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APPLICATION OF ALGAE IN AIR POLLUTION CONTROL TECHNIQUE

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ABSTRACT:- *Air pollution is caused when harmful substances are introduced into the earth's atmosphere. It may also cause harm to other living organisms such as animals and food crops and may also damage the natural or built environment. Human activity and natural processes can both generate air pollution. Here a biological method is being used to remove the pollutants present in the air. Algae such as spirulina which is capable of reducing the carbon-di-oxide (CO_2), nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) in the polluted air and generating oxygen. The equipment comprises of the culture tank filled with the culture fluid including algae and air supply unit. By radiating the light throughout the equipment using sunlight during the morning and fluorescent lamps during night in the presence of carbon-di-oxide (CO_2) photosynthesis will occur, where the conversion of the carbon di oxide occurs which results in the oxygen production. In addition to it algae-utilizes nitrogen dioxide (NO_2) and sulfur dioxide (SO_2) as nutrients during the photosynthesis. As a result, the polluted air which is passed through the equipment generates the purified air, which has high concentration of oxygen.*

Keywords: Air pollution, Spirulina, Photosynthesis, Absorbance, Optical density, oxygen

1. INTRODUCTION

Air pollution is growing day by day and its threat is becoming a challenge which we need to overcome. Every life form one way or another is getting affected by this threat. Air pollution are caused by various pollutant may it be primary like sulfur dioxide, carbon monoxide, volatile organic compounds, chlorofluorocarbons CFCs etc. or secondary like ozone, peroxyacetyl nitrate (PAN). Each pollutant has its own threats to us, out of which some creates grave danger to human life. The basic process of photosynthesis is plants and other organisms to convert light energy, normally from the sun, into chemical energy that can be later released to fuel the organism activities and thus release oxygen as a

by- product. Most plants, most algae, and cyanobacteria perform photosynthesis, and such organism are called photoautotrophs. Microalgae are sunlight-driven cell factories that convert carbon dioxide to potential biofuels, foods, feeds and high value bio-actives. Though we tried to use algae to reduce air pollutant such as sulfur dioxide, nitrogen dioxide and converting carbon dioxide into oxygen by process of photosynthesis

2. TYPES OF AIR POLLUTANT:

PRIMARY POLLUTANT	SECONDARY POLLUTANT
1- Oxides of Sulfur (SO_2, SO_3)	1- Sulfuric acid
2- Oxides of Carbon (CO, CO_2)	2-Ozone
3- Oxides of Nitrogen (NO, NO_2)	3-formaldehyde
4- Lead(pb), Hydrocarbons, H_2S	4-PAN (peroxyacetyl nitrate)

NATIONAL AMBIENT AIR QUALITY STANDARD

S. No.	Pollutant	Time Weighted average	Concentration in Ambient Air	
			Industrial, Residential, Rural and Other Area	Ecologically sensitive area (notified by Central Govt.)
1	Sulphur Dioxide (SO_2), mg/m^3	Annual	50	20
		24 hours	80	80

2	Nitrogen Dioxide (NO_2), mg/m^3	Annual	40	30
		24 hours	80	80
3	Particulate Matter (size less than 10 mm) or PM_{10} mg/m^3	Annual	60	60
		24 hours	100	100
4	Particulate Matter (size less than 2.5 microns) or $PM_{2.5}$ mg/m^3	Annual	40	40
		24 hours	60	60

(Source: Central pollution Control Board, 2009)

3. EFFECT OF AIR POLLUTANT

The effects of various pollutants can be understood in terms of health aspects and environmental aspects. The effects are summarized in the following table:

Pollutants	Major effects	
	Health effects	Environmental effects
Sulphur oxides (SO_x)	Respiratory problems, Heart and lung disorders, Visual impairment	Acid rain
Nitrogen oxides (NO_x)	Pulmonary disorders, increased susceptibility to respiratory infections	Precursor of ozone formation in troposphere, Aerosol formation
Particulate matter (PM)	Respiratory problems, liver fibrosis, lung/liver cancer, Heart stroke, Bone problems	Visibility reduction
Carbon monoxide (CO)	Anoxemia leading to various cardiovascular problems. Infants, pregnant women, and elderly people are at higher risk	-
Ozone (O_3)	Respiratory problems, Asthma, bronchitis *etc.*	O_3 in upper troposphere causes green- house effects, Harmful effects on plants as it interferes in photosynthesis and results in death of plant tissues since it assists in the formation of Peroxyacetyl nitrate (PAN)
Lead (Pb)	Serious effects on central nervous system since it is absorbed rapidly in blood stream, Anaemia, toxic for soft tissues and bones	-
Ammonia (NH_3)	Immediate effects lead to burning of eyes, nose, throat, and respiratory tract. Prolonged effects result in blindness, lung damage, or death.	-

