

**International Journal of Innovative Research in Science, Engineering and
Technology**

An ISO 3297: 2007 Certified Organization, Volume 2, Special Issue 1, December 2013

Proceedings of International Conference on Energy and Environment-2013 (ICEE 2013)

On 12th to 14th December Organized by

Department of Civil Engineering and Mechanical Engineering of Rajiv Gandhi Institute of Technology, Kottayam, Kerala, India

WASTE WATER TREATMENT BY ALGAE

Arya Krishnan, Anand Lali Neera

Government Engineering College, Thrissur, Kerala, India

Government Engineering College Thrissur, Thrissur, Kerala, India

Abstract: As many research works are going on in the field of wastewater treatment, a newly developed wastewater treatment by algae is gaining much importance. The algae selected for the study was Oedogonium and Chara sp. Various parameters like Biological oxygen demand (BOD), Chemical oxygen demand (COD), Ammonia Nitrogen and Phosphate were observed after the treatment. Percentage reduction rate of 59.61(BOD), 53.97 (COD) were observed. This is an environmentally safe alternative for treating wastewater.

1.INTRODUCTION

Waste water treatment is gaining much importance in recent years with the intension of reusing it. For the treatment of wastewater large amount of materials are to be supplemented. Nutrient rich wastewater instead of discharging into environment is supplemented for the growth of algae in the wastewater treatment. Thus nutrients can be reused and wastewater can be treated and thus reducing the negative impacts. As the algae takes up N and P, the wastewater can be treated with algae. This paper explains wastewater treatment by macroalgal species.

2.Materials and methods

2.1. Selection of algae

For the present study freshwater algae such as Oedogonium and Chara was taken. Oedogonium was collected from Vadakechira where as Chara was taken from Kanimangalam Sasta temple pond, Thrissur. Algae of suitable amount was collected in cans and washed thoroughly with tap water and placed in the respective set up for the experimental study. Algal species were identified at Botany laboratory, Thrissur.

2.2. Selection of wastewater

Wastewater chosen was rice mill wastewater which contains N and P. Experiments were performed under laboratory based batch conditions since algae shows high growth rates over the batch growth period. The rice mill wastewater was collected from Nambiyattukudy agro mills, Perumbavoor, Ernakulam. Synthetic wastewater whose characteristics were similar to rice mill wastewater was used in the study for optimizing the parameters[1]. The composition of this synthetic wastewater was given in Table 1. The optimum conditions obtained were applied for the treatment of natural wastewater. The characteristics of synthetic and natural ricemill wastewater was given in Table 2.

Table 1:-Composition of Synthetic wastewater

Compound	Concentration
Sodium acetate trihydrate (mg/l)	8000
D Glucose anhydrate (mg/l)	8000
Kaolin (mg/l)	266
Ammonium Chloride (mg/l)	2000
Disodium hydrogen phosphate (mg/l)	200
Potassium dihydrogen phosphate (mg/l)	200

Parameter	Unit	Characteristics of Synthetic waste water	Characteristics of natural waste water
pH	-	6.68	7.6
TDS	mg/l	5430	780
Turbidity	NTU	268	42
BOD	mg/l	1200	424.4
COD	mg/l	2480	1160
Ammonia Nitrogen	mg/l	134	14.7
Phosphate	mg/l	88	34

Table 2:-Characteristics of wastewater

2.3 Procedure

The synthetic wastewater of about 5 litres was fed into the feed tank and by gravity it was fed into the rectangular reactor of 35 x 25 x 18 cm size. The reactor was operated at room temperature. Each algae of initial dosage 60 g was fed to the reactor. Then the operating parameters

were varied to find the optimum condition [2].

2.4. Optimization of number of days

The synthetic wastewater was fed to the reactor containing 60 g of each algae. No pH adjustment was made. Then at each day samples were collected and analysed for the various parameters like pH, TDS, Turbidity, BOD, COD, Ammonia Nitrogen and Phosphate.

