2) - This is by far the most emitted form of human caused air pollution. Although CO_2 is currently only about 405 parts per million in earth's atmosphere, billions of metric tons of CO_2 are emitted annually by burning of fossil fuels. CO_2 increase in earth's atmosphere has been accelerating.

Sulfur oxides (SO_x) - particularly sulfur dioxide, a chemical compound with the formula SO_2. SO_2 is produced by volcanoes and in various industrial processes. Coal and petroleum often contain sulfur compounds, and their combustion generates sulfur dioxide. Further oxidation of SO_2, usually in the presence of a catalyst such as NO_2, forms H_2SO_4, and thus acid rain. This is one of the causes for concern over the environmental impact of the use of these fuels as power sources.

Nitrogen oxides (NO_x) - Nitrogen oxides, particularly nitrogen dioxide, are expelled from high temperature combustion, and are also produced during thunderstorms by electric discharge. They can be seen as a brown haze dome above or a plume downwind of cities. Nitrogen dioxide is a chemical compound with the formula NO_2. It is one of several nitrogen oxides. One of the most prominent air pollutants, this reddish-brown toxic gas has a characteristic sharp, biting odor.

Carbon monoxide (CO) - CO is a colorless, odorless, toxic yet non-irritating 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

Volatile organic compounds (VOC) - VOCs are a well-known outdoor air pollutant. They are categorized as either methane (CH_4) or non-methane (NMVOCs). Methane is an extremely efficient greenhouse gas which contributes to enhanced global warming. Other hydrocarbon VOCs are also significant greenhouse gases because of their role in creating ozone and prolonging the life of methane in the atmosphere. This effect varies depending on local air quality. The aromatic NMVOCs benzene, toluene and xylene are suspected carcinogens and may lead to leukemia with prolonged exposure.

Particulates, alternatively referred to as particulate matter (PM), atmospheric particulate matter, or fine particles, are tiny particles of solid or liquid suspended in a gas. In contrast, aerosol refers to combined particles and gas. Some particulates occur naturally, originating from volcanoes, dust storms, forest and grassland fires, living vegetation, and sea spray. Human activities, such as the burning of fossil fuels in vehicles, power plants and various industrial processes also generate significant amounts of aerosols. Averaged worldwide, anthropogenic aerosols—those made by human activities—currently account for approximately 10 percent of our atmosphere. Increased levels of fine particles in the air are linked to health hazards such as heart disease, altered lung function and lung cancer.

4.POLLUTION SOURCES

There are various locations, activities or factors which are responsible for releasing pollutants into the atmosphere. These sources can be classified into two major categories.

Anthropogenic (man-made) sources:

These are mostly related to the burning of multiple types of fuel.

Stationary sources include smoke stacks of power plants, manufacturing facilities (factories) and waste incinerators, as well as furnaces and other types of fuel-burning heating devices. In developing and poor countries, traditional biomass burning is the major source of air pollutants; traditional biomass includes wood, crop waste and dungMobile sources include motor vehicles, marine vessels, and aircraft. Controlled burn practices in agriculture and forest management. Controlled or prescribed burning is a technique sometimes used in forest management, farming, prairie restoration or greenhouse gas abatement. Fire is a natural part of both forest and grassland ecology and controlled fire can be a tool for foresters. Controlled burning stimulates the germination of some desirable forest trees, thus renewing the forest.Fumes from paint, hair spray, varnish, aerosol sprays and other solventsWaste deposition in landfills, which generate methane. Methane is highly flammable and may form explosive mixtures with air. Methane is also an asphyxiant and may displace oxygen in an enclosed space. Asphyxia or suffocation may result if the oxygen concentration is reduced to below 19.5% by displacement.Military resources, such as nuclear weapons, toxic gases, germ warfare and rocketry

5.NATURAL SOURCES:

Dust from natural sources, usually large areas of land with little or no vegetation

Methane, emitted by the digestion of food by animals, for example cattle

Radon gas from radioactive decay within the Earth's crust. Radon is a colorless, odorless, naturally occurring, radioactive noble gas that is formed from the decay of radium. It is considered to be a health hazard. Radon gas from natural sources can accumulate in buildings, especially in confined areas such as the basement and it is the second most frequent cause of lung cancer, after cigarette smoking.

