Removal of Dyes of Textile Rejects by Activated Carbon

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Abstract: The composition of wastewater from the textile industry varies enormously from one moment to another depending on the nature of the dyes used, the type of tissue, methods used and the concentration of added chemicals. In most cases the dye effluents are characterized by strong color, high temperatures, high and random values of pH, amounts of suspended solids and COD-concentrations close to the limit values set by the draft Moroccan standards.

The study of turbidity indicates a variation between 120 and 190 NTU for the three samples. As for their conductivity varies between 5,2 and 20 $mS.cm^{-1}$. Moreover their pH varies in the field of basic pH. Measuring the temperature of these three samples showed values varying between 25 and 30 ° C. The levels of suspended solids range between 146,8 and 514,7 mg L^{-1}.

The results show that the measured absorbance at 436 nm decreased to 2,020 A and it stabilizes at this value. To the absorbance of the color measured at 525 nm decreases to 3,072 A and it stabilizes. The absorbance measured at the wavelength 620 nm decreases and reaches a minimum value of 1, 918 A after ten hours.

Keywords: Activated carbon, turbidity, absorbance, adsorption, waste water.

1. INTRODUCTION

In the textile industry the water and chemicals products are consumed during the manufacturing process. The chemicals products used are diverse. An significant portion Is located in downstream of the process circuits in discharges and sewage especially in dyes. Among thesis compounds, there are significant quantity of suspended solids, Dispersing agents, salts, metals traces and high concentrations of COD [1]. There are wide quantities of various dyes [2] this account for Two Thirds of total market [3]. The annual textile production is about 30 million tons and require 7 10^5 tons of dyes. What deriving a significant source of pollution [4] and having a detrimental impact on the environment.

To fight against this huge problem of pollution of effluents from the textile industry, several technical treatment-have-been tested. Biological processes (aerobic and anaerobic) are cheaper. However, thesis technical are sensitive to poorly biodegradable dyes [5]. In addition, a wide variety of physicochemical met photolysis, coagulation flocculation [8], chemical oxidation, ion exchange, photo catalysis [9] and membrane filtration.

In this study we studied the wastewater of industrial textile unit. After characterizing the wastewater the trials treatment by adsorption in CAB, were conducted at the laboratory scale, by studying the removal of color and turbidity.

2. MATERIEL AND METHODS

2.1. Characterization of Reject

The wastewater from the textile industry especially the dyeing effluents containing organic dyes, chemicals products, salts, detergents, heavy metals and other [10]. So Wastewater from dyeing contains the main pollutants in the textile industry [2].

To assess the pollution discharged by this type of industry in the environment, a physicochemical characterization was performed for the overall dyeing effluent chosen for this study. Table **1** shows the analysis results of three different samples taken just before the point of discharge of sewage into the urban drainage system.

The results show that the physicochemical characteristics of the textile effluent vary from sample to another. Indeed, the composition of the wastewater from the textile industry varies enormously from one moment to another depending on the nature of the dyes used, the type of tissue, methods used and the concentration of added chemicals [11, 12]. In most cases the dye effluents are characterized by strong color, high temperatures, high and random values of pH, amounts of suspended solids and COD-concentrations close to the limit values set by the draft Moroccan standards [13, 14].

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Table 1: Physicochemical Characterization of Wastewater of Dyeing

Paramètre	Sample I	Sample II	Sample III	limite value (Draft Moroccan Standard)
Conductivité (ms/cm)	20 ,1	5,2	12,5	-
Turbidité (NTU)	190	120	145	-
pH	12	7,9	11,15	6,5-8,5
T(°C) Mes(mgL^{-1})	30,2 514,7	28,7 238	25 146,8	35-600
NO_3^- (mgL^{-1}) SO_4^{2-}(mgL^{-1})	300,2 360,7	225 266	14,2 342,3	--400
PO_4^{3-}(mgL^{-1}) Cl^-(mgL^{-1})	2,33 4986	3,1 3325	3,4 2873	--
Pt(mgL^{-1}) DCO(mgL^{-1})	35,2 797	13 606,8	10,13 681	10-1000
Abs(436nm)	-	0,433	-	-
Abs(525nm)	-	0,567	-	-
Abs(625nm)	-	0,723	-	-

