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Treatment of Textile Wastewater with Activated Carbon Produced from Plum Seed Shell

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Abstract

This study demonstrates that activated carbon produced from plum seed shells is an effective adsorbent for treating highly polluted textile wastewater from the Wandwin area. The raw effluent was strongly alkaline (pH 12.4) and contained elevated colour, TSS, TDS, COD (1280 mg/L), and BOD; pH was corrected using alum coagulants prior to adsorption. Using an equilibrium activated carbon concentration with Ce = 50 mg/L, COD was dramatically reduced to 20 mg/L, and removal efficiencies for other parameters ranged between 74.94% and 99.29%. Adsorption data fit the Langmuir isotherm well (R^2 = 0.97832), indicating monolayer adsorption and a strong affinity between pollutants and the plum seed shell carbon. The treated effluent met Myanmar's National Environmental Quality Guideline (NEQG) across all measured parameters, supporting the conclusion that plum seed shell activated carbon is both effective and sustainable for textile wastewater remediation. The research may contribute to civil, enviromental engineering and related domains.

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A. Introduction

The wastes includes solid waste and wastewater. One of the wastes, textile wastewater is disposed by textile industry, which is situated in Wandwin. Therefore, daily generating of wastewater is increased depending on production processes. The textile wastewater presents physical impurities and chemical impurities. In this research, the daily discharge of textile industry is about 3000 gallons per day in dying processes. Daily generation of wastewater contains high concentration of parameters. Therefore, textile wasteawter must be treated before disposing. The treatment process included coagulation and flocculation, absorbent filter medium that is plum seed shell activated carbon.

B. Research Method

The methodology of this study is as shown flow chart of the study in figure 1.

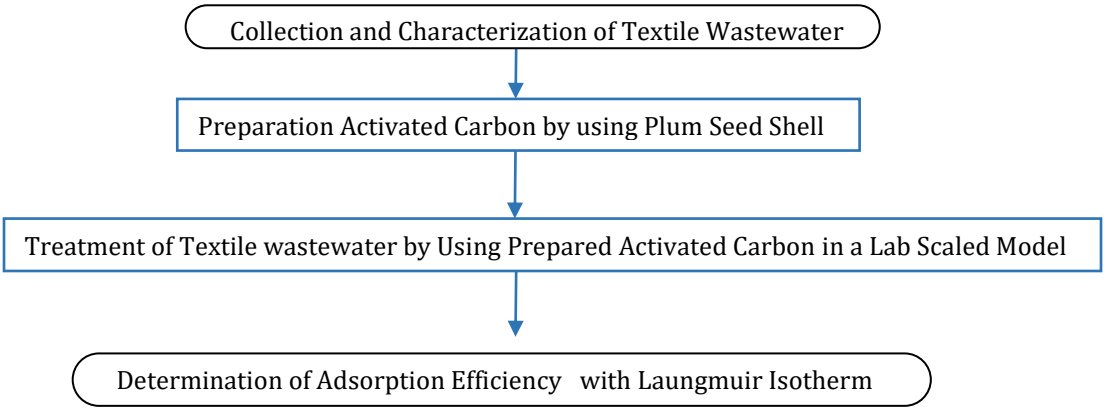

Figure 1. Flow Chart of the Study

B.1. Collection of Textile Wastewater

The methodology of this study is as shown flow chart of the study in figure 1. First step is collection and charaterization of textile wastwawter, second step is preparation activated carbon by using plum seed shells, third step is treatment of textile wastewater by using prepared activated carbon ina lab scaled model and final step is determination of adsorption efficiency with Langmuir isotherm.