4. LITERATURE SURVEY

Neda Jalilian et al. (2020) Microalgae are biological sources with an extensive range of biotechnological applications, e.g., for bioremediation of industrial and municipal wastes. Microalgae are used to monitor environmental toxicants like pesticides, heavy metals, and pharmaceuticals and in the final stage of wastewater treatment when organic pollution should be removed. CO2 capturing is also important due to the environmental issues. Macro/microalgae cultures, depending on their growth stages and life cycles, have great potential for CO_2 fixation. They are a dominant group of microorganisms for biological treatments with regards to their substantial biosorption ability to deactivate toxic heavy

metals. Actual carbon bio-fixation can be employed in the direction of environmental sustainability and economic facility. Besides, algae are sustainable feedstock to produce a wide range of biofuels by applying thermochemical or biological conversion methods.

A. S. A. El-Eslamboly et al. (2019) This study was conducted during seasons 2016 and 2017 to control the root-knot nematode Meloidogyne incognita in cucumber, cultivated in infected soil, using some algal treatments under greenhouse conditions, at Kaha Farm, Qaluobia Governorate, Egypt. Six algal treatments were tested: two foliar applications of Spirulina and Amphora, two drenched soil applications of Spirulina and Amphora, two treatments using Spirulina, as spraying and drenching, and Amphora, as spraying and drenching, in addition to the Rugby nematicide (10% Ebufos , at the rate of 5 g/m2) and control. Rugby was applied by a soil prepared in its experimental units. After 15 days from transplanting, the algal extract treatments were applied twice monthly for 3 months. The same concentration (2 g/l) of both types of algae was applied in both foliar and drench treatments. The control was sprayed only by water. The results indicated that the soil drenched with Amphora or Spirulina extracts had significant increments in vegetative growth, yield, and fruit quality. In contrast, the control plants had the lowest values in all criteria. Amphora (sprayed with soil drenched) treatment gave 2.5 and 2.69 folds the control in marketable yield in 2016 and 2017 seasons, respectively. The combination of sprayed and soil drenched with Amphora was more effective in nematode's control or in enhancing plant resistance for nematode as shown at most nematode parameters, especially the rate of nematode reproduction factor (RF), which reached 0.42 and 0.45 in both seasons, respectively.

Yunes Panahi et al. (2018) Environmental contamination, principally caused by the toxic chemicals from human activities or industrial processes, includes air, water, and soil contamination. Therefore, the development of highly efficient methods for providing an appropriate environment is needed for the industrialized countries. Nanotechnology provides novel treatment approaches and creates new technologies with superior advantages compare to the conventional techniques. Through the present research, the recent developments in nanotechnology have been reviewed, and potential applications of nanomaterials for the removal of pollutants from air, water and wastewater have been discussed.

Lazuardi Umar et al. (2015) Environmental problems including water and air pollution, over fertilization, insufficient wastewater treatment and even ecological disaster are receiving greater attention in the technical and scientific area. In this paper, a method for water quality monitoring using living green algae (Chlorella Kessleri) with the help of the intelligent mobile lab (IMOLA) is presented. This measurement used two IMOLA systems for measurement and reference simultaneously to verify changes due to pollution inside the measurement system. The IMOLA includes light emitting diodes to stimulate photosynthesis of the living algae immobilized on a biochip containing a dissolved oxygen microsensor. A fluid system is used to transport algae culture medium in a stop and go mode; 600s ON, 300s OFF, while the oxygen concentration of the water probe is measured. When the pump stops, the increase in dissolved oxygen concentration due to photosynthesis is detected. In case of a pollutant being transported toward the algae, this can be detected by monitoring the photosynthetic activity.

Tinglin Huang et al. (2016) The physical control technologies mainly include the mixing–oxygenating technology, dilution and scour, sediment dredging, and coverage. The chemical control technologies mainly include phosphorus precipitation and passivation, restoration of acidified lakes or reservoirs, and sediment oxidation. The ecological control technologies mainly include bioremediation, phytoremediation, and biomanipulation remediation. By analysing and comparing the tested data, for water sources such as reservoirs, the mixing–oxygenating technology is more suitable for decreasing endogenous pollution and controlling eutrophication.

