Research Article

Efficacy and Effective Treatment of Textile Industry Effluent Using Synthesized Activated Carbon of *Tribulus terrestris*

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ABSTRACT

In general, textile waste water contains high concentrations of organic compounds, heavy metals, high temperature, high COD, high pH, suspended particles, non-biodegradable materials and strong color (Environmental Engineering Association of Thailand). Activated carbon has been widely used for the removal of various organic and inorganic pollutants in wastewater or gaseous media because of its large surface area and high adsorption capacity. *Tribulus terrestris* is a fruit-producing Mediterranean plant that's covered with spines. It is also called puncture vine. People use the fruit, leaf, or root of the *Tribulus terrestris* plant as medicine. The plant *Tribulus terrestris* was collected and chemical modified carbon was synthesized from *Tribulus terrestris* and activated carbon prepared by using muffle burner from chemical modified carbon. The column was prepared for dye removal using by the activated carbon and inactivated carbon. The effluents were filtered and feeding the effluents by using packed activated and inactivated carbon and the chemical parameters were analyzed before and after treated samples. The effectiveness of activated and inactivated carbon was compared for filtration of effluent. The *Tribulus terrestris* activated carbon also inhibit the microorganisms in the wastewater of Textile Industry.

Keywords: Activated carbon, pH, BOD, COD, TDS, TS, TSS.

INTRODUCTION

Effluents from textile industry is a major cause of water pollution. In general, textile wastewater contain high concentrations of organic compounds, heavy metals, high temperature, high COD, high pH, suspended particles, non biodegradable materials and strong color[1]. Textile wastewater is once a source of pollution, which could have effects on the ecology and environmental[2].

There are many methods of effluent treatment such as, ion exchange[3], Coagulation and flocculation[4], oxidation[5], reverse osmosis[6], biological decolonization[7]and adsorption[8] to reduce pH, color and TDS from textile effluent, among them use of coagulants has been applied conventionally or mostly in Bangladesh.

Activated carbon possess unique properties when compared to other class of organic substance. It contains substantial quantity of adsorbed oxygen and hydrogen. Activated carbon has been widely used for the removal of various organic and inorganic pollutants in wastewater or gaseous media because of its large surface area and high adsorption capacity[9]. Activated carbon has proven to remove or adsorb large amount of bacteria like *pseudomonas aeruginosa* and *Escherichia coli* from fresh and potable water systems[10].

Tribulus terrestris, is also known as Gokshura, Puncture Vine, Caltrop, Yellow Vine, Goat head, devil's horn. *Tribulus terrestris* is native to sub-Himalayan forests of India, Burma, and several other countries. The parts of the plant are known to be used as traditional herbal medicine to treat various ailments such as kidney infection, impotence, cancer[11] and fruits of the herb have antihypertensive[12] activity. *Tribulus terrestris* is beneficial for a variety of things such as low water maintenance capacity, hair fall, rheumatic pain, headache/stress, weak nervous system, obesity, menstruation, bed wetting, piles and eye problems.

Water pollution has become a rising concern over the last century due to the rapid growth in population, urbanization and industrialization. One of the principal causes of water pollution is due to the disposal of large amounts of industrial wastes into the water bodies without sufficient misuse management systems.

In particular, remediation of industrial wastes, such as dyes and phenolic compounds, have raised wide concerns from the scientific community and public alike, because of their toxicity carcinogenic, mutagenic properties and poor biodegradability[13]. Synthetic dyes are one of the largest contributors to environmental pollution due to the express development in textile, plastics, pharmaceutical, food and cosmetic industries[14]. Synthetic dyes which are highly colored and visible can affect the photosynthetic function in aquatic life due to diminution in light diffusion and therefore affecting the food chains.