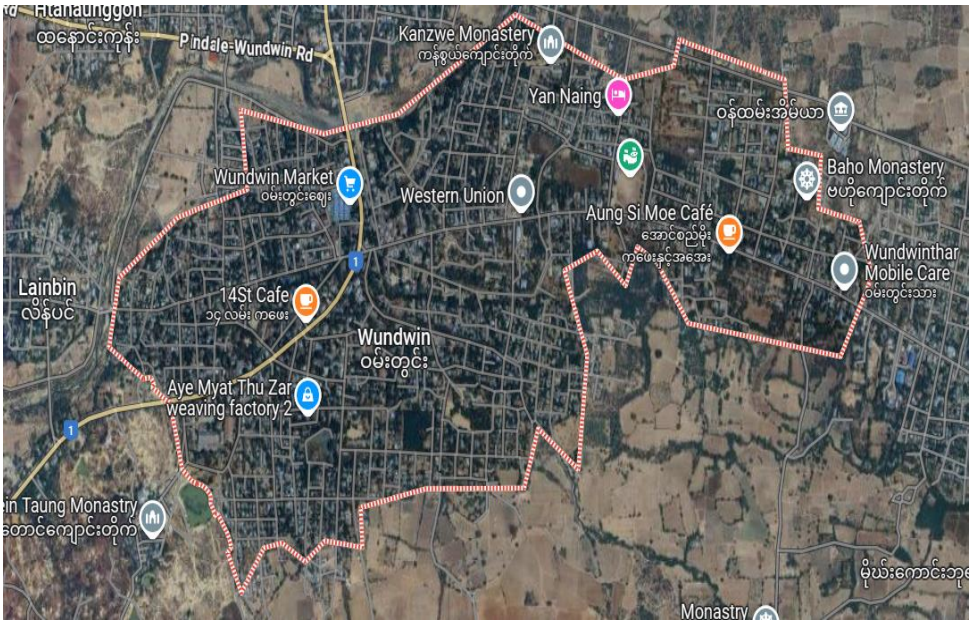

Figure 2. The Location of Study Area

i. Characterization of Textile Wastewater

In textile industry, the dyeing processes include desizing, scouring, bleaching, mercerizing and dyeing. And then, textile wastewater parameters such as pH, colour, TSS, TDS, COD, and BOD are determined concentrations in Environmental Engineering Laboratory of Yangon Technological University. Textile wastewater quality compared with the value of National Enviromental Quality Guidelines Myanmar (NEQG)[4]. The concentration of textile wastewater parameters are shown in table I.

Table 1. Comparison of Concentration of Textile Wastewater with NEQG Values

Sr.No.	Parameters	Effluent of Textile Wastewater	Maximum Limit of Textile Effluent Value (NEQG guideline)
1.	pH	12.4	6 – 9
2.	Colour(TCU)	2000	
3.	Total Suspended Solids(mg/l)	11000	50
4.	Total Dissolved Solids(mg/l)	4208	80-110
5.	Chemical Oxygen Demand (COD)(mg/l)	1970	160
6.	Biochemical Oxygen Demond (BOD)(mg/l)	800	30

pH value leads to alikaline and that must be reduced to the limits of NEQG values. The total suspended solids is 11000 mg/l that is more than about 220 times of maximum limit of textile effluent value of NEQG Myanmar. Similarly, the concentration of total dissolved solids, COD and BOD values are situated over 42%,

10% and 8 % the maximum limit of NEQG values. Directly discharged of textile wastewater is impact to environment and emviromental resources pollution. Therefore, textile wastewater is treated by using activated carbon in this study.

ii. Preparation of Plum Seed Shell Activated Carbon

In central Myanmar, plums are grown in various soil . The plum jam, juice and plum seeds produces the plum seed shells, which are solids wastes from these production processes. These solid wastes are typically used as natural fertilizer, as a substitute for charcoal, or burned as fuel for production of fried potatoes snacks, among other uses. In this study, the solid wastes plum seed shells are converted into activated carbon and used in the textile wastewater treatment processes.

iii. Carbonization of Plum Seed Shell

First, the plum seed shells are washed with water. They are then dried in sunray 2 to 3 days and placed in muffle furnace 1 hr at 500°C [6]. The processes of clean and dried process , carbonization of plum seed shells and using activator such as sulphuric acid and preparing steps are shown in figure 3.

iv. Activation of Carbonize Plum Seed Shell

The surface area of plum seed shells naturally has some shrinkage, which may help filter suspended solids in wastewater. The carbonized plum seed shells were immersed in various normalities of concentrated sulphuric acid(H_2SO_4) as an activator. The activating agent was applied at sample-to-activator ratios of1:2,1:3 and 1:4, with the activation process carried out over 24 hours. After activation, the immersed carbon is cleaned with distilled water to reach pH level 6 to 7 and that are placed in oven 30 minutes at 100°C.

