MACROPHYTIC TREATMENT OF TEXTILE WASTE WATER TOGETHER WITH ROOT ZONE TECHNIQUE

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Abstract - *Textile industry is one of the largest industrial sectors in India. For the working of textile industry they consumes large amount of water for coloring, bleaching, sizing etc. Thus high amount of waste water is released from such industries. The effluent from these industries contain highly poisonous chemicals and dyes. So before discharging they should be treated. Macrophytic treatment method is a new emerging technology for the treatment of such industrial effluents. Biological treatment of waste water is highly efficient method for detoxification and also it does not causes further pollution. Water hyacinth is a troublesome weed in India which is having high production rate. Root zone technique is another biological treatment method. Here in this paper macrophytic treatment system is coupled with the root zone system. This study is used to evaluate the most suitable treatment method for textile waste water. Optimization study should be done for macrophytic treatment system i.e., optimum pH, dilution and contact time. Finally the treated water from root zone is also analyzed after treatment.*

Key Words: **Water hyacinth, macrophytic waste water treatment, root zone system**

1. INTRODUCTION

Water is the essential source of life on the earth as we need water in every walk of life on one side, on other side polluted water can be lethal for existing life. Water pollution is the contamination of water bodies (e.g. lakes, rivers, oceans, aquifers and groundwater). This form of environmental degradation occurs when pollutants are directly or indirectly discharged into water bodies without adequate treatment to remove harmful compounds. Different physical and chemical methods used for this purpose suffer from serious limitations like high cost, intensive labour, alteration of soil properties and disturbance of soil native microflora. Phytoremediation is the name of a set of technologies that use plants to degrade, extract, or contain contaminants from soil and water [2]. The textile industrial sector is one of the most important and largest industrial sectors in India. Among various industries, textile industry ranks first in usage of dyes for adding colors to the fibers such as cotton; animal fibers such as wool and silk; and a wide range of synthetic materials such as nylon, polyester, and acrylics. Textile industries consume a large volume of water and chemicals for making various textile goods and as a result, large volume of effluent discharged on land with or without treatments [3]. Aquatic macrophytes are reported to be more effective in wastewater treatment in comparison to terrestrial plants because of their faster growth, larger biomass production, relative higher capability of pollutant uptake, and better purification effects due to direct contact with contaminated water [4]. In this study the textile waste water is treated successfully by using macrophytic treatment along with root zone technique. The macrophyte used for treatment are water hyacinth (Eichornia crassippes). In root zone treatment the plant used are marigold.

2. MATERIALS AND METHODS

In the study the textile effluent is treated with aquatic macrophyte water hyacinth with a retention period of 24 hours. The physico chemical parameters such as pH, alkalinity, turbidity, conductivity, BOD, COD and dissolved oxygen are analyzed before and after treatment. To get maximum efficiency to the treatment optimum values of process parameters like concentration, pH and contact time of waste water should be determined. To check the validity of the optimization a verification experiment were done with the optimized process parameters. For further purification of the waste water root zone is established. The treated water is given to the root zone system with a detention period of 24 hours. Also checked the physico chemical parameters of treated water from root zone.

2.1 Selection of macrophyte

The plants suitable for macrophytic waste water treatment are selected based on its characteristics. The root of the plants should provide habitat for growth of microorganisms. Rhizosphere of the plants is considered as the important section of aquatic macrophytes. Growth rate of plants should be high and also have high tolerance to pollutants. So that it can survive the adverse conditions. Water hyacinth is such a macrophyte which have the capacity to tolerate any adverse conditions. It have high absorption capacity and growth rate is also very high.

2.2 Collection of water samples

For the present study the textile industry effluent is collected from Narayani textiles Pvt. Ltd, Kannur, Kerala. The collected effluent samples were stored in the refrigerator for analyzing the parameters such as pH, alkalinity, conductivity, BOD, COD and dissolved oxygen.

3. EXPERIMENTAL SETUP

3.1 Macrophytic waste water treatment system

This system having three simple plastic tank of 5L capacity which is filled with the waste water and aquatic macrophyte water hyacinth. For the treatment the water hyacinth is collected, cleaned and stored in another tank and introduced into experimental tank while testing. Same amount of water hyacinth is filled in each 3 plastic tanks. The waste water is kept in the experimental tank for 24 hours and parameters are analyzed. Optimization study were conducted with various process parameters such as dilution (25%, 50%, and 75%), pH (6, 7, and 8) and contact time (1, 2, 3, 4, 5, 6, 7 days). Then the experiment is continued with the optimum concentration, pH and contact time. Aquatic macrophytic treatment system is a floating treatment wetland method. It consists flooded treatment basin with macrophytes with thick mat of roots and rhizomes.