One of the most important challenges that occur worldwide is the rapid increase in water expenditure due to population growth, urbanization and industrialization. Daily, the water resources are contaminated by industrial effluents, and this affect both the quality of ecosystems and the health of all living forms[15]. One of the most applicable categories of environmental pollutants is the one caused by dyes, which are present in large amount in the wastewater from various industrial activities such as textile, dying, tanner, pulp and paper, paint and pigments[16].

1) Anionic dyes, such as azine, triphenylmethane, anthraquinone, nitroso, and xanthene, are utilized for silk, modified acrylics, nylon, wool, etc.

2) Cationic dyes, such as crystal violet, methylene blue, and amaranth, are utilized for modified nylons, polyesters, paper, polyacrylonitrile, and in medicines[17]. Also, dyes can be categorized according to the chemical composition (chromophore) or based on their applications.

There are several methods to remove the dye molecules from dye-polluted water. These technologies can be separated into three categories: physical, chemical, and biological treatments[18].

The production process of activated carbon is mainly divided into three steps, dehydration, carbonization, and activation. Dehydration is a drying process for removal of moisture from raw material and during carbonization organics contained in raw material are changed into primary carbon, which is a mixture of amorphous and crystallized carbon, tar, and ash. Activation, which is the main step in the process, is generally carried out in two ways, gas activation and chemical activation. Gas activation is a physical process in which raw material passes through carbonization at a low temperature and is activated usually by CO_2, water steam, and air[19].

MATERIALS AND METHODS

This study was involved that treatment of textile industry wastewater using synthesized Activated and inactivated Carbon of *Tribulus terrestris*

Collection of *Tribulus terrestris*

Tribulus terrestris collected from in and around the Erode district, Tamil Nadu, India. All the parts of the weed were washed thoroughly with water for several times to remove earthy matter, dust and other foreign impurities. It was cut into small pieces, dried in sunlight until all the moisture was evaporated. The dried material was ground in a domestic blender to a coarse powder. The powdered biomass was stored in an airtight plastic container and used for the preparation of Activated carbon.

Collection of Effluents

The textile wastewater was obtained from the textile dyeing factory in and around the Erode and Tirupur District, Tamil Nadu, India. The wastewater was collected in polyethylene bottles which were stored in refrigerator before experiments and treatments. A total of 5 industrial effluents sample was collected.

Preparation of Carbon

Tribulus terrestris Activated Carbon (TTAC) was prepared by mixing of raw powder with excess of Sulphuric acid solution. Charring of the materials occurred immediately with evolution of fumes and heat in both the cases. When the reaction subsided, the whole reaction mixture was placed in an oven maintained at 120- 140ºC for a period of 24 hours.

Activated carbon preparation

The final mixture was filtered and repeatedly washed with distilled water to remove excess presence of free acid residues. The washed material was dried at 110ºC, and finally activated at 700ºC using muffle Furner.

Making column for dye removal using by the Activated and In-activated carbon

A column experiment was set up in order to test and compare two different filter materials-Activated carbon and inactivated carbon for the reduction of organic matter, calcium, magnesium, carbonate, bicarbonate, hardness, TDS, pH, COD and BOD in Effluents. The two columns were filled with some bottom gravel, sponge and the main filter material (sand and Activated carbon) and some top gravel (sponge and stones). The physical properties of the filters were recorded and then the effluents application phase and chemical analysis started.

Feeding of the Effluents

Effluent was fed from morning until evening with a daily load of different samples. The room temperature in the laboratory was between 20 and 21^{0}C. The samples were fed using a petroleum pump. The samples were poured evenly over the top gravel surface of the filters. Accumulation of water drops inside the column wall was to be avoided, but still occurred to a certain extent. In order to observe clogging where the accumulation of pollutants will reduce the Activated and inactivated carbon in the filters and start of outflow from the filters was collected in the conical flasks or bottles.

After and Before sample - Chemical Analysis

Samples of the inflow and outflow were collected for the chemical analysis. Samples of the inflow effluents were taken and stored in the fridge in order to be analyzed after the feeding event together with the outflow samples. Chemical parameters were determined before and after samples; pH, TDS, calcium, magnesium, carbonate, bicarbonate, hardness, TS, TSS, COD and BOD.