The study of turbidity indicates a variation between 120 and 190 NTU for the three samples. As for their conductivity varies between 5,2 and 20 mS.cm-1. Moreover their pH varies in the field of basic pH, with high values and that sometimes exceed the range limit set by the Moroccan draft standards. This strongly influences the quality of wastewater and can have several impacts on the receiving environment. Indeed, the pH has a direct effect on living organisms. Measuring the temperature of these three samples showed values varying between 25 and 30°C. The levels of suspended solids range between 146.8 and 514.7 mg L^{-1} (Table **1**). These changes in pH, temperature, TSS and conductivity are comparable to those reported by [13-15].

These samples are rich in organic matter. Indeed, COD levels recorded in Table **1** range from 606-797 mgL^{-1}. These values coincide with the results of [8, 13-15]. Moreover, their phosphorus levels vary between 10 and 35 mg L^{-1}. These results are superior to those reported by [14]. This high load of oxidable materials is mainly due to chemicals products, and organic dyes and the nature of the cellulose fibers (Table **1**) used during the dyeing process.

In addition to the significant organic load, these samples show high concentrations of sulfate, chlorides and nitrates. The sulphate content vary between 266 and 360 mg L^{-1}. While addition, high levels of chloride ions were detected (2.87 to 4.98 g L^{-1}). Nitrate ions recorded alarming values ranging from 14.2 to 300 mg L^{-1}, their use by aquatic plants accelerates their uncontrolled spread and contributes to oxygen depletion by inhibiting photosynthesis.

Textile effluents discharges are complex, loaded with organic and inorganic materials. They have varying characteristics with time and can be toxic of microorganisms. The negative impact of the rejection of this effluent on the receiving environment proves indisputable and requires pretreatment prior to discharge. On the other hand, and any project of a pollution control industry, a homogenization basin is necessary.

2.2. Process Used

The method applied to the treatment of the effluent from the textile industry is summarized in the following scheme:

Settling and adjusting the pH = 1.2 of the effluent 50 ml + 0.6g activated carbon

↓

(Or different masses in case of mass effect study) Agitation for 26 hours at T = 20 ± 2 ° C

↓

Filtering the suspension

↓

Analysis of physicochemical parameters: pH, conductivity, turbidity and absorbance (436 nm, 525 nm and 620 nm)

3. RESULTS AND DISCUSSION

3.1. Study of the Adsorption

3.1.1. Monitoring Changes of Conductivity, Turbidity and pH during Processing

In order to know the impact of the support-adsorbing on pH, conductivity and turbidity of industrial waste, we tried to measure these parameters during treatment with activated carbon.

