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A Review On Application of Algae in Air Pollution Control Technique

Ashwini Bagmare[1] | Dilendra Jasutkar[2] | Hiradas Lilhare[3]

[1]PG Student,Civil Engineering Department, Swaminarayan Siddhanta Institute Of Technology, Nagpur, Maharashtra, India
[2]Assistant Professor, Civil Engineering Department, Swaminarayan Siddhanta Institute Of Technology, Nagpur, Maharashtra, India
[3]Assistant Professor, Civil Engineering Department, Swaminarayan Siddhanta Institute Of Technology, Nagpur, Maharashtra, India
Corresponding Author Email ID: fmwadsa@gmail.com

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ABSTRACT

Air pollution is one of the biggest threats for the environment and affects everyone: humans, animals, crops, cities, forests, aquatic ecosystems. Air pollution is caused by the presence in the atmosphere of toxic substances, mainly produced by human activities, even though sometimes it can result from natural phenomena such as volcanic eruptions, dust storms and wildfires, also depleting the air quality.Various primary and secondary air pollutants are the reasons behind it which are formed by various stimuli. To overcome the threats various control technologies like cyclonic separation, various scrubbers, hydrodynamic separator etc were used. One more method bio-filtration is used which uses living micro or macro organisms to biodegrade waste or harmful constituents. Air pollutants can be removed by the process of bio filtration. Aim of the review paperis to use algae in air pollution control technique and determine its efficiency when coconut fibres were used as filter bed. Hydrogen sulphide was prepared by Kipp's apparatus. Filter bed of coconut coir was designed. Known concentration of hydrogen sulphide was passed through filter bed and concentration of passed air was measured by iodometric method. The collected algae were spread in filter bed. The known concentration of hydrogen sulphide was then passed through this filter bed consisting algae and passed air's final concentration was again determined.As photosynthetic organisms, algae convert water and CO2 into organic matter without excess energy and are an alternative source of bioenergy production and pollution reduction.

KEYWORDS-Algae, Air Pollution, Hydrogen sulphide, Iodometric method, Bio-filtration

1. INTRODUCTION

Photoautrophic organisms like algae can absorb some of the air pollutants. Algae produce over 71% of the earth's oxygen in the process of photosynthesis. Algae belong to organisms which are able to absorb CO_2, NO_2, SO_2 that are important nutrients for them. Algae such as **spirulina** which is capable of reducing the carbon-di-oxide (CO2), nitrogen dioxide (NO2) and sulfur dioxide (SO2) in the polluted air and generating oxygen.

Air pollution can be defined as an alteration of air quality that can be characterized by measurements of chemical, biological or physical pollutants in the air. Therefore, air pollution means the undesirable presence of impurities or the abnormal rise in the proportion of

some constituents of the atmosphere. It can be classified in 2 sections: **visible** and **invisible** air pollution.

Air pollution causes:

Air pollution is caused by the presence in the atmosphere of toxic substances, mainly produced by human activities, even though sometimes it can result from natural phenomena such as volcanic eruptions, dust storms and wildfires, also depleting the air quality.

Anthropogenic air pollution sources are:

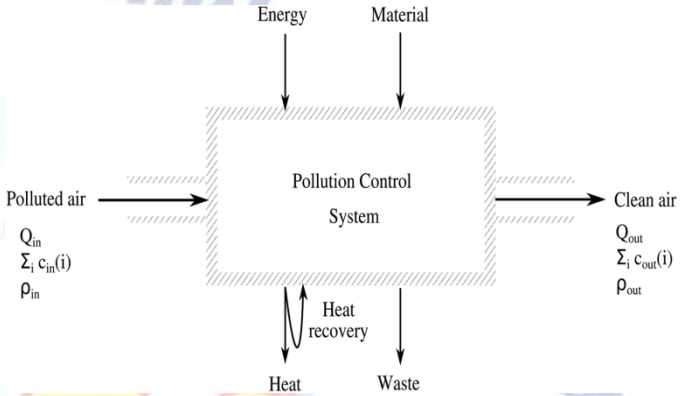
1.Combustion of fossil fuels, like coal and oil for electricity and road transport, producing air pollutants like nitrogen and sulfur dioxide

2.Emissions from industries and factories, releasing large amount of carbon monoxide, hydrocarbon, chemicals and organic compounds into the air

3.Agricultural activities, due to the use of pesticides, insecticides, and fertilizers that emit harmful chemicals

