TREATMENT OF TEXTILE EFFLUENT USING PHOTO-FENTON PROCESS IN PRESENCE OF BANANA PEEL AS AN ADSORBENT

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Abstract - *Textile effluent seems to be great thread to environment and human health. This effluent contains colouring pigments, heavy metals, other metallic pollutants, organic and inorganic pollutants. The treatment of wastewater form textile industries are hectic task in current situation. Some of the available conventional treatment techniques are not efficient and cost efficient, so treatment of wastewater is not efficient and effective. But the adsorption process seems to be efficient and economical for the treatment of textile wastewater. This adsorption process can be enhancing by adding some chemical to it like, ferrous components, hydrogen peroxide. These chemicals enhance the activity of the treatment process. This technique is called to be Fenton process. This fenton process can be further optimized by provide high energy to the treating chemicals. Supply of energy is achieved by using UV-lamp. The UV lamp emit light at lower wavelength containing high amount of energy. These energy is sufficient to excite the atom of adsorbent and increase its treatment efficiency. The enhanced fenton process using UV-lamp is called as Photo-Fenton process. For this as a initial step, the adsorbent is identified, synthesised and parameter for treatment like pH, dosage, temperature, contact time is optimized in this project phase 1, and also to conduct the Photo-Fenton process, an reactor is designed and fabricated as per requirement. Banana peel adsorbent is choose for this treatment process. The running and optimization of Photo-Fenton reactor is planned to complete during Project phase 2. The Optimized dosage is 2.0g/l at pH 7, with the contact time of 120min in a open environment with the removal efficiency of about 86.2.*

Key Words: Photo-fenton, UV-Lamp, Banana peel adsorbent, colour, efficient.

1. INTRODUCTION

The Indian textile and clothing industry, as one of the oldest industries of the country, has witnessed several changes in fortune during the post-independence period. It accounts for over 20 percent of industrial production and is closely linked with the agricultural and rural economy. The textile industry uses vegetable fibres such as cotton, animal fibres such as wool and silk, and a wide range of synthetic materials such as nylon, polyester, and acrylics important problems of the surface water. The chemical reagents used are very diverse in chemical composition, ranging from inorganic compound to polymers and organic compound. The colour is an evident indicator of water pollution by the dyes. Industrial dye effluents are visible even at concentrations lower than 1mg/l. Synthetic organic dyes are generally recalcitrant in nature. Moreover, some dyes and their degradation products are carcinogenic. Composite textile wastewater is characterized mainly by measurements of biochemical oxygen demand (BOD), chemical oxygen demand (COD), suspended solids (SS) and dissolved solids (DS). In most cases BOD/COD ratio of the composite textile wastewater is around 0.25 that implies that the wastewater contains large amount of non-biodegradable organic matter.

TEXTILE WASTEWATER TREATMENT

The treatment of textile wastewater is very complex, because the raw materials processed and the intermediate products manufactured vary greatly in their nature and composition. The composition of waste varies even in same industry as a result of transition from one raw material to another and continual changing of process lines and also due to type of fabric manufactured. Before treatment, a separation of different types of wastewater into following group takes place:

- Concentrated liquids (e.g., dyeing, finishing, printing)
- Medium polluted wastes (e.g., washing, rinsing)
- Low to zero polluted wastes (e.g., cooling water).

The various methods of treatment of textile wastewater are as follows:

- Physical treatment
- Physico-chemical treatment
- Biological treatment
- Advanced oxidation processes

ADVANCED OXIDATION PROCESS

The advance oxidation processes(AOPs) are considered as promising and ambient temperature processes for the treatment of calcitrant compounds in water, groundwater. The AOPs are preferred over other treatment technologies because they are fast, efficient and completely oxidize the waste water into CO2 and H2O. The AOPs are broadly divided into two categories such as non-photochemical advanced oxidation methods and light assisted AOPs known as advanced oxidation photochemical methods. The effluent treatment methods, which generate hydroxyl radicals to treat effluent without using light energy are termed as non-photochemical methods and include the application of H2O2 and ozone alone or in combination, such as hydrogen peroxide and ozone (H2O2/03) and hydrogen peroxide and ferrous ions (H2O2/Fe+2) known as Fenton process.