RESULTS AND DISCUSSION

The weed plant was collected from in and around Erode District, Tamil Nadu, India. The Chemical modified carbon was synthesized from *Tribulus terrestris* and the activated carbon was prepared using muffle burner from chemical modified carbon. The filtrate column was prepared for dye removal using by the activated carbon. The effluents were filtrated by using packed activated and inactivated carbon.

The chemical parameters were analyzed before and after treatment.

Dye removal of an industrial effluent by using activated and inactivated carbon

Table 1: Result of Effluent water sample – I – Before and After treatment

S.NO	Parameters	Before Treatment	After treatment	
			Activated carbon treatment	Inactivated carbon treatment
1.	OD VALUE	1.2±0.1	0.65±0.02	0.81±0.02
2.	Ph	8±0.2	6.3±0.1	7.033±0.305
3.	TOTAL HARDNESS (mg/l)	520±2	208±1	442±2
4.	CALCIUM (mg/l)	210±1	78±2	182±1
5.	MAGNESIUM (mg/l)	310±2	130±2	260±1
6.	BICARBONATE (mg/l)	260±1	52±1	130±2
7.	CARBONATE (mg/l)	130±2	52±2	78±1
8.	TS (gm)	10.5±0.1	1.3±0.1	1.8±0.1
9.	TDS (ppm)	2050±1	1750±1	1878±2
10.	TSS (gm)	0.4±0.2	0.02±0.01	0.35±0.02
11.	BOD (mg/l)	321±1	212.8±0.1	221.76±0.01
12.	COD (mg/l)	800±2	610.3±0.1	720±1

Table 2: Result of Effluent water sample – II – Before and After treatment

S.NO	Parameters	Before Treatment	After treatment	
			Activated carbon treatment	Inactivated carbon treatment
1.	OD VALUE	1.72±0.01	0.65±0.01	1.13±0.02
2.	pH	12.2±0.2	7.5±0.2	8.4±0.1
3.	TOTAL HARDNESS (mg/l)	1140±1	266±1	608±1
4.	CALCIUM (mg/l)	50±2	114±2	380±2
5.	MAGNESIUM (mg/l)	190±1	153±1	228±1
6.	BICARBONATE (mg/l)	950±1	76±2	152±2
7.	CARBONATE (mg/l)	798±1	228±2	266±1
8.	TS (gm)	2.4±0.2	0.4±0.2	0.6±0.2
9.	TDS (ppm)	2450±1	1990±1	2270±1
10.	TSS (gm)	0.25±0.01	0.13±0.01	0.19±0.01
11.	BOD (mg/l)	316±2	201.6±0.1	210.56±0.01
12.	COD (mg/l)	840±1	720±1	800±2

Table 3: Result of Effluent water sample – III – Before and After treatment

S.NO	Parameters	Before Treatment	After treatment	
			Activated carbon treatment	Inactivated carbon treatment
1.	OD VALUE	0.65±0.01	0.11±0.01	0.42±0.01
2.	pH	9.2±0.1	8.2±0.1	8.7±0.2
3.	TOTAL HARDNESS (mg/l)	240±2	120±1	150.3333±1.527
4.	CALCIUM (mg/l)	135±1	60±2	90±2
5.	MAGNESIUM (mg/l)	105±1	60±1	60±1
6.	BICARBONATE (mg/l)	225±1	15±2	50±1
7.	CARBONATE (mg/l)	150±2	45±1	120±1
8.	TS (gm)	31.8±0.1	9.8±0.1	9.9±0.1
9.	TDS (ppm)	2530±2	2240±1	2380±2
10.	TSS (gm)	0.09±0.01	0.03±0.02	0.06±0.01
11.	BOD (mg/l)	124.8±0.1	22.4±0.1	89.6±0.1
12.	COD (mg/l)	420±2	120±2	320±1