4.Waste production, mostly because of methane generation in landfills

Air pollution is growing day by day and it 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 sulphur dioxide, carbon monoxide, volatile organic compounds, chlorofluorocarbons CFCs etc or secondary like ozone, peroxyacytele nitrate (PAN). Each pollutant has its own threats to us, out of which some creates grave danger to human life. According to IS code 15200-2002 code of safety for hydrogen sulphide, when it exceeds the permissible limit of 10 ppm is fatally poisonous gas which affects respiratory tract, even causes skin irritations and eye itchiness. To check threats by pollutants various methods like absorption, adsorption, bio filtration etc are there. Biofiltration technique is one of most efficient technique which takes microorganisms in action to treat polluted air. This bio filtration technique has used bacteria and fungi in bio film. We have algae in tremendous quantity and these algae are very much efficient in capturing carbon dioxide and using that in their further growth. Algae's contribution in Oxygen concentration is very well known and appreciated. So why not to use algae for air pollution control technique? So aim of this project is to use these algae and observe if they can treat polluted air. For that we first need to produce known concentration of any pollutant. Hydrogen sulphide can be produced by Kipp's apparatus using sulphuric acid and ferrous sulphate (John wiley& sons, 1900). To know the concentration of produced hydrogen sulphide iodometric back titration method can be done. The bio filter bed can be produced using various material like wood chips, peat, plastic media of different shapes, glass etc. In this method, coconut fibre has been used to prepare filter bed. The algae were collected from local ponds and used for filtration.



Alage:

Algae encompasses a large and varied group of autotrophic, photosynthetic organisms most of which have a very simple structure. They occur as single-cells, multi-cells or also as giant kelps. They are considered simple, as most do not have the same types of cells as found in land plants with the most complex being seaweed. Algae are made up of eukaryotic organisms and have a nucleus within a membrane and plastids enclosed in one or more membranes.

Algae as a Biofuel:

A number of government agencies and companies are funding efforts to minimize operating and capital costs and make algae fuel production commercially viable. Attempts are being made to cultivate algae into large amounts for making bioethanol, biodiesel, biogasoline, biobutanol, biomethanol and other biofuels.

Benefits of algal fuels are:

- They can be cultivated with minimal impact on fresh water resources
- Can be produced using waste and ocean water
- Are biodegradable and harmless to the environment even if spilled

- Algae for Wastewater Treatment: The use of algae for wastewater treatment is more advantageous than conventional wastewater treatments. Some of the key benefits are:
- Economical – It is a cost-effective technique for the removal of phosphorus, nitrogen and pathogens when compared to sludge processes and other secondary treatment procedures.
- Low Energy Requirements – Conventional wastewater treatment processes involve aeration, which is energy intensive whereas, algae-based wastewater treatments produce oxygen that is needed for aerobic bacteria. Algae offers an efficient way for nutrient consumption and provide aerobic bacteria with oxygen through photosynthesis.
- Reductions in Sludge Formation – In traditional wastewater treatment facilities, the sludge obtained contains hazardous solid waste that finally finds its way to landfills. However, in algal wastewater treatment facilities, the resulting sludge with algal biomass has a large amount of energy that can be processed further to make fertilizers or biofuels. Algal technology does not use chemicals and the whole effluent treatment procedure is simple and results in minimum sludge formation.
- GHG Emission Reduction – According to the US EPA, conventional wastewater plants contribute significantly to greenhouse gases. Algae-based wastewater treatments release carbon dioxide but the consumption by algae is greater than what is released, making the whole system carbon negative.
- Production of Useful Algal Biomass – The algae biomass obtained is a source of biodiesel.

Photobioreactor or Algae Bioreactor:

A photobioreactor or an algae bioreactor is used to cultivate algae to produce biomass or fix carbon dioxide emissions. Algae bioreactors are used for the production of fuels such as bioethanol and biodiesel for the reduction of pollutants such as CO_2 and NOx in flue gases emitted from power plants. These photoreactors are based on the photosynthetic reaction performed by algae containing chlorophyll. With the help of sunlight and dissolved carbon dioxide, CO_2 is made accessible by dispersing it into the reactor.

Other Eco-friendly Application:

- Algae can be used for trapping fertilizers present in farm runoff. After harvesting they can be used as fertilizer.
- Since algae can grow in harsh conditions and do not require many nutrients they are cultivated in places that are not suitable for agricultural purposes therefore, they do not compete for arable land as well as use wastewater, not freshwater.
- Unlike row crops, algae does not depend on specific seasons. Algae can thrive wherever there are warm temperatures and plenty of sunlight.
- Algae is grown in seawater as well as in desert ponds. Algae can also grow in waste water and water containing phosphates, nitrates and other contaminants.
- Since algae is carbon neutral, it can help the environment by taking CO_2 from the air. Algae farms can be located near carbon producing refineries or power plants.