Fenton system (H2O2 /Fe+2)

The Fenton system involves the combined application of hydrogen peroxide and iron catalyst and a voluminous literature on its application to treat industrial wastewater is available. The Fenton system as compared to other AOPs is advantageous as it offers a cost effective source of hydroxyl radicals, and is easy to operate and maintain. The Fenton process involves following reactions,

$$Fe^{+2} + H_2O_2 \rightarrow Fe^{+3} + OH\bullet + OH^-$$

$$OH\bullet + Fe^{+2} \rightarrow OH^- + Fe^{+3}$$

$$OH\bullet + H_2O_2 \rightarrow H_2O + HOO\bullet$$

$$Fe^{+3} + H_2O_2 \rightarrow Fe\text{-}OOH^{+2} + H^+$$

$$Fe\text{-}OOH^{+2} \rightarrow HOO\bullet + Fe^{+2}$$

$$HOO\bullet + Fe^{+2} \rightarrow Fe^{+3} + HOO^-$$

$$Fe^{+3} + HOO\bullet \rightarrow Fe^{+2} + O_2 + H^+$$

The overall efficiency of the system is directly affected by operating parameters like pH and Fe2+ contents. H2O2 is unstable and easily decomposes itself in the basic environment (pH> 10). The efficiency of the system increases with increasing Fe2+ contents because it accelerates the production of hydroxyl radicals. An increase in H2O2 /Fe+2 ratio, increases the efficiency at certain level but further increase stops the reaction as excess H2O2 causes the scavenging of HO• radicals.

Photo-Fenton system (H2O2/ Fe+2/UV)

UV light assisted Fenton process, known as Photo Fenton process, is also considered to be one of the most effective methods for decomposing water-soluble organic pollutants. The UV light of wavelength ranging between 100 - 400 nm is commonly generated by using UV lamp, and a mercury lamp is the most common UV light source.

UV irradiation of H2O2 accelerates the production of highly reactive species, mainly hydroxyl radicals (OH-). An alternate pathway is through the generation of HO2- ions, which also absorb the UV radiation of 254 nm wavelength and produce hydroxyl radicals as

$$H_2O_2 \rightarrow H^+ + HO_2^-$$

$$HO_2^- + (hv) \rightarrow OH^- + O^-$$

These hydroxyl radicals can oxidize organic compounds producing organic radicals (R•), which have potential to initiate a radical chain oxidation Factors that influence the efficiency of Photo Fenton process include initial colour intensity, H2O2 /Fe+2 concentrations, pH, temperature, alkalinity.

2. MATERIALS AND METHODOLOGY

SAMPLE COLLECTION AND RESERVATION

The effluent was collected in polythene containers of 10liters capacity and was brought to the laboratory with due care and was stored at 4oC for further analysis. The physical and chemical characteristics of textile effluent parameters were analyzed as per standard procedures.

REACTOR VOLUME AND DIMENSIONS

To determine the required reactor volume and dimensions, the organic loading, superficial velocity, and effective treatment volume must all be considered. The effective treatment volume is that volume occupied by the sludge blanket and active biomass. An additional volume exists between the effective volume and the gas collection unit where some additional solids separation occurs and the biomass is dilute. The nominal liquid volume of the reactor based on using an acceptable organic loading is given by

Vn= QS0/ Lorg

Where Vn= nominal (effective) liquid volume of reactor, m3

Q = influent flow rate, m3/h

S0= Influent COD,kg COD/m3

Lorg= organic loading rate, kg COD/m3.d

REACTOR DESIGN CALCULATION

To determine the required reactor volume and dimensions, the organic loading, superficial velocity, and effective treatment volume must all be considered. The nominal liquid volume of the reactor based on using an acceptable organic loading is given by

Step 1: To find the influent flow rate

$$V_n = QS_0 / L_{org}$$

$$\frac{Q\ (0.3Kg\ SCOD\ COD/m3)}{(1.3Kg\ SCOD\ COD/m3.d)} = Q = 8.67\ l/d.$$

(Assume $V_n = 2$lit.)

Step 2: To find the total liquid volume of the reactor

$$V_L = V_n / E$$

$$V_L = \frac{2l}{0.85} = V_L = 2.35\text{lit.}$$ (effectiveness factor= 0.85)

Step 3: To find velocity of wastewater

$$V = Q/t$$

$$2.35 = \frac{8.67}{t} \quad = \quad t = 3.69 \text{ m/h.}$$

Step 4: To find the area of the reactor

$$A = Q/v$$

$$A = \frac{(8.67 l/d)}{(3.69 m/h)} \quad = \quad A = 0.00325\text{m}$$

Step 5: To find the diameter of reactor

$$A = \frac{\pi}{4} D^2$$

$$0.00325 = 0.785D^2 \quad = \quad D = 0.05\text{m}$$

Step 6: To find the reactor height based on liquid volume

$$H_L = V_L/A$$

$$H_L = \frac{2.35\times10^{-3}\ m^3}{0.00325\ m^2}$$

$$\mathbf{H_L = 0.6m}$$

TREATMENT BY H2O2/FeSO4/UV

Synthetic dye solutions were injected in the reactor and dosed with different H2O2 volumes (5 to 40 ml) and FeSO4 dosage as (2gm to 6gm) to study the effect of H2O2 concentration and FeSO4 concentration on the dye degradation. Also experiments were conducted by changing the pH conditions (2, 3, 5, 7, and 9), irradiation time as (10, 20, 30, 40 and 60 minutes) and maintaining the UV intensity 36 W as constant throughout the process to study the effect of these factors on the degradation efficiency. Furthermore, samples were taken and analysed to study the removal percentage of BOD and COD of the solution and the kinetics of the reaction. Afterwards the most optimal conditions for degradation and decolourization of the synthetic dye solution were chosen and then applied on the wastewater sample. As previously mentioned, the wastewater was placed in the reactor, and treatment took place using the optimal condition.