Table 4: Result of Effluent water sample – IV – Before and After treatment

S.NO	Parameters	Before treatment	After treatment	
			Activated carbon treatment	Inactivated carbon treatment
1.	OD VALUE	0.74±0.02	0.55±0.01	0.68±0.01
2.	pH	9.6±0.1	7.8±0.1	8.4±0.1
3.	TOTAL HARDNESS (mg/l)	144±1	88±1	96±1
4.	CALCIUM (mg/l)	96±1	48±1	56±1
5.	MAGNESIUM (mg/l)	48±1	40±1	40±2
6.	BICARBONATE (mg/l)	80±1	40±1	48±2
7.	CARBONATE (mg/l)	160±1	80±1	120±1
8.	TS (gm)	11.9±0.1	4.35±0.01	7.35±0.01
9.	TDS (ppm)	1000±2	939±1	989±1
10.	TSS (gm)	0.28±0.01	0.05±0.02	0.23±0.02
11.	BOD (mg/l)	150.6±0.1	78.4±0.2	123.2±0.2
12.	COD (mg/l)	440±2	320±1	360±1

Table 5: Result of Effluent sample – V – Before and After treatment

S.NO	Parameters	Before treatment	After treatment	
			Activated carbon treatment	Inactivated carbon treatment
1.	OD VALUE	1.98±0.01	1.51±0.01	1.69±0.02
2.	pH	13±0.1	6.8±0.1	8.2±0.2
3.	TOTAL HARDNESS (mg/l)	420±1	210±1	270±1
4.	CALCIUM (mg/l)	300±1	150±1	240±1
5.	MAGNESIUM (mg/l)	120±1	60±1	30±1
6.	BICARBONATE (mg/l)	180±1	60±2	80±2
7.	CARBONATE (mg/l)	300±2	120±1	240±2
8.	TS (gm)	31.9±0.1	14.5±0.2	18.4±0.2
9.	TDS (ppm)	2720±1	1260±1	2520±2
10.	TSS (gm)	1.52±0.01	1.36±0.01	1.47±0.01
11.	BOD (mg/l)	176.8±0.1	123.2±0.1	161.28±0.01
12.	COD (mg/l)	880±1	600±2	720±1

SUMMARY AND CONCLUSION

Water pollution is a major global problem. It has been suggested that water pollution is the leading worldwide cause of death and diseases. Some plants have additional systems to remove nutrients and pathogens. Industries that generate wastewater with high concentrations of organic matter, toxic pollutants or nutrients such as ammonia, need specialized treatment systems.

In the present study of investigation the activated carbon prepared from *Tribulus terrestris*, the textile industry samples collected from in and around Tirupur and Erode District.

The samples were treated with prepared activated and inactivated carbon. Treated processes have been shown to be the most effective method for the removal of contaminants from the effluent.

Activated carbon obtained from *Tribulus terrestris* carbon effectively its used for this study showed significant performance in the reduction of color, pH, TDS, TS, TSS, bicarbonate, carbonate, calcium, magnesium, BOD and COD from the waste water sample.

As a result of this study, the activated and inactivated carbon was prepared from *Tribulus terrestris* can be used as an effective treatment for the removal of Effluents from wastewater.

Most of the literature reported on the removal of effluents characteristics by using activated carbon. The *Tribulus terrestris* is a weed and also it is a medicinal plant and it used as antimicrobial, antioxidant, antibacterial agent.

From this study it may be concluded that the utilization of activated carbon prepared from *Tribulus terrestris* in a column system for effective treatment of wastewater contaminated with Effluents.

Thus the *Tribulus terrestris* activated carbon also inhibit the microorganisms in the wastewater of Textile Industry. So we concluded that the activated carbon of *Tribulus terrestris* helps to treat the effluent of textile waste water.

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