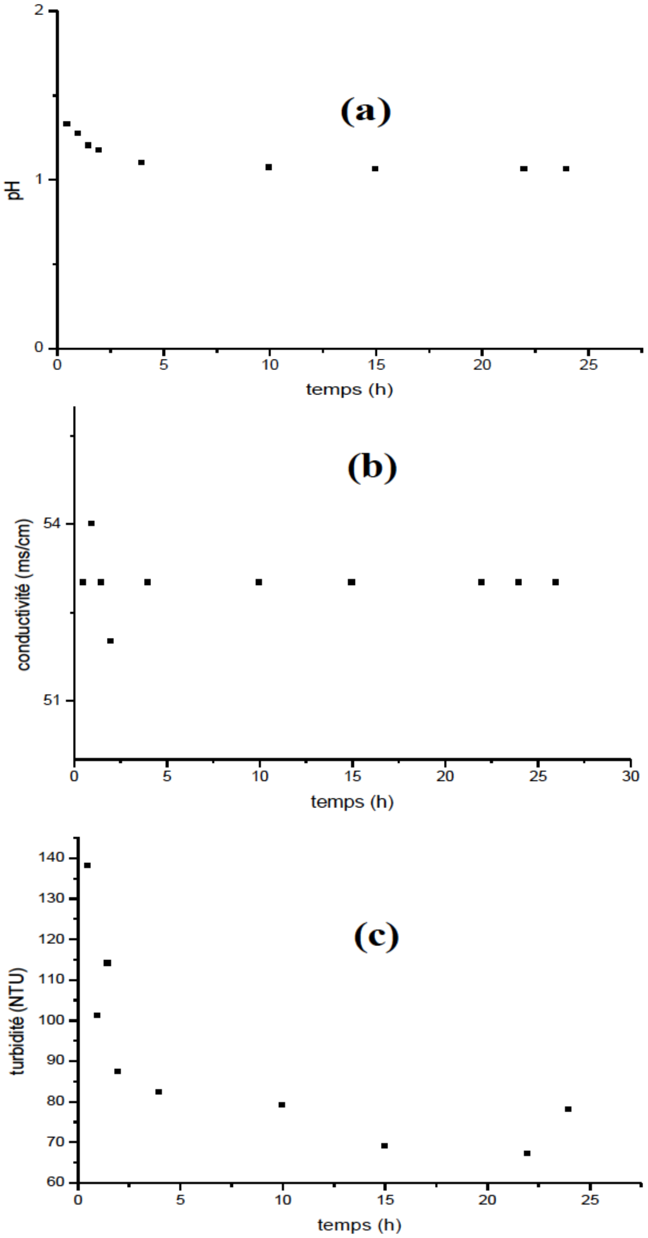

Figure 1: Monitoring changes of conductivity, turbidity and pH during processing.

m_{ads} = 12g.L^{-1}, pH_i = 1,2, v = 50 mL et T = 20°C.

The monitoring results of the change in pH, conductivity and turbidity of the effluent during treatment by activated carbon (Figure **1**), show that these parameters not aware of any significant variation in reported to the mass of material used. On the curve (a) of Figure **1**, we see just a small decrease in initial pH value (pH_0 = 1.33) during the first four hours, then stabilized at 1.06 to the minimum value from tenth hour. Curve (b) shows the conductivity ranges from 53 ms cm^{-1} to 52 cm^{-1}ms and passes by the value of 54 ms^{-1} cm during the first four hours. As a result it is stabilized at the value of 53 ms^{-1} cm. This shows that no release of ions was observed for the mass of the activated carbon used.

While the curve (c) show that turbidity decreased during treatment, she spends 138 to the minimum 67 NTU during the first 22 hours, followed by a small increase in the value of 78 NTU. This means that the turbidity is heavily eliminated by activated carbon over time.

3.1.2. Monitoring the Change in Color in Function of Time

Studies on the effect of the contact time between the CAB adsorbent and the adsorbate are of considerable importance. Rapid fixing of adsorbate and steady establishment in a short duration means the effectiveness of the adsorbent so that it is used in the treatment of wastewater.

The monitoring results of the color variation for the wavelengths 436 nm, 525 nm and 620 nm, in the contact time during the adsorption of the color of the effluent, are illustrated in Figure **2**.

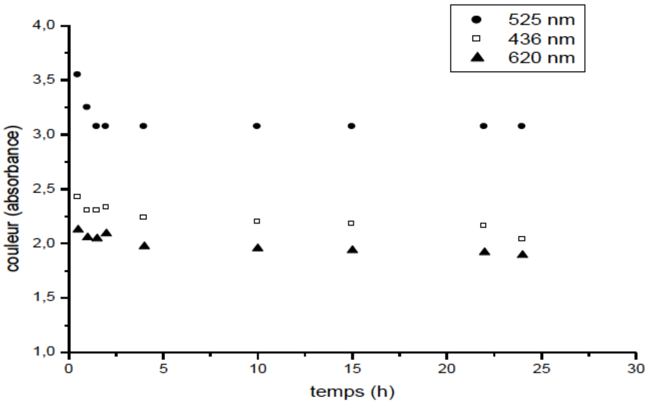

Figure 2: Monitoring the change in color in function of time.

m_{ads} = 12g.L^{-1}, pH_i = 1,2, v = 50 mL et T = 20°C.

These results show that the absorbance measured at 436 nm decreases from 2.426 A to 2.240 A for the first four hours. Thereafter, we do not see significant changes, it is almost stable at the minimum value of 2,200 A for 20 hours following.