Fig. 1 Treatment of textile waste water by using water hyacinth

3.2 Root zone system

In root zone method the waste water is treated through a filter media along with phyto remediation. In this set up a plastic bucket with filter media act as phyto remediation chamber. Phyto remediation bed is provided with an outlet pipe to collect the treated water. This system is provided in the open air with horizontal water flow. The lower part of bucket was filled with gravel of size ranging between 2.5 cm-3 cm up to height of 15cm from bottom of bucket. Another layer of sand was filled up to height of 15cm and soil was filled over sand layer up to height of 20cm. To prevent leakage from outlet tap it was sealed with M-seal. The collected water is analyzed in the laboratory. Marigold flower species are planted in the bucket for aesthetic appearance. The treated water from Macrophytic waste water treatment system are introduced in the root zone system. After 24hr the parameters are analyzed. This system is subsurface flow wetland with vertical flow. Effluent moves vertically from top layer down through substrate and out.

Fig. 2 Root zone system with marigold plant

4. RESULTS AND DISCUSSION

4.1 Normal treatment without optimization

At first the textile waste water is treated with water hyacinth to remove pollutants from water without any optimization. The results of the study are given in following section.

Table 1 Effect of normal treatment without optimization

Parameters	Before treatment	After treatment	Percentage removal (%)
pH	11.65	10.11	-
Conductivity(µs/cm)	3812	1402	63.22
Alkalinity(mg/l)	820	173	78.90
DO(mg/l)	4.3	8.8	-
BOD(mg/l)	550	220	60
COD(mg/l)	1600	660	58.75

Fig 3 Treated textile waste water after normal treatment

After normal treatment without any optimization the percentage removal efficiency of various parameters such as conductivity, alkalinity, BOD and COD are 63.22, 78.90, 60, 58.75%.

4.1 Effect of Ph

To study the effect of pH add acid or base to the textile waste water in order to change the pH. pH was adjusted by using 0.1 M NaOH and 0.1 M HCl. Experiment is conducted by different pH values such as 6, 7, and 8 with optimum dilution and 24 Hr detention period.

Table 2 Percentage removal efficiency with pH optimization

Parameters	Percentage removal (%)		
	pH		
	6	7	8
Conductivity(μs/cm)	55.92	60.38	71.93
Alkalinity(mg/l)	76.21	78.04	78.65
BOD(mg/l)	70.54	71.63	76
COD(mg/l)	63	72	81

The results show that percentage removal is lower at pH 6, 7 than pH 8. Maximum removal efficiency is at pH 8. Hence the optimum pH found in this study for maximum removal of various parameters is 8.

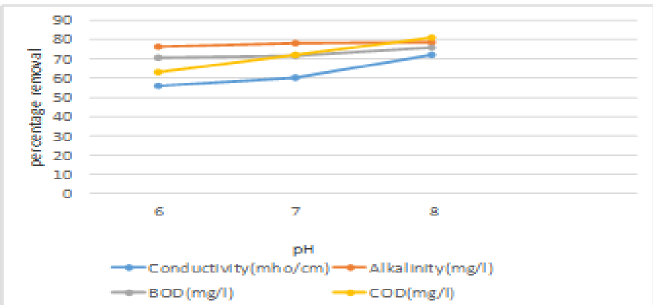

Chart -1 Percentage removal efficiency of various parameters against pH

4.2 Effect of dilution

To study the effect of dilution on waste water treatment, carrying out the experiment with different dilutions of waste water with 24 Hr detention period. Collected samples are treating with different dilutions such as 25%, 50%, and 75%. For 25% dilution 2.5L waste water is taken and make the volume up to 10L by using distilled water. Similarly studying the effect of 50%, and 75% by diluting with waste water and optimum values are calculated.

Table 3 Percentage removal efficiency of various parameters with optimum pH and dilution

Parameters	Percentage removal (%)		
	Dilution		
	25%	50%	75%
Conductivity(μs/cm)	58.77	44.56	38.66
Alkalinity(mg/l)	43.75	40.24	39.01
BOD(mg/l)	68.75	52.94	38.88
COD(mg/l)	58.40	44.11	40.64

The results revealed that maximum percentage removal of various parameters are at a dilution of 25% waste water. Hence optimum dilution is 25%.