Smoke and carbon monoxide from wildfires

Vegetation, in some regions, emits environmentally significant amounts of Volatile organic compounds (VOCs) on warmer days. These VOCs react with primary anthropogenic pollutants—specifically, NO_x, SO_2, and anthropogenic organic carbon compounds — to produce a seasonal haze of secondary pollutants. Black gum, poplar, oak and willow are some examples of vegetation that can produce abundant VOCs. The VOC production from these species result in ozone levels up to eight times higher than the low-impact tree species. Volcanic activity, which produces sulfur, chlorine, and ash particulate

6.HEALTH EFFECTS

Mortality

Cardiovascular disease

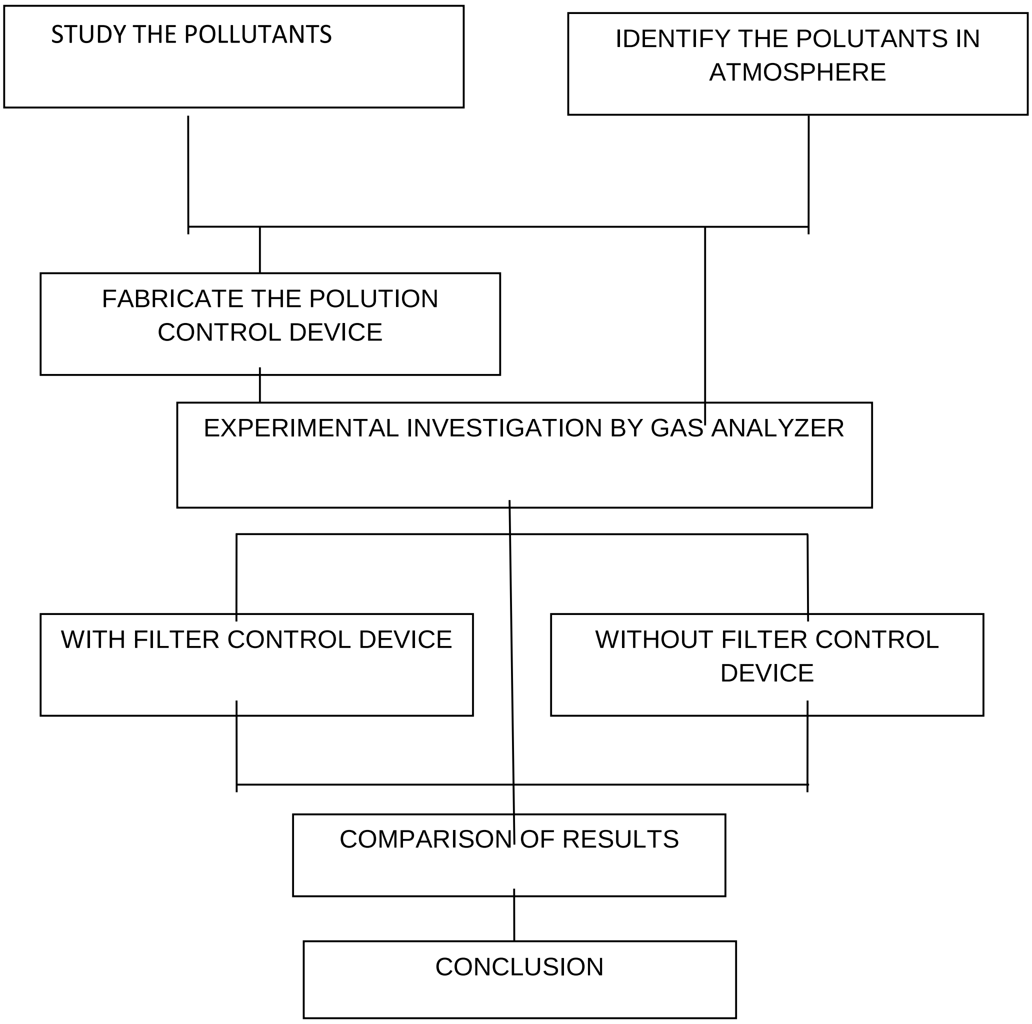
Lung disease

Cancer

7.APPLICATION OF MEMBRANE ABSORPTION PROCESS

Polymeric membranes have also found a new application possibility – as separation (contact) surface of two phases. For example two flowing liquids, or flowing gas and liquid can be separated by means of a porous hydrophobic membrane. Since the membrane is porous, the contact between two liquids is possible in for Air Treatment Polymeric membranes spite of the fact that it forms a separating barrier between both phases. In order to separate water phase from gas phase or from another water phase the membrane must have hydrophobic character. Due to the above it is possible to carry out a process similar to extraction, and the absorption of gases with the use of membrane units. By the application *Membrane Techniques* ... 7 of capillary membranes for that purpose (e.g. from polypropylene) we can obtain high phase contact surfaces (over 1000 m2/m3). Such compact installations are cheaper than classical absorbers having a contact surface of about 100 m2/m3. A membrane can form a permeable barrier between the liquid and gas phase. When the membrane is porous, gas impurities diffuse through the pores and are absorbed by the liquid passing on its other side, and in the case of nonporous membrane the impurities dissolve in the material of the membrane and then diffuse through it. The contact surface between gas phase and liquid phase depends solely on the type of membrane, and not on the flux volume of flowing media. Absorption in the liquid phase can be effected by physical separation or chemical reaction, and the separation selectivity only depends on the type of absorbent. Fig. 10 presents the functioning of the porous membrane in the process of gas absorption With the application of capillary modules, very efficient contactors of the gas-liquid type can be constructed. Most of the absorbents applied in the conventional absorption process can be also used in membrane absorbers. During the utilization of membrane gas absorbers it must be ensured that the liquid phase is not mixed with the gas phase. This means that with respect to porous membranes, the absorption liquid should not be allowed to penetrate inside the pores. It depends on the size of pores, pressure difference on both sides of membrane and the affinity of absorption liquid with the membrane material, and it is connected with the wettability in the system solid body (membrane) - liquid. Membrane pores