WeimingHu et al. (2015) Polyvinylidene fluoride (PVDF) hollow fiber membranes with nano-TiO2 (5% of PVDF by mass, average size = 25 nm) additives were fabricated and applied for high-density algae (Chlorella vulgaris) cultivation. At the average light intensity of 121 μmol/m2/s, the algal membrane bioreactors (A-MBR) operated at a hydraulic retention time of 0.5 d and an average solids retention time of 25 d had an average algae biomass concentration of 2350 ± 74 mg/L (in COD units) and algal biomass production rate of 6.5 ± 0.1 g/m2/d. The A-MBRs removed an average of 78% of phosphorus from the wastewater at the initial total phosphorus concentrations ranging from 3.5 to 8.6 mg/L.

(**Juliana Botelho Moreira 2015**) Biological processes are alternatives for combating pollution and generating new products. The microbial metabolism degrades and removes pollutants, which generates fewer environmentally harmful products. In this scenario, microalgae have been studied for wastewater treatment, toxic metal bioremediation, carbon dioxide (CO_2), bio-fixation, biofuel, biopolymer and Nano fiber production. Various cultivation conditions have been studied to increase the micro algal biomass productivity and reduce production costs. Semi-continuous cultivations have several advantages compared with batch and continuous processes. Semi-continuous processes involve periodically replacing part of the microalgae culture medium with fresh culture medium (dilution). Such cultivation methods can be used for larger scale biomass production while maintaining a high microorganism growth rate. The same inoculum can be used for long periods, which avoids idle time due to harvesting the formed biomass, cleaning the photo bioreactor and

initiating the process. Another advantage of this process is control of the nutritional and kinetic parameters.

5. METHODOLOGY

5.1: Culturing of algae

The microalgae spirulina is to be used for this project. Cells are cultivated in the modified culture medium with ratio 1:1. It is stored under sunlight with complete aeration. The sub culturing is to be done for every 10 days. The culture medium is to be maintained at a temperature of 20˚c to 40˚c. It is preferred that the pH value of the culture fluid is 10.5 Constituents of culture media are: sodium bicarbonate, sodium chloride, potassium sulphate, magnesium sulphate, sodium nitrate, ferrous sulphate (in required proportions).

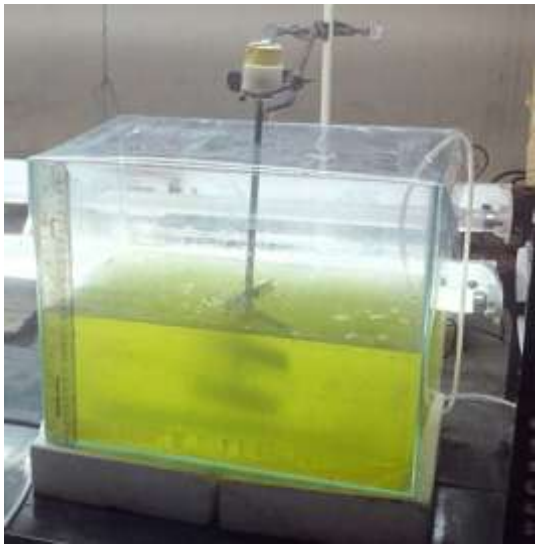
Procedure: 1 litre of distilled water to be taken in a conical flask, and it is to be sterilized using auto clave for about 15 minutes at 120˚c. it is being cooled until it reaches to room temperature. Chemicals are being weighted. Chemicals are being added to sterile water and stirred until all chemicals are dissolved. Make the nutrient media and spirulina in ratio 1:1

5.2: Experimental setup

The primary objective of this method is to provide a system for purifying a polluted air by using spirulina algae, which is capable of reducing NO_2, SO_2, CO_2 & CO from the polluted air and generating oxygen.

Materials Required: Spirulina, gas cylinder, battery, pipes and wires, LED lights.

Procedure: The system consists of culture tank filled with the culture fluid including spirulina. The required pollutant gases are supplied to the tank using a gas cylinders, which is connected to it. LED lights are connected to the system to radiate light to the culture. The culture fluid in presence of CO2 & light undergoes photosynthesis to convert CO_2 into O_2. In addition, the algae use NO_2 & SO_2 as a nutrient.