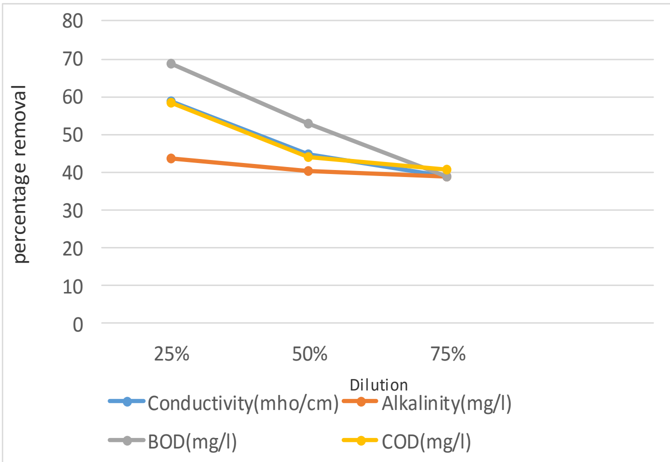

Chart -2 Percentage removal efficiency of various parameters with optimum pH and dilution

4.3 Effect of contact time

To study the effect of contact time three 5L containers with macrophytes and a blank is prepared.

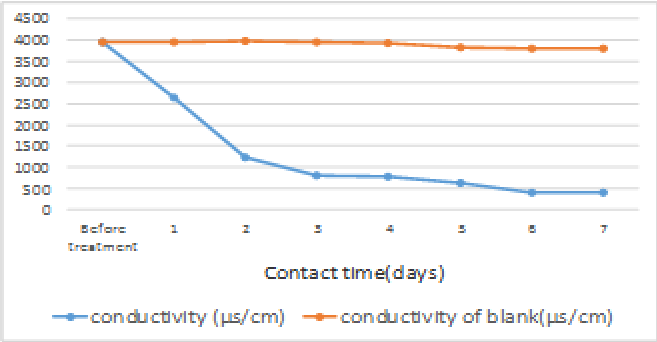

Chart -3 Variation of conductivity with optimum pH and dilution for blank and treated water

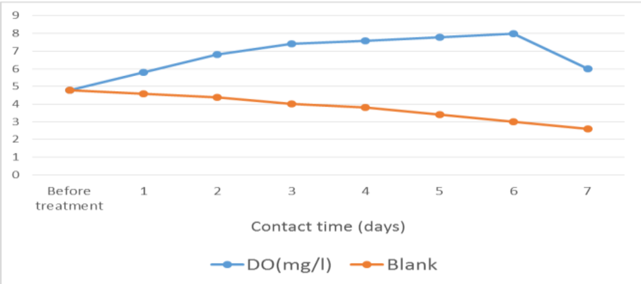

Chart -4 Variation of DO with optimum pH and dilution for blank and treated water

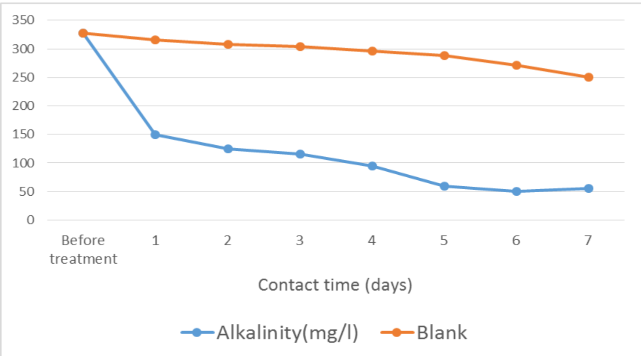

Chart -5 Variation of alkalinity with optimum pH and dilution for blank and treated water

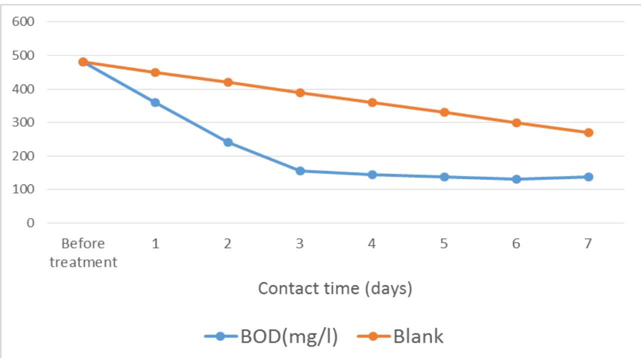

Chart -6 Variation of BOD with optimum pH and dilution for blank and treated water

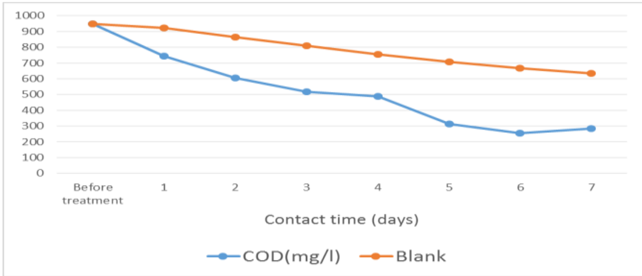

Chart -7 Variation of COD with optimum pH and dilution for blank and treated water

The graphs shows that reduction of various parameters is very high for treated water than blank with time.