To the absorbance of the color measured at 525 nm decreases of 3.547 A to 3.072 A for the initial two hours. Thereafter, it stabilizes the 3,072 Aminimum value.

The absorbance measured at the wavelength 620 nm decreases and reaches a minimum value after ten hours. During the first four hours the absorbance of the staining decreased to 2,125 A 1,972 A, to stabilize at a minimum value of 1, 918 A after ten hours of stirring.

Staining measured at three wavelengths (436 nm, 525 nm, 620 nm) decreases during the time of treatment. This confirms the elimination of dyes by activated carbon adsorption. This can be explained by the fact that a large number of vacant sites on the adsorbate surface are available for adsorption during the initial stage. And thereafter, the occupation of the rest of vacant surface sites became difficult. This is due to the repulsive forces between the molecules of dyes adsorbed on the adsorbent, and the molecules of the dyes of the liquid phase [4]. The three curves are similar.

3.2. Study of the Mass Effect

3.2.1. Monitoring Changes of Conductivity, Turbidity and pH during Processing

After each treatment trial, we measured the pH, turbidity and conductivity rejection based on the mass of CAB, to see the effect of the mass of adsorbent used on these physicochemical parameters. The results are shown in Figure **3**.

From the curve (a) of Figure **3** we see a slight decrease in the pH of the medium from 1.60 to 1.1, for a variation of the CAB mass used of 0.3 g to 0.8 g.

On the curve (b) of the same figure, which represents the variation of the conductivity with the CAB mass used, the conductivity shows a small decrease. It goes from 42.4 ms / cm to 41 mS / cm when the CAB mass increases from 0.3 g to 0.6 g. Then it stabilizes at the minimum value of 41 mS / cm even if we add more CAB mass. This may be due to the fact that no release of ions was observed for all the masses of the activated carbon used.

Curve (c) of Figure **3** shows the variation of the turbidity as a function of the amount of discharge of CAB used. This curve shows a small increase in the turbidity of 27.09 NTU to 29.2 NTU, followed by a decrease of 29.2 NTU at the minimum value of 12.5 NTU when the CAB mass Password of 0.3 g to 0.6 g. In following with the increase of the mass used, the turbidity remains constant at the minimum value of 12.5 NTU. This means that the turbidity is eliminated by the CAB over time.