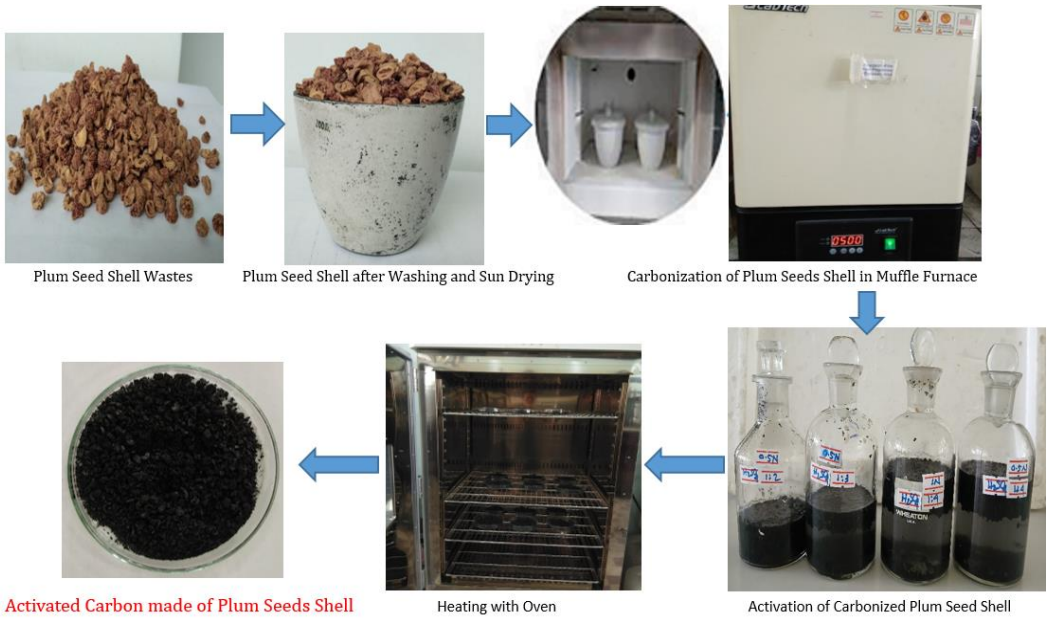

Figure 3. Preparation of Plum Seeds Shell Activated Carbon

Carbonization and activation processs of plum seed shell are described in table 2. Preliminary adsorption tests are conducted on activated carbon using four

different activated carbon samples AC_1 to AC_4. The selection of the best activator is based on several normality 0.5N,1N and 2N of H_2SO_4 and weight ratio of activation is 1:2, 1:3 and 1:4 respectively. The total porosity and surface area of activated carbon is using Scanning Electron Microscope (SEM) test results is presented in figure 4. According to test results, the best activator is AC_4 . The surface porosity area from SEM results is shown in table 2.