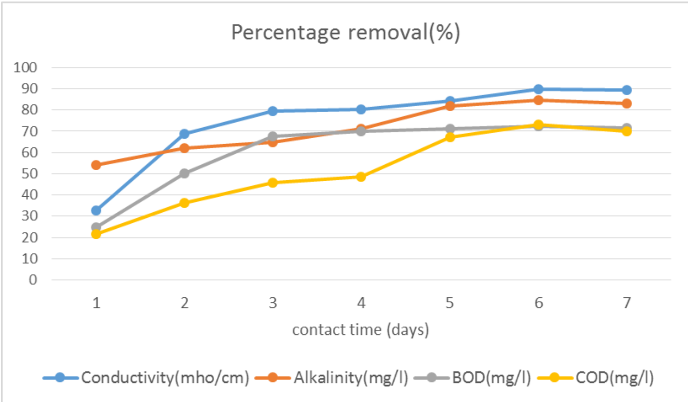

Chart -8 Percentage removal efficiency of various parameters

The results show that maximum removal efficiency of various parameters is at a contact time of 6 days. Hence the optimum contact time is 6 days.

4.4 Verification test

A verification test is conducted with the optimum pH 8, optimum dilution 25% and contact time of 6 days. The table 4 represents the variation of various parameters during the verification experiment. During the verification test the removal efficiency of conductivity, alkalinity, BOD and COD is 86.89, 89.32, 73.33, 83.33 % respectively.

Table 4. Effect of treatment with optimization

Parameters	Before treatment	After treatment	Percentage removal (%)
Conductivity(µs/cm)	3990	523	86.89
Alkalinity(mg/l)	515	55	89.32
DO(mg/l)	4.6	8.8	-
BOD(mg/l)	450	120	73.33
COD(mg/l)	1200	200	83.33

4.5 Root Zone treatment system

Table 5 Effect of root zone system

Parameters	Raw effluent	Root zone treatment	Percentage removal (%)
Conductivity(µs/cm)	3990	201	94.96
Alkalinity(mg/l)	515	32	93.78
DO(mg/l)	4.6	10	-
BOD(mg/l)	450	24	94.66
COD(mg/l)	1200	80	93.33

Fig 12 Untreated textile effluent and treated water from macrophytic and root zone system

The treated water from the macrophytic treatment system is given to a root zone system. Here also a reduction in various parameters occurs. The Conductivity reduces from 523 to 201 µs/cm. alkalinity reduces from 55 to 32 mg/l which is within the land discharge limit. BOD reduces from 120 to 24 mg/l. COD reduces from 200 to 80 mg/l which is also within the land discharge limit. Color of the sample reduces from macrophytic system to root zone system and it is analyzed by visual comparison method. Untreated water have dark greenish color. This dark colored water changes to yellowish colored after macrophytic treatment. Further treatment of this water in root zone system makes the water colorless. From fig. 12 its clear that color of the solution goes reduces from untreated to macrophytic system to root zone system.

Table 6 Variation of parameters of raw effluent treated water from root zone

Parameters	Before treatment	After treatment	Percentage removal (%)
Conductivity(µs/cm)	523	201	61.56
Alkalinity(mg/l)	55	32	41.81
DO(mg/l)	8.8	10	-
BOD(mg/l)	120	24	80
COD(mg/l)	200	80	60

Thus for the combination of the macrophytic and root zone system reduces the pollutants drastically. Thus the treatment of textile waste water with combined macrophytic and root zone system will reduce the parameters efficiently. The treated water from root zone system will not affect the ground water.

3. CONCLUSION

In this study analyzed the ability of the macrophyte water hyacinth to degrade the contaminants of textile industry effluent. Textile waste water contain huge amount of inorganic and organic pollutants. Water hyacinths have the ability uptake the pollutants and convert into less dangerous substance. Here the study is conducted with various pH, dilution and contact time. Maximum percentage reduction of various parameters such as conductivity, alkalinity, BOD and COD are occurred at a pH 8, dilution 25% and contact time of 6 days. The maximum percentage reduction of parameters such as conductivity, alkalinity, BOD and COD by applying the optimum values are 86.89, 89.32, 73.33, 83.33%. By coupling the root zone method with macrophytic system, increases treatment efficiency. Percentage reduction of parameters such as conductivity, alkalinity, BOD and COD of treated water from root zone are 61.56, 41.81, 80, 60%. Removal efficiency of parameters conductivity, alkalinity, BOD and COD from raw effluent to root zone are 94.96, 93.78, 94.66 and 93.33%. Thus combination of macrophytic and root zone system is highly efficient treatment method.

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