2.5 Optimization of pH

After optimizing number of days, the pH of synthetic wastewater was varied. The synthetic wastewater with different pH was fed to the reactor with 60 g of each algae. The selected pH were 4, 5, 6, 7 and 8. The samples collected after the optimized day were analysed for the various parameters.

2.6 Varying algal species

Oedogonium and Chara algae of 60 g each were taken separately for treating with synthetic wastewater. Combination of algal species of 60 g were also taken for the study simultaneously.

2.6.1 With aeration

After fixing optimum days and pH the synthetic wastewater was treated with Oedogonium and Chara algae separately of 60 g. Aeration of 9 l/min has been provided. The samples were analysed after treatment. The same has been repeated with the combination of algal species.

2.6.2 Without Aeration

After fixing optimum number of days and pH treatment of algae with synthetic wastewater has been carried out without aeration. Here also combination of algal species has been taken for the treatment. Similarly individual algal species also has been taken for the treatment [3]. Samples after treatment has been taken for the analysis of the parameters.

2.7 Varying algal dosage

The synthetic wastewater was treated with algal species of varying dosage after optimizing number of days and pH. Aeration has been provided. 20, 40, 60, 80, 120 and 140g of each algal species were taken for the study. The samples collected after treatment were analysed for the various parameters.

3. Results and discussion

The treatment of synthetic rice mill wastewater with algae was studied with varying conditions and the optimum has been finalized for doing with natural wastewater. Performance of Oedogonium and Chara algae for the treatment of synthetic wastewater was first carried out.

Table 4. Percentage removal of different parameters with time (in days)

Parameters	Time in DAYS									
	1st	2nd	3rd	4th	5th	6th	7th	8th	9th	10th
TDS,mg/l	20.63	22.65	29.48	18.42	26.7	28.55	74.22	42.91	42.36	42.08
Turbidity,NTU	6.34	14.55	19.03	20.89	25.37	37.31	39.93	22.39	21.64	16.79
BOD, mg/l	19.93	43.79	51.88	55.82	65.67	72.33	80.82	63.33	62.95	61.38
COD,mg/l	21.89	41.57	47.22	48.39	50	79.03	82.26	16.13	15.32	13.02
Ammonia Nitrogen, mg/l	12.54	23.73	32.98	36.79	45.22	46.87	47.76	28.51	24.1	15.29
Phosphate, mg/l	29.55	37.5	45.45	52.27	54.55	100	100	100	100	100

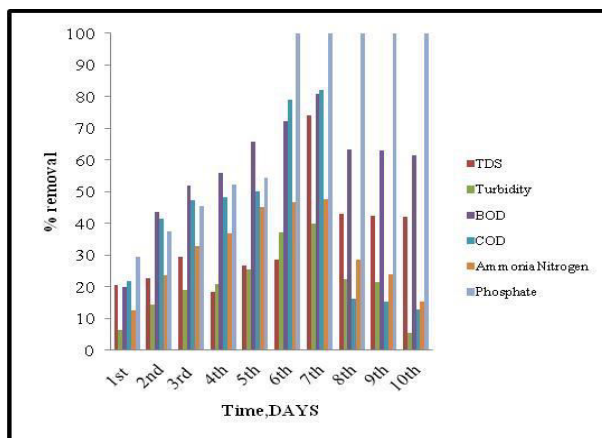


Figure 1. Percentage removal of parameters with time

As the number of days get increased the removal efficiency of various characteristics also get increased. At seventh day the removal of TDS, Turbidity, COD, BOD and Ammonia Nitrogen was found to be maximum. But with Phosphate maximum removal was found to be at the sixth day. BOD removal of 80.82%, COD of 82.26%, TDS of 74.22%, Ammonia Nitrogen of 47.76%, Turbidity of 39.93% was obtained at the seventh day whereas 100% removal of Phosphate was obtained at the sixth day and as the days goes on increasing, the removal capacity of algae decreases. After 7th day algae degradation starts and it may have caused a decrease in the removal rate.