1.2 AIM & OBJECTIVE

The objective of the present study is to design the coconut filter bed in treating hydrogen sulphide gas. Also, to treat hydrogen sulphide gas by coconut fibre bed with wild algae.

2. LITERATURE REVIEW

In this section the literature meeting the goal of study i.e. application of algae in air pollution control technique is reviewed. Algae create more than 70% of oxygen by photosynthesis. Algae seem to have the capacity to ingest carbon dioxide, nitrogen dioxide and sulphur dioxide. Moreover carbon dioxide escalates their growth to further extent. Algae have more photosynthetic efficiency than plants and herbs so they are more able to catch carbon dioxide. Various plants discharges high rate of carbon dioxide like coal terminated plants. In this cases if we can incorporate algae in filtration media than we will be in side of benefit.

Research Summary-1

Studying the remarks by (Munoz et al, 2009) wastewater can be used as microalgae supplement and algal biomass could get the opportunity to be, soon, a budgetary and suitable material for specific removal of heavy metals from waste water. Vent gasses from various plants are

culprit for creating more than 7% of the aggregate world CO2 generation mechanical fumes gasses contains up to 15% CO2.

Research Summary-2

(Cheng et al. (2006)) concentrated on carbon dioxide expulsion from air by microalgae refined in a layer photograph bioreactor. He found that the photosynthetic CO2 obsession was unequivocally subject to the amassing of CO2 consistently gave amid the algal development. In light of study by KeiunKodo, YasumasaKodo, Makoto Tsuruoka(1998) a system for cleansing a sullied air by using green growth development, for instance, Spirulina is fit for decreasing carbon dioxide (CO2), nitrogen oxide (NOx) and/or sulfur oxide (SOx) in the dirtied air and creating oxygen. That is, this structure includes a general public tank stacked with a general public fluid including the green development, an air supply unit for convincing the polluted air into the lifestyle fluid to separate carbon dioxide and nitrogen oxide and/or sulphur oxide in the lifestyle fluid, and a lighting unit for radiating a light to the lifestyle fluid. By exuding the light to the lifestyle fluid in the region of carbon dioxide, photosynthesis of the green development is raised to change over carbon dioxide into oxygen. Besides, the green development uses the nitrogen oxide and/or sulphur oxide as a supplement in the midst of the photosynthesis. In this way, the present system can adequately refine the debased air to make a cleaner air, which is rich in oxygen.

Research Summary-3

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.

Research Summary-4

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.

Research Summary-5

YunesPanahi 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.

Research Summary-6

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.

Research Summary-7

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 CO2 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.

3. PROPOSED METHODOLOGY

3.1 SAMPLING COLLECTION

1. Wild Algae:

- Collection of algae: plastic bottle can be taken which was first de-chlorinated. Using the bottle algae was collected along with water. Algae were allowed to settle down when left overnight.
- The flasks petridishes all which is to be used when working with algae were sterilised using autoclave at 121oC for 15 min at 15 psi. And were allowed to cool (Atlas, 2010)
- The collected algae was sterilised too. And antifungal was then added about 1gm.
- The collected algae can be further divided to number of algal broths were nutrients can be provide for further growth of algae. The broth can be left for incubation in room temperature.

[Fig.3.1: algae collected in bottle]

2. Coconut Fibre:

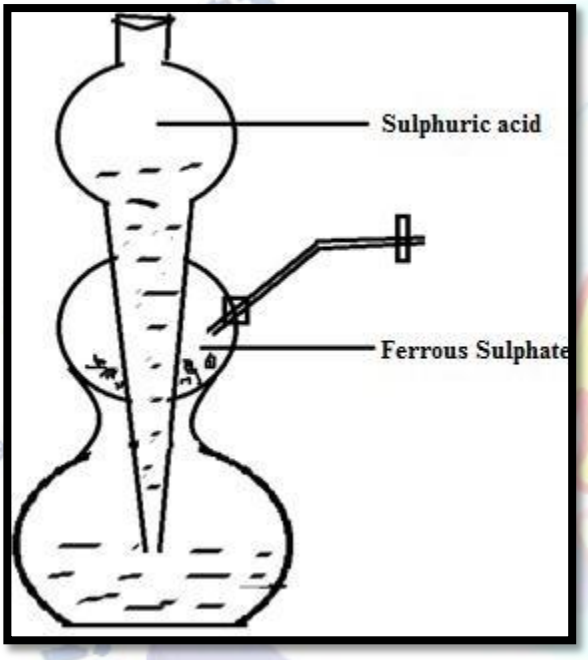
Coconut fibre is collected. The fibre (10-15cm) is given a proper shape when compressed.

