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MICRO-ALGAE AND ITS GOOD BENEFITS IN CHEMICAL PROCESS INDUSTRY EFFLUENTS TREATMENTS, TELANGANA STATE.

KEY WORDS: Bio monitoring, Industrial effluents, water characteristics, Heavy Water Plant

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ABSTRACT

The pollution status of the effluents from chemical process industry was studied qualitatively by using micro algae during a period of on year. The study of micro algae benefits observed has been calculated in the pilot scale laboratory and has been revalidated with similar applications cited. The influence of cyanobacteria on removal of oil and grease, sulphide, BOD, COD, and TDS was good. *Cladophora, Lyngbya* and *Scytonema* removed these pollutants up to 85 to 90%.

Introduction:

Water is essential for all living beings including plants for their existence. Water pollution is far most hazardous creating problem affecting our daily life in multiple dimensions. Industries release their effluents into the water bodies which may alter the physico chemical characters. The basic constituents which can pose a threat to the environment are mainly temperature, pH, Total Dissolved Solids (TDS), Hydrogen Sulphide (H_2S), Bio-chemical Oxygen Demand (BOD), Chemical Oxygen Demand (COD), Oil and Grease, Chloride (Cl^-) and Sulphate (SO_4), etc.

Biological treatment involves the transformation of minerals and non viable organics into biomass in specialized habitats supporting distinctive, yet complex communities of living organisms. Park *et al.* (1996) developed a single biological treatment system by using algal and kept species for the reduction of oil for effluents waters. The algal and bacterial growth with industrial waste waters was shown to be effective and of low cost for the removal of pollutants. The vast ecological role of cyanobacteria in flowing waters was studied by Loza *et al.* (2013), Sherwood *et al.* (2015) noted a large number of endemic cyanobacteria from Hawaii, indicating the need for more extensive sampling and descriptions to fully characterize the cyanobacteria. and also By incorporating algal system into converting waste water has potential to improve the water quality of effluent by reducing nutrients and metal load into fresh water ecosystems. Several unique features of cyanobacteria were studied such as oxygenic photosynthesis, high biomass yield, growth on non-arable lands and a wide variety of water sources (contaminated and polluted waters), generation of useful by-products and bio-fuels, enhancing the soil fertility and reducing green house gas emissions, (Singh et al., 2016).Mass cellular of algae in waste water significantly contribute to management of fresh ecosystem by providing more environmentally sound approach to reduce eutrophication potential of point source of human wastes than is achieved by current treatment practices.

There was growing world wide interest in development of efficient treatment methods for industrial wastes, concurrently with the need for alternative source of protein and water.

Pilot Experimental Work :

The three algal species, *Cladophora*, *Lyngbya*, and Scytonema *were* collected in nearby aquatic system and cultured and preserved in the laboratory. Five plastic containers were taken and five liters of pond water was amended with 0.1, 0.2, 0.3, 0.4 and 0.5 % of oil. Immediately algal culture transferred into plastic containers and incubated out side for 15 days. After incubation time, chlorophyl content and protein contents were estimated in the algal species and the percentage of oil removal was calculated.

Results and Discussions:

Based on pilot plant observation and results validating above data good practice plants have been cited below. The samples analysis comparison at one of the Heavy Water Plants at Manuguru have been validated. The influence of micro algae on the removal of oil and grease was studied in 15 days of incubation period and results are reported in tables 8.1-8.3.

The oil and grease concentration (table –8.1) susbstantially decreased with the growth of *Cladophora*. A gradual reduction in total chlorophyll content was found while increasing oil concentration. The protein content was also seen decreasing with increase in oil concentration. The total chlorophyll was 1.3 mg/g in 0.1% oil while it was 0 mg/g in 0.5% in oil amendment. The protein content was found ranging from zero to 1.35 mg/g. The percentage reduction of oil and grease was 40 initially while it was 0 when 0.5% oil was added.

The substantial decreased the growth of *Lyngbya* was observed on the increase in oil and grease concentration. Similarly a gradual reduction in total chlorophyll content and protein content also decreased. The total chlorophyll content was 1.221 mg/g in 0.1% oil while it was 0.3 mg/g in 0.5% oil amendment. The protein content ranged from 1.5 to 0.2 mg/g in 0.1% and 0.5% oil. At 0.1% of oil and grease concentration the removal by Lyngbya was 35% and it reduced drastically when the concentration of oil and grease was increased up to 0.5%.(Table -8.2).

when oil and grease concentration was increased the substantial decrease in the growth of *Scytonema* was observed. Similarly appreciable reduction in total chlorophyll and protein contents was noticed when oil was added. The total chlorophyll content was 1.009 mg/g in 0.1% oil and it was 0.0284 mg/g in 0.5% oil amendment. The protein content was found ranging from 1.5 mg/g to 0.22 mg/g in 0.1% oil respectively. The percentage reduction of oil and grease content was 20 initially and 0 when 0.5% of oil was added (Table – 8.3)