Table 5. Variation of different parameters with different pH

Parameters	4	5	6	7	8
TDS, mg/l	16.76	26.21	51.75	81.39	80.98
Turbidity, NTU	6.72	13.06	26.87	40.29	34.7
BOD, mg/l	17.07	42.47	49.89	68.49	52.25
COD, mg/l	16.13	19.35	40.32	58.06	47.58
Ammonia Nitrogen, mg/l	46.12	50.67	53.51	56.42	53.73
Phosphate, mg/l	42.05	48.86	63.64	71.59	70.45

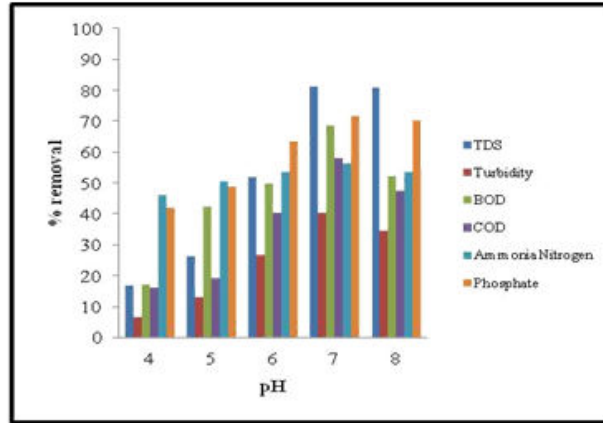


Figure 2. Variation of different parameters with different pH

As pH changed from acidic to alkaline the removal efficiency got increased and maximum removal has been obtained at pH 7. Afterwards, as the pH was again made alkaline, i.e. at pH 8, there was not much increase in the removal rate and a slight decrease in the values has been found. Most of the biological reactions occur at neutral pH [5] and the algae grown water also shows pH 6.8 and it was the condition prevailing for the better growth of algae.

Table 6. Percentage removal of parameters with combination of algal species and with aeration

Parameters	% removal
	combination of Oedogonium and Chara
TDS, mg/l	81.39
Turbidity, NTU	13.06
BOD, mg/l	68.49
COD, mg/l	58.06
Ammonia Nitrogen, mg/l	56.42
Phosphate, mg/l	71.59

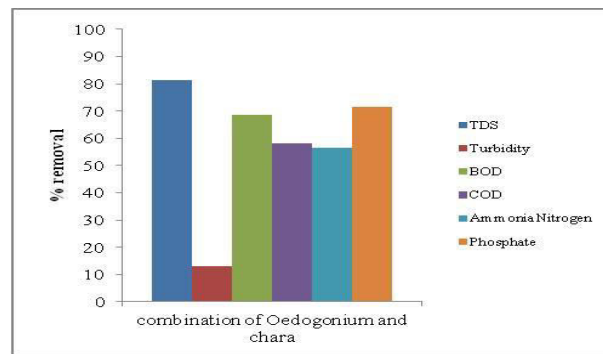


Figure 3. Percentage removal of parameters with combination of algal species and with aeration

Percentage removal of 81.39% TDS, 71.59 % Phosphate, 68.49 %BOD, 58.06% COD, 56.42% Ammonia Nitrogen, 13.06% Turbidity were obtained. Since algae is an aerobic organism and require oxygen for their survival and additional aeration rate of 9 l/min will remove parameters from wastewater than without providing aeration [4]. In anaerobic conditions it cannot survive.

Table 7. Percentage removal of parameters with varying algal dosage

% removal	% removal with varying dosage of algae					
	20 g	40g	60g	80g	120 g	140 g
TDS,mg/l	44	81	81	40	16	11
Turbidity, NTU	41	63	13	26	22	4
Ammonia Nitrogen, mg/l	41	61	56	47	48	42
Phosphate , mg/l	38	72	71	0	0	0
BOD, mg/l	12	69	68	44	24	0
COD, mg/l	12	59	58	14	5	0