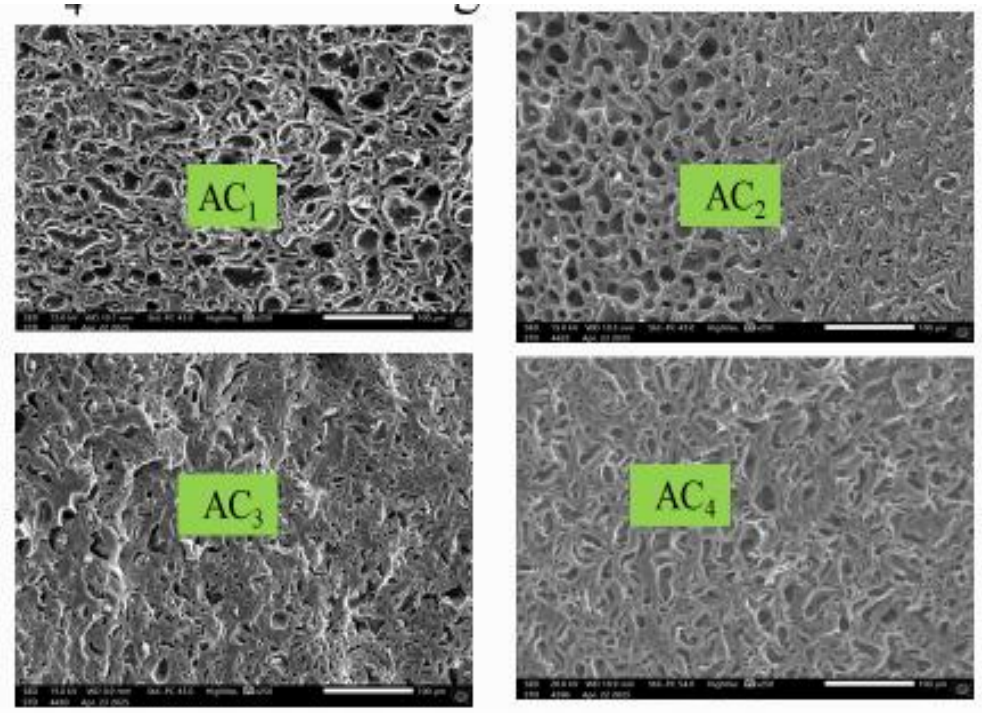

Figure 4. SEM Results of Surface Area for AC_1, AC_2, AC_3 and AC_4

Table 2. Carbonization, Actvation and Area of Porosity for AC_1,AC_2, AC_3 and AC_4

Sr. No.	Carbonization		H_2SO_4		
	Time	Temperature	Normality	Ratio	% Area of Porosity
AC_1	1 hr.	500°C	1 N	(1:4)	28.502
AC_2	1 hr.	500°C	0.5 N	(1:2)	20.629
AC_3	1 hr.	500°C	0.5 N	(1:3)	24.978
AC_4	1 hr.	500°C	0.5 N	(1:4)	31.283

First, pH adjustment is carried out by mixing textile wastewater with alum. Then, the optimum alum dosage is 1gram per litre of textile wastewater according to Jar test. After mixing, the pH level of textile wastewater nearly remains 6.0 which is suitable for the activated carbon used in this study. After the pH adjustments, the wastewater flows in adsorption filtration tank, which contains different amount of absorbent, contact time of wastewater and absorbents is 60 minutes. The following figure 5 shows the treatment processes of textile

wastewater and figure 6 shows the lab scale treatment plant model. The treatment plant dimension is described in table 3.