TABLE -8.1: INFLUENCE OF *CLADOPHORA* ON EFFLUENT WITH OIL AND GREASE AFTER 15 DAYS OF INCUBATION

Oil & Grease concentration	Growth	Total Chlorophyll content (mg/g)	Protein content (mg/g)	Percent reduction of oil & grease
Control	3+	1.319	1.50	-
0.1%	2+	0.680	1.35	40%
0.2%	2+	0.521	0.85	30%
0.3%	1+	0.310	0.50	20%
0.4%	1+	0.058	0.25	10%
0.5%	0	0.000	0.00	0%

TABLE – 8.2: INFLUENCE OF *LYNGBYA* ON EFFLUENT WITH OIL AND GREASE AFTER 15 DAYS OF INCUBATION

Oil & Grease concentration	Growth	Total Chlorophyll content (mg/g)	Protein content (mg/g)	Percent reduction of oil &
Control	4+	1.513	1.75	-
0.1%	3+	1.221	1.50	35%
0.2%	3+	0.956	1.20	20%
0.3%	2+	0.828	0.81	15%
0.4%	2+	0.619	0.50	10%
0.5%	1+	0.305	0.20	0%

TABLE – 8.3: INFLUENCE OF *SCYTONEMA* ON EFFLUENT WITH OIL AND GREASE AFTER 15 DAYS OF INCUBATION

Oil & Grease concentration	Growth	Total Chlorophyll content (mg/g)	Protein content (mg/g)	Percent reduction of oil & grease
Control	4+	1.075	1.8	-
0.1%	3+	1.009	1.5	20%
0.2%	3+	0.097	1.1	10%
0.3%	2+	0.061	0.85	5%
0.4%	2+	0.044	0.61	0%
0.5%	1+	0.028	0.22	0%

The treatment of *Cladophora* on the improvement of effluent quality was studied and reported during 30 days of incubation. The BOD levels continually decreased over 10 to 30 days and 100% decrease was noted in 30 days of incubation. The COD levels were decreased substantially and reduced 93% at its last incubation. The sulphide levels were reduced to 300 ppm in 30 days of incubation with 92% removal. The TDS levels were removed by 80% in 30 days of incubation. The oil and grease levels were reduced 50% in 10 days of incubation and a 100% in 30 days of incubation (Table – 8.7).

The treatment with *Lyngbya* for the improvement of effluent quality was studied and reported during 30 days of incubation. The oil and grease levels were observed to be reduced 50% in 10 days of incubation. The TDS level was observed 5 ppm in the last incubation giving 90% reduction in TDS level. Similarly the sulphide level was reduced 1500 ppm, 1000 ppm and 300 ppm after 10, 20 and 30 days of incubation and giving 88% sulphide removal. COD level was noticed to be completely removed after last day of incubation giving 100% removal efficiency in 30 days. BOD levels were reduced substantially and 100% removal was observed in the last days of incubation (Table – 8.8).

From Table – 8.9, it was noted that BOD levels were decreased from 10 to 30 days of incubation by *Scytonema* that was used to improve the effluent quality. The BOD was thus observed to be 80% decreased in 30 days. COD levels were substantially decreased and reduced to 90% at its last incubation. The sulphide levels were reduced to 1500 ppm, 1000 ppm and 200 ppm in 10, 20 and 30 days of incubation giving 92% removal efficiency after the last incubation. The TDS levels were noticed to be completely removed in the last incubation. Oil and grease levels were reduced to 63% in 10 days, 88% in 20 days and 100% removal was observed in the last incubation.

TABLE – 8.4: TREATMENT EFFICIENCY BY USING *CLADOPHORA* ON EFFLUENT WATER OF CHEMICAL PROCESS PLANT AT MANUGURU

Parameter	Days of incubation				Percent removal after last incubation
	0	10	20	30	
BOD (ppm)	08 - 10	07	05	0	100%
COD (ppm)	20 - 30	18	07	2	93%
Sulphide S- - (ppm)	2000 - 2500	1500	1000	300	88%
TDS (ppm)	40 - 50	30	20	10	80%
Oil & Grease (ppm)	06 - 08	4	2	0	100%

TABLE –8.5: TREATMENT EFFICIENCY BY USING *LYNGBYA* ON EFFLUENT WATER OF CHEMICAL PROCESS PLANT AT MANUGURU

Parameter	Days of incubation				Percent removal after last incubation
	0	10	20	30	
BOD (ppm)	08 - 10	06	04	00	100%
COD (ppm)	20 – 30	10	05	00	100%
Sulphide S- - (ppm)	2000 - 2500	1500	1000	300	88%
TDS (ppm)	40 – 50	20	10	05	90%
Oil & Grease (ppm)	06 - 08	04	02	00	100%

Table – 8.6: TREATMENT EFFICIENCY BY USING *SCYTONEMA* ON EFFLUENT WATER OF CHEMICAL PROCESS PLANT AT MANUGURU

Parameter	Days of incubation				Percent removal after last incubation
	0	10	20	30	
BOD (ppm)	08 - 10	06	04	02	80%
COD (ppm)	20 – 30	15	10	03	90%
Sulphide S- - (ppm)	2000 – 2500	1500	1000	200	92%
TDS (ppm)	40 – 50	30	15	00	100%
Oil & Grease (ppm)	06 - 08	03	01	00	100%

DISCUSSION:

The rationale for the use of algae and bacteria serves as a criterion of pond operation and may be used as a guideline for the changes required increasing algal growth and improving effluent quality. Oran *et al*. (1979) established beneficial relationship between high rate algae pond and with aerobic bacteria. The patterns of algal biomass and related bacterial biomass are assessed in the present study in relation to the contaminant concentration. Soeder (1976) reported the removal of contaminants during their low concentrations by algal and bacterial genera.