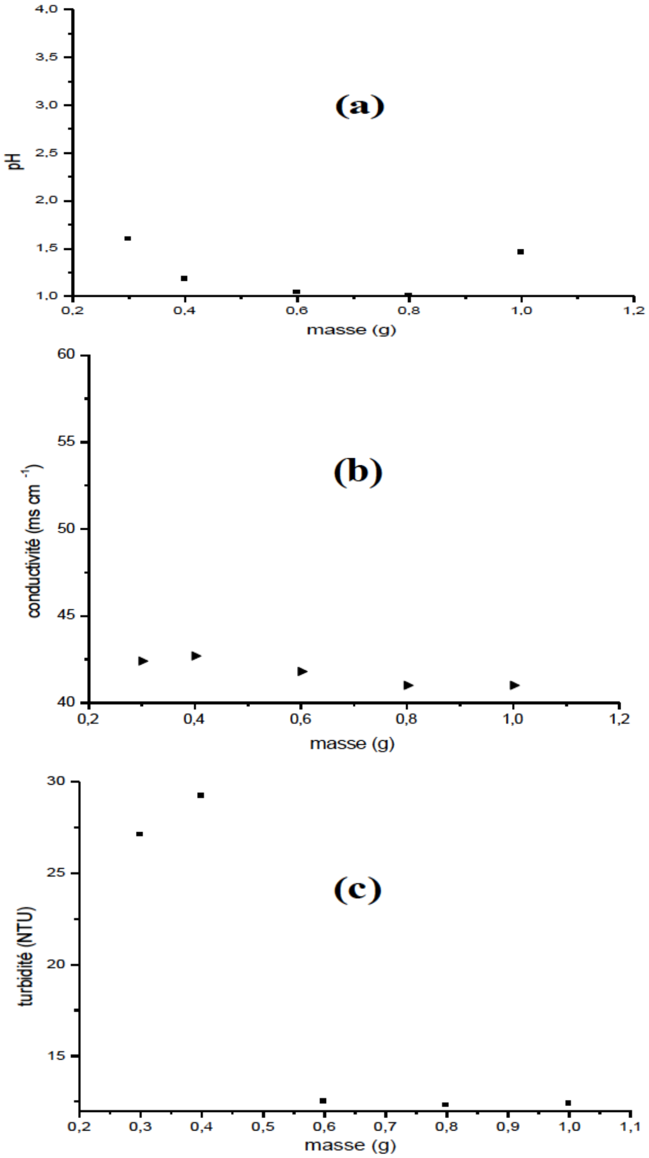

Figure 3: Monitoring changes of conductivity, turbidity and pH during processing.

m_{ads} = 12g.L^{-1}, pH$_i$ = 1,2, v = 50 mL et T = 20°C.

3.2.2. Monitoring the Change in Color in Function of Time

As well as for the study of the adsorption, during the treatment with different masses, we measured the absorbance of the color to the three wavelengths 436 nm, 525 nm and 620 nm as a function of the mass (Figure **4**).

The curve of the absorbance at the wavelength 436 nm, shows that the latter knows a decrease of 0.03 A to a minimum of 0.007 A with the increase of CAB mass to 0.8 g of 50 ml of solute. Then, with the increase in the mass, the absorbance appears almost without change.

In the same figure, the curve of the absorbance at the wavelength of 525 nm, shows the decrease in absorbance of 0.096 A to the minimum value of 0.051 A for a dose of 0.8 g of CAB.

To the absorbance at the wavelength 620 nm shown in Figure **4**, it also decreases of 0.078 A to 0.013 A when the CAB mass used increases from 0.3 g to 0.8 g. Then it is stabilized at the minimum value of 0,013 A with increasing CAB mass.

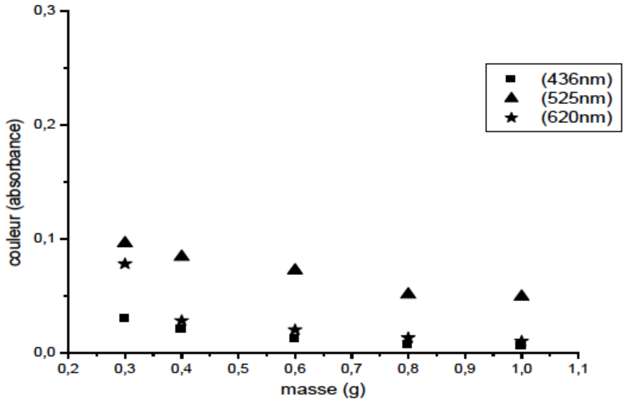

Figure 4: Suivi monitoring the change in color in function of mass.

m_{ads} = 12g.L^{-1}, pH_i = 1,2, v = 50 mL et T = 20°C.

So we find that the color removal to the three wavelengths increases to a maximum value. And then remains constant with increasing CAB mass. Indeed for high masses of CAB, there is more than the number of active sites available for the molecules of adsorbate which will travel to the solution to the surface of the cabinet in order to look for these active sites. From these experimental results we conclude that for proper disposal must be used an optimal amount of neighboring CAB of 16 g / L.

4. CONCLUSION

This study qualitatively and quantitatively evaluates the effluents from the textile industry whose waste water is discharged into the receiving environment without any treatment.

The rejection of the textile industry is a rejection loaded in color, it has a basic pH. Treatment with activated carbon helps to reduce the levels of dyes so that they obey the standards. Monitor the conductivity, pH and turbidity during the treatment of this rejection has shown that changes in the conductivity and pH may be negligible compared to the contribution of the support to the elimination of dyes.

The adsorption treatment results show that activated carbon:

- The kinetics activated carbon adsorption is characterized by a slow saturation time (4 hours).
- Removal of textile dyes with activated carbon shows that the adsorption process is important depending on the mass of the adsorbate. Indeed, the active carbon reduction allowed almost all dyes to a mass of 16 g / l.

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