5.3: Analysis of NO_2 and SO_2

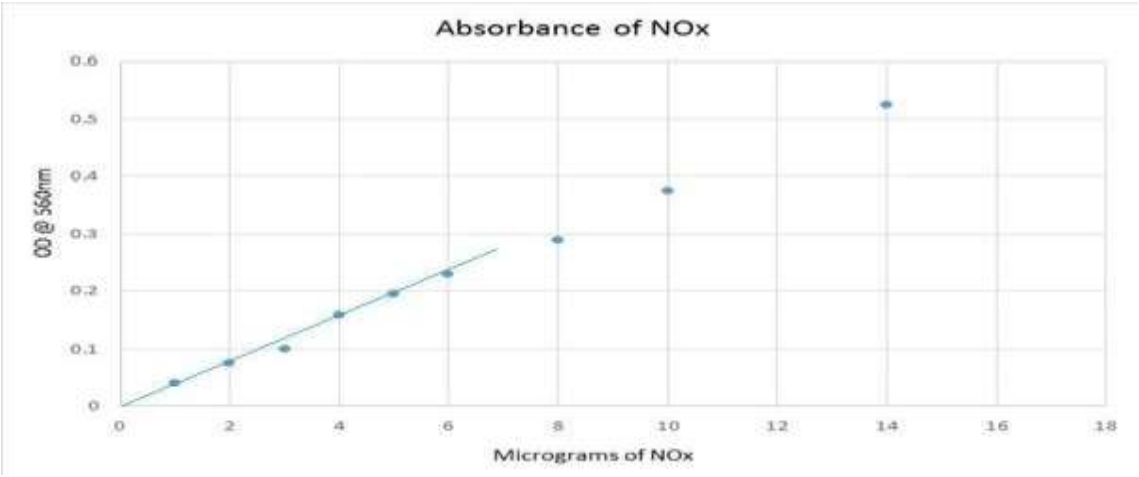
NO_2 and SO_2 are the two important dangerous gases that are present in the polluted air. There are different methods to analyse the concentration of NO_2 & SO_2. The NO_2 and SO_2 gases which are present in the air are consumed by the spirulina during photosynthesis as a main nutrient. The concentration of these gases present in the polluted air is obtained by analysing the amount of NO_2 and SO_2 that are dissolved in the algae (spirulina).

Materials required: Spectrophotometer, calorimeter, chemicals, glassware, reagents, cuvette

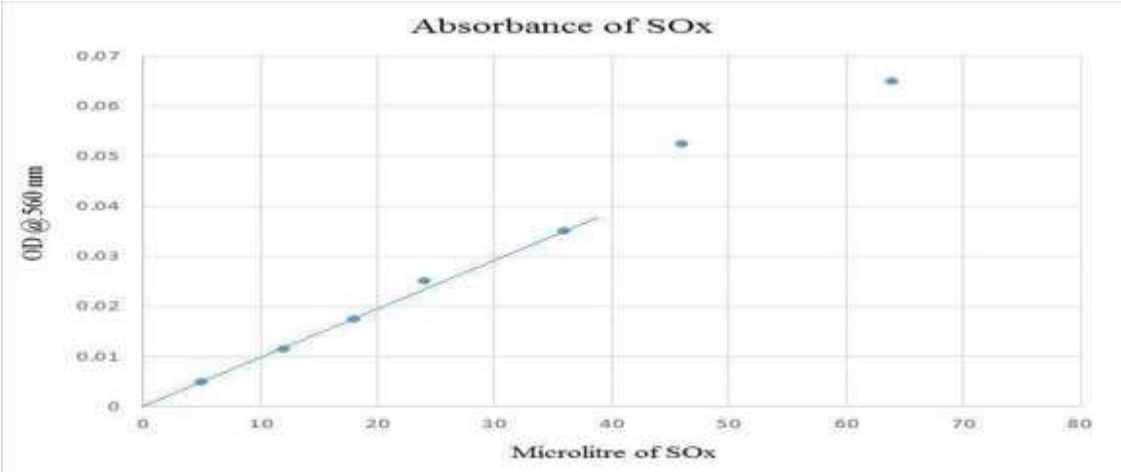
Chemicals required: p-rosaniline hydrochloride, formaldehyde, Sulphamic acid, NEDA solution, sulphanilamide.

Analysis of SO_2: Sample is being taken, Sulphamic acid and rosaniline HCL, HCHO is being added. Kept it on RT and absorbance is being calculated @ 560nm

Analysis of NO_2: Sample is being taken, sulphanilamide and NEDA solution being added and kept at RT. Absorbance is being calculate @ 560nm



Graph 1: Standard calibration curve of nitrogen oxide



Graph 2: Standard calibration curve of sulphur oxide

6. CONCLUSION

This report mainly focuses on the reduction of pollutants of air. Here it is done by passing the pollutant gases to the equipment containing spirulina. The algae utilize the carbon dioxide, nitrogen dioxide and sulphur dioxide as the nutrients for its growth. By the process of photosynthesis where carbon dioxide is converted to oxygen utilizing nitrogen dioxide and sulphur oxide as nutrients spirulina has reduced the pollutants. Through series of test it is found that the amount of nitrogen dioxide, carbon dioxide and sulphur dioxide has been reduced

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