[Fig.3.2: Collection of Coconut Fibre]

3.2 METHODOLOGY

1. Production of Hydrogen sulphide:

- Ferroussulphateis put in middle chamber.$2NH_2SO_4$ is used.To make $2NH_2SO_4$27.17 ml of pure H_2SO_4 is diluted to500ml.
- Stop cock is put in open condition then acid from bottom chamber which have travelled from top chamber goes to middle chamber and react with in and H_2S is generated
- And then stop cock is put in closed condition which creates pressure and stops there action.And no longer is H_2S produced.



[Fig.3.3: Kipp'sapparatus]

2. Determination of concentration of pollutant H_2S

- Flasks containing 30ml absorber i.e.cadmium chloride solution were taken
- H2s was passed through these absorber
- Sample was titrated with excess of potassium iodine solution. Reading is noted as A when yellow colour is achievd.End point is checked by HCl.
- After 10min it was back titrated with 0.025N sodium thio sulphate solution.colour disappeared and starch solution is used as indicator.
- Observations were noted in table 3.
- Hydrogen sulphide concentration is measured by equation. 1

$$concentration\ (ppm) = \frac{12400 * A * B}{c} \quad [1] H_2S$$

Where;

A=Volume of iodine solutionB=Normality of iodine solutionC=volume ofsample taken

3. Pollutant removal by filterbed with algae

- Filterbed which is wetted with nutrient is taken in laminar air flow chamber
- There freshly collected algae is placed in filterbed.
- H_2S is passed through the filter media i.e.flter bed with wild algae.
- It was left for1hour.
- Then the gas passed throughth is media is collected and passed through absorbing solution i.e.cadmium sulphate solution.
- And iodometric method is followed to find the concentration of hydrogen sulphide passed through filter media.

A.Pollutant removal efficiency calculation:

Removal efficiency is found out by equation 2 =

$$\eta\ (\%) = \frac{initial\ conc - final\ conc}{initial\ conc} * 100 \quad .....(2)$$

4. CONCLUSION

This review paper 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.

FUTURE SCOPE

Algae is highly beneficial in terms of its general usage as well as environmental applications. The days are not far away when we will live in buildings that will be beautifully enclosed in photosynthetic membranes and vertical gardens, harvesting solar energy, producing bioproducts and food for city dwellers. Imagine algae

systems that recycles waste into fuel, animal food and bio-fertilizers.

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Conflict of interest statement

Authors declare that they do not have any conflict of interest.

REFERENCES

[1] P.M. Ndegw, A.N. Hristov, J. Arogo , R.E. Sheffield,A review of ammonia emission mitigation techniques for concentrated animal feeding operations , March 2008.

[2] Maxwell B.Randa,DavidE.Cooper,Chee-Pan Woo Graham C.Fletcher,KevinA.Rolfe,Compost filters for H2S removal from anaerobic digestion and rendering exhausts. February 1981

[3] R.A. Pandey , S.N. Mudliar, S. Borgaokar National Environmental Engineering Research Institute, Nehru Marg, Nagpur 440 020, India, Treatment of waste gas containing diethyl disulphide (DEDS) in a bench scale bio-filter, February 2008.

[4] Harish, M. (2012). A study on air pollution by automobiles in Bangalore city.

[5] Kodo, K.Kodo, Y., &Tsuruoka, M. (2000) U.S Patent No. 6083,740. Washington, DC U.S Patent and trademark office.

[6] Pray, H. A., Schweickert, C. E., &Minnich, B. H. (1952). Solubility of hydrogen, oxygen, nitrogen, and helium in water at elevated temperatures. Industrial & Engineering Chemistry, 44(5), 1146-1151.

[7] Ra, S., &Rajendranb, S. Growth measurement technique of microalgae.

[8] Sumardiono, S., Budiyono, I. S., &Sasongko, S. B. (2014). Utilization of biogas as carbon dioxide provider for Spirulina platensis culture. Current Research Journal of Biological Sciences, 6(1), 53-59.

[9] Yen, H. W., Ho, S. H., Chen, C. Y., & Chang, J. S. (2015). CO2, NOx and SOx removal from flue gas via microalgae cultivation: A critical review. Biotechnology journal, 10(6), 829-839.

[10] Ra, S., &Rajendranb, S. Growth measurement technique of microalgae.

[11] Yen, H. W., Ho, S. H., Chen, C. Y., & Chang, J. S. (2015). CO2, NOx and SOx removal from flue gas via microalgae cultivation: A critical review. Biotechnology journal, 10(6), 829-839.