do not get wet when the wetting angle is higher than 90 and pressure difference on both sides of the membrane is limited by the size of pores. For water absorption liquids there are suitable membrane materials such as polypropylene and teflon. Since surface tension is decreasing along with temperature, the breakthrough pressure (opening of pores) decreases along with the increase of temperature. For nonporous membranes, the permeation of liquid depends on pressure difference and affinity between polymer and absorption liquid since the liquid must first of all penetrate the inside of the matrix. When there are fast chemical reactions taking place in the presence of membranes, the transport of matter is limited by diffusion stage in gas phase and therefore it depends on hydrodynamic conditions over the membrane surface, its properties (porosity, thickness, morphology) and transport properties (diffusion index). The values of mass transfer coefficient in such conditions range from 0.001 to 0.1 m/s [11]. The application of membranes for gas absorption has a lot of advantages over the conventional solutions where columns with filling are used: - operation of contact unit does not depend on the vol ume of gas flux or liquid flux, - such phenomena as snatching up of liquid drops by gas, column flooding, formation of channels or foaming do not occur, - the units are compact due to the application of membrane

8.METHODOLOGY



9.CONCLUSION

Owing to huge amount of the CO_2, chemical absorption may be more suitable than physical absorption purpose. However, chemical absorption is an energy intensive process in which
more than 60% of total energy consumed in stripper for thermal regeneration of CO_2-rich chemical absorbents. Various methods like chemical looping combustion (CLC) and rotating packed

bed method use many sophisticated apparatus to absorb carbondi- oxide. Other methods include the use of cryogenics or solvents which require very strict conditions perform an
efficient absorption. To make absorption as practical application, the future research could be focused on the improvements of absorbent formulation and process efficiency. To achieve the purpose, the following approaches are suggested: i. to use absorbents with less corrosion, less viscosity. low vapor
pressure, rapid reaction rate with CO2, high CO2 absorption capacity, and less regeneration energy, a compromised formulation is needed because all the mentioned properties may not be satisfied in the meantime, ii. to enhance high gas-toliquid mass and heat transfer rates in absorber and stripper, iii. to reduce equipment volume and capital cost, iv. to prevent the negative effects of SOx, NOx, and oxygen on absorbent16, and v. to develop a more suitable model for the scale up purpose. The nanoparticles discussed in this paper have capabilities to absorb carbon dioxide and nitrogen dioxides. These when embedded onto a nanomembrane filter, acts as an absorbent to these greenhouse gases. By proper distribution of the particles and suitable placement of the nano membranes in the vehicle could have been the efficient absorption process.

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