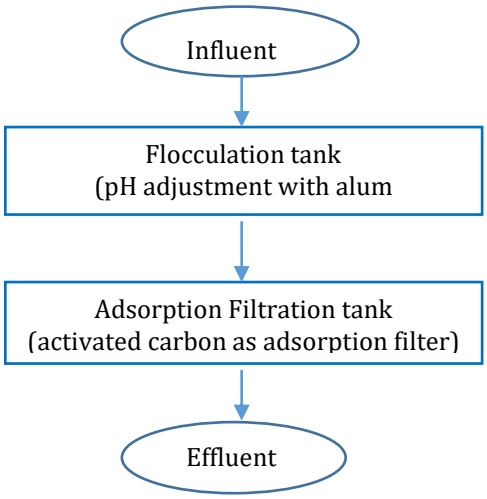

Figure 5. Treatment Processes of Textile Wastewater

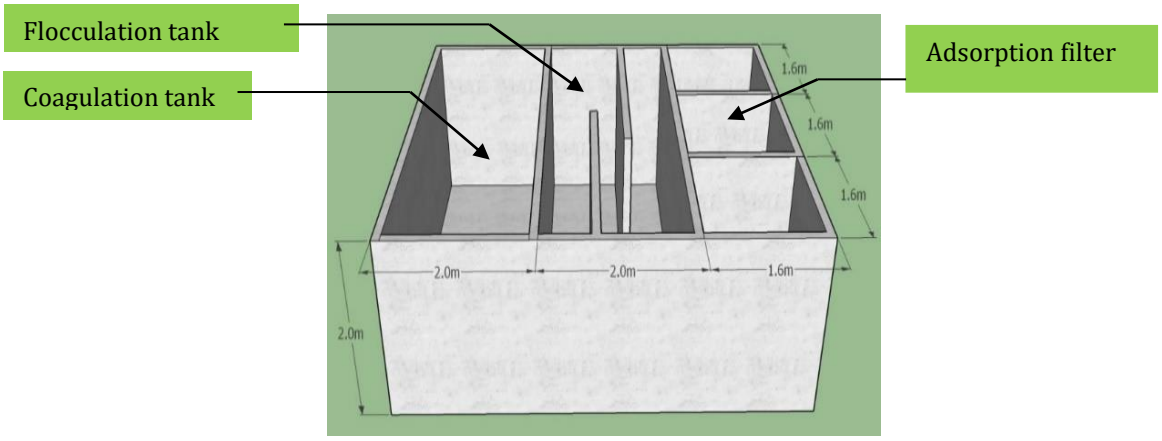

Figure 6. Treatment Plant Model

Table 3. Lab Scaled Model of Textile Wastewater Treatment Plant

Sr. No.	Dimension of tank	Coagulation tank	Flocculation tank	Absorbent Filter
1.	No. of unit	1	1	1
2.	Depth of tank	200 mm	200 mm	200 mm
3.	Width of tank	200 mm	200 mm	160 mm
4.	Length of tank	340 mm	340 mm	160 mm

C. Result and Discussion

The adsorption process of the activated carbon on textile wastewater is carried out in this process. During the wastewater filtration processes, the treated water is collected with 110 liter per hour per square meter after a contact time of

60 minutes.This determination aims to find out the relationship between the number of substances adsorbed by the adsorbent and the concentration in the liquid phase at equilibrium. Isotherm determination to reduce COD in the textile wastewater is performed with varying mass of 10 gm/l; 20 gm/l; 30 gm/l; 40 gm/l; and 50 gm/l respectively. The concentration of parameters for effluent is shown in table 4 and removal percentage of parameter concentrations is described in table 5.

Table 4. Concentration of Treated Effluent at Different Equilibrium Concentration of Adsorbents

Parameters of Effluents	**pH adjustment of textile Wastewater**	**Different Mass of Absorbents (gm/l)**				
		10	**20**	**30**	**40**	**50**
		Concentration of Treated Water				
pH	6.3	6.2	6.1	6.1	6.0	6.0
Colour (mg/l)pt	700	60	40	15	10	5
Turbidity(mg/l)	1050	192	128	96	96	64
EC(μ s)	2308	680	642	366	365.2	353.3
Total hardness(mg/l)	1200	60	56	56	56	58
Total suspended solids	2200	58	46	18	36	46
TDS	1850	120	105	90	85	78
COD	1280	308	138	38	28	20
BOD(mg/l)	602	151	68	22.5	19	11.5

Table 5. Removal Efficiency at Different Equilibrium Concentration

Parameters of Effluents	**pH adjustment of textile Wastewater**	**Different Mass of Absorbents (gm/l)**				
		10	**20**	**30**	**40**	**50**
		Removal Percentage of Parameters Concentration (%)				
Colour (mg/l)pt	700	97.00	98.00	99.25	99.50	99.75
Turbidity(mg/l)	1050	97.63	98.42	98.81	98.81	99.21
EC(μ s)	2308	91.92	92.37	95.65	95.66	95.80
Total hardness(mg/l)	1200	96.47	96.71	96.71	96.71	96.59
Total suspended solids	2200	99.47	99.58	99.84	99.67	99.58
TDS	1850	97.15	97.50	97.86	97.98	98.15
COD	1280	83.96	92.81	98.02	98.54	98.96
BOD(mg/l)	602	81.13	91.50	97.19	97.63	98.56

Using an adsorbent amount of 20 mg/l, the concentration parameters of effluent fell within the limit of NEQG guideline. Therefore, the optimum amount of absorbent is 20mg for 1 liter of textile wastewater. The effect of different adsorbent masses on reducing the concentration of parameters. Based on the data in table 4, the initial COD concentration in tht textile wastewater is 1280 mg/l.