Shelef *et al* . (1978) visualized the following assumptions with the reduction in contaminants by microscopic organisms; (1). Uniform distribution of suspended organisms in the effluent under continuous mixing, (2). Negligible evaporation and seeping loses. (3). No nutrient efficiency with the pond. It can be stated that under favourable operating conditions with high algal productivity the reduction level can be substantially reduced. Organic and inorganic substances which are released into the environment as a result of domestic, agricultural and industrial water activities lead to organic and inorganic pollution (Mouchet, 1986; Lim et al., 2010

Patterson and James (1985) studied the reduction levels of oil in effluents treated with different microscopic algal species. Park *et al.* (1996) developed a single biological treatment system by using algal and kept species for the reduction of oil for effluents waters. Abdel-Raouf *et al.*(2012) studied the role of micro algae in industrial waste water treatment.

The microbial communities in industrial wastewater bioreactors can be used as model systems to study the evolution of new metabolic pathways in natural ecosystems. Jou and Huang (2003) investigated that biological treatment processes are economical and efficient methods that can be used for treating waste water from oil industry. A large amount of waste discharged from eight largest industries such as oil, cement, textile, steel, pulp and paper, tannery, and distillery industries includes a variety of gaseous, liquid, and solid waste, which persist for long period of time into the environment and causes serious threats to the environment, human, animal and as well as plants (Chandra and Chaudhary, 2013).

CONCLUSION:

The use of micro algae provides good biological agents for removal of oil and grease. The efficiency of these biological organisms was observed high when the oil concentration was low. The biological organisms were also capable in reduction of BOD, COD, TDS and sulphides and the efficiency was increased with retention time. This is simply a pilot scale experimentation designed and organized in the controlled conditions. The large scale application of micro-algae for the treatment of large volumes of industrial effluents is possible only after redesigning the experiment and optimizing the conditions for its application.

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References:

1. Abdel-Raouf. N., Al-Homaidan, A.A., and Ibraheem. I.B.M., (2012) Microalgae and wastewater treatment. Saudi J Biol Sci. 19: 257–275.
2. Chandra R and Chaudhary S. (2013). Persistent organic pollutants in environment and health hazards. Int. J. Bioassays 2(09): 1232–1238
3. Jou, C.I.G. and G.C. Huang (2003). A pilot study for oil refinery waste water treatment using a fixed film bioreactor, Adv. Environ. Res. 7: 463-469.
4. Lim S., Chu W., Phang S. Use of Chlorella vulgaris for bioremediation of textile wastewater. J. Bioresour. Technol. 2010;101:7314–7322. [PubMed]
5. Loza V, Perona E, Mateo P (2013) Molecular fi ngerprinting of cyanobacteria from river biofi lms as a water quality monitoring tool. Appl Environ Microbiol 79:1459–1472
6. Mouchet P. Algal reactions to mineral and organic micropollutants, ecological consequences and possibilities for industrial scale application; a review. Water Res. 1986;20:399–412.
7. Oron, G. Gideon., G. Shelef, A. Lavi, A. Meyden and Y. Azov (1979). Algae/Bacteria ratio in high rate ponds used for waste treatment. Applied and Environemental Microbiology.38:570-576.
8. Patterson,S., and W. James (1985). Industrial Wastewater Treatment. Stoneham , MA.Butterworth Publishers. Inc : 277-281.
9. Park, T.I, K.H. Lee, D.S. Kun and C.W. Kun (1996). Petrochemical waste water treatment with aerated submerged fixed-film reactor (ASFFR) under high organic loading rate. Water Sc., Teehool. 34:9-16.
10. Soeder, C.J. (1976). Zur Verwendung Von Microalgen fuer Ernachrings Zwecke.Naturewise senschaftro. 63: 121-138.
11. Shelef, G., R. Moraine, and G.Oron (1978).Animal feed Protiens and water for irrigation from algal Ponds. Water Poll. Control. 11:281-294.
12. Sherwood AR, Carlile AL, Vaccarino MA et al (2015) Characterization of Hawaiian freshwater and terrestrial cyanobacteria reveals high diversity and numerous putative endemics. Phycol Res 63:85–92
13. Singh JS, Kumar A, Rai AN and Singh DP (2016). Cyanobacteria: a precious bio-resource in agriculture, ecosystem and environmental sustainability. Frontiers in Microbiology, 7: 529