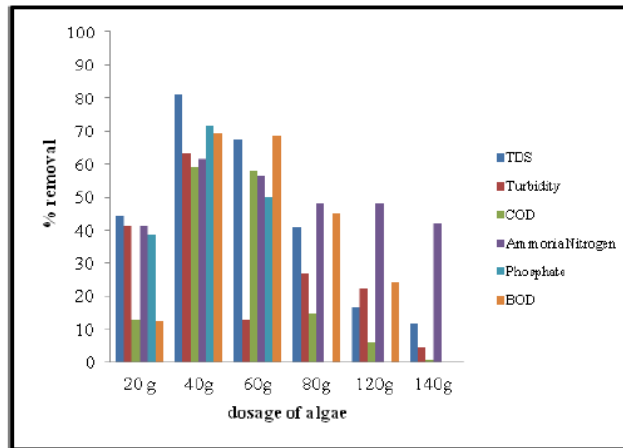


Figure 4. Percentage removal of parameters with varying algal dosage

4. NATURAL WASTEWATER TREATMENT

Natural wastewater of 5 litres was collected from Nambiyattukudy agro mills, Perumbavoor, Ernakulam. Parameters checked and results are compared with control and represented below.

Table 8. Percentage removal of parameters in natural wastewater

Parameters	% removal	
	with algae	without algae (control)
TDS, mg/l	54.12	10.35
Turbidity, NTU	93.07	28.05
BOD, mg/l	78.64	35.53
COD, mg/l	53.97	27.78
Ammonia Nitrogen, mg/l	47.12	25.54
Phosphate, mg/l	77.33	26.67

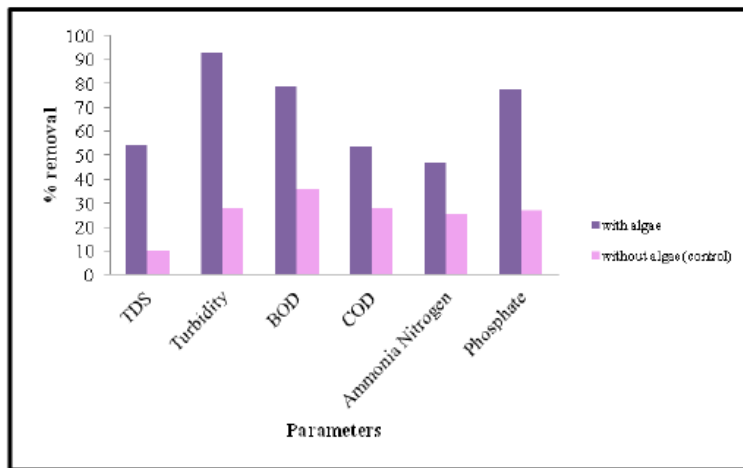


Figure 5. Percentage removal of parameters in natural wastewater

Total volume of 5 litres of natural ricemill wastewater taken under optimum conditions of retention time 7 days, pH 7, combination of algae with aeration, 40 g algal dosage shows removal of 54.12% TDS, 93.07% Turbidity, 78.64% BOD, 53.97% COD, 47.12% Ammonia Nitrogen, 77.33% Phosphate.

5. CONCLUSION

Synthetic wastewater treatment using algal species has been done with varying conditions and it was optimized. Natural wastewater treatment with the optimized conditions of retention time 7 days, pH 7, combination of algae with aeration, 40 g algal dosages was carried out and removal of 54.12% TDS, 93.07% Turbidity, 78.64% BOD, 53.97% COD, 47.12% Ammonia Nitrogen, 77.33% Phosphate were

obtained. Since some of the parameters are not within the limit, post treatment has to be provided.

REFERENCES

- [1] Deviram GVNS et al. " Purification of wastewater Using algal species". European Journal of Experimental Biology, 1(3):216-222, 2011.
- [2] Karin Larsdotter. "Wastewater treatment with microalgae". Vatten 62:31-38, 2006.
- [3] J.B.K. Park et al. Bioresource Technology 102: 35- 42, 2011.
- [3] Hong-Ying HU et al. "Domestic wastewater reclamation coupled with Biofuel: A Novel wastewater treatment process in the future". Journal of Water and Environment Technology, 9(2), 2011.
- [4] Monica C.Rothermel."Coupling the wastewater treatment process with an algal photobioreactor for nutrient removal and renewable resource production", University of Pittsburgh, 2011.