After treatment with activated carbon, the COD value decreased due to the adsorption processes. The qe value calculated as follow and the calculation step is:

$$q_e = \frac{(C_o - C_e)V}{M}$$

where, qe = amount absorbated at equilibrium mg/g

C_e = equilibrium concentration mg/l

C_o = initial concentration mg/l

V = volume of wastewater l

M = mass of absorbent mg

To determine the adsorption isotherm model, the data is plotted as curves based on the linear forms of the Langmuir isotherm. The linearity values obtained are R^2 = 0.97832 for Langmuir isotherm. The adsorption pattern is determined by comparing the degree of curve linearity, with the R^2 value closest to the number 1 indicating a very close (linear). Thus, the resulting model is accurate, and the activated carbon is acceptable for textile wastewater treatment processes. After treatment processes, the effluent is treated using activated carbon at dosages ranging from 10 gm/l to 50mg/l. In this research, the Laungmuir isotherm model based on COD concentration are shown in table 6. The isotherm curves based on equilibrium concentration C_e and amount absorbated at equilibrium q_e are determined in the process. The linear Langmuir isotherm curves are presented in figure 7.

Table 6. Sorption Abilities in different Amounts of Activated Carbon

Weight of AC(mg/l)	Co (mg/l)	Ce (mg/l)	qe (mg/g)	logCe	logqe	Ce/qe
50	1280	20	44.6	1.30103	1.40140	0.79365
40	1280	28	55.55	1.44716	1.49554	0.89457
30	1280	38	73.733	1.57978	1.61700	0.91787
20	1280	138	105.6	2.13988	1.75664	2.41681
10	1280	308	194.2	2.48855	1.98767	3.16872

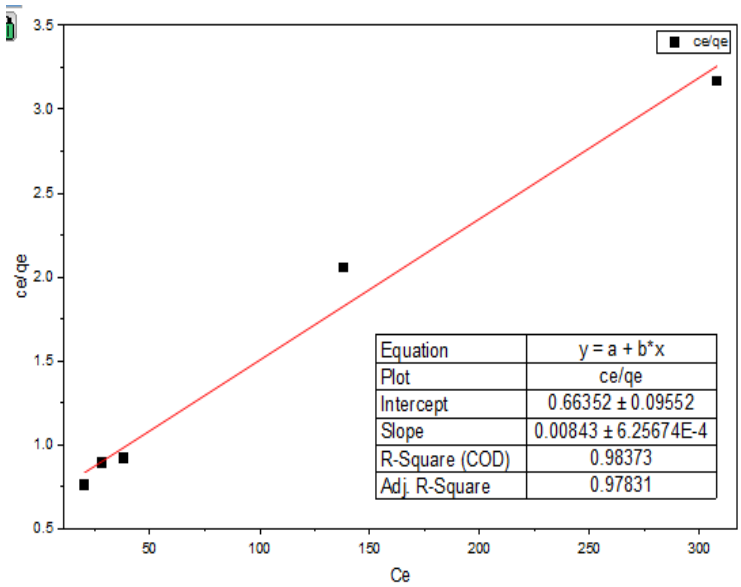

Figure 7. Isotherm Model for Laungmuir (linear) of Textile Wastewater

D. Conclusion

In this study, the treatment of textile wastewater achieves by using plum seed shell activated carbon. Based on NEQG values the cocerntration of consider parameters are acceptable. In thus, treated effluent can be safely disposed without damaging water resources. The treatment efficiency of lab scaled wastewater treatment model can be reduced approximately (99.29%) of colour, (99.75%) of turbidity, (99.21%) of TSS,(95.80%) of EC,(96.59%) of Total hardness,(99.58%) of Total suspended solids, (97.91%) of TDS, (99.29%) of BOD, and (98.96%) of COD respectively. The excellent fit (R^2 = 0.97831) from Langmuir isotherm model adequately describes the adsorption process. Under the given conditions (32°C, pH 5.5, 110 l/ h/m^2 rate of collection), the plum seed shell activated carbon effectively reduced COD from 1280 mg/l to as low as 20 mg/l (at 50 mg/L dose), achieving more than 98.44% removal. Therefore, the treated water can be safely disposed into the surrounding water bodies.

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