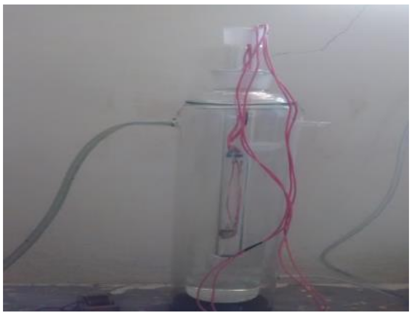


Fig 1 : UV Reactor setup

3. RESULT AND DISCUSSION

CHARACTERISTICS OF WASTEWATER

- Dyeing wastewater contains colour dosing, chemicals, cooling water, dye wastes, cleaning water.
- It is characterized by high concentrations of dyes, organic and inorganic contents
- Salting activities during dyeing process may result in high salinity levels. Wastewater may also contain acids, hydros with a number of active ingredients as well as significant biofilm.
- Other wastewater steams include cooling water from utilities, storm water, rinsing.

Table 1: Characteristics of Waste Water

Parameters	Typical Value
pH	10 – 13
Colour	Dark green
Total dissolved solids	5000-6000 mg/l
BOD	700-850 mg/l
COD	1500-1800 mg/l

WASTEWATER CHARACTERIZATION USING UV-SPEC.

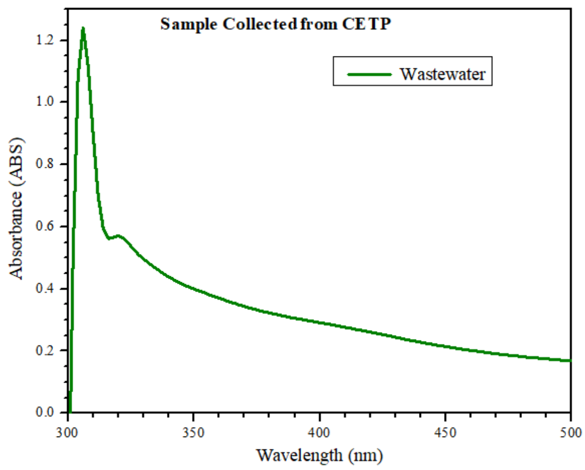


Fig 2: Wastewater Characterization Using Uv-Spec.

The collected sample has the peak absorbance of 1.4 ABS. It is found to be the maximum pollutance concentration of sample in my project. For plotting graph wavelength is taken along X-axis with the unit nm, and absorbance is taken along the Y-axis with the unit ABS

ABSORBANCE OF WASTEWATER AT pH 3 FOR 30 MINS

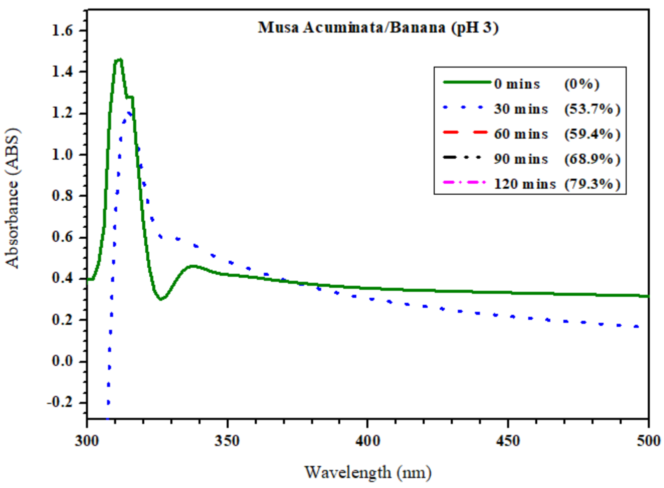


Fig 3: Absorbance Of Wastewater At Ph 3 For 30 Mins

The above graph shows that the absorbance of wastewater treated at pH 3 with a contact time of 30 mins. The maximum peak of the graph is recorded as 1.464 ABS. The pollutance removal efficiency at pH 3 with contact time of 30 mins is found to be 53.7%.

ABSORBANCE OF WASTEWATER AT pH 3 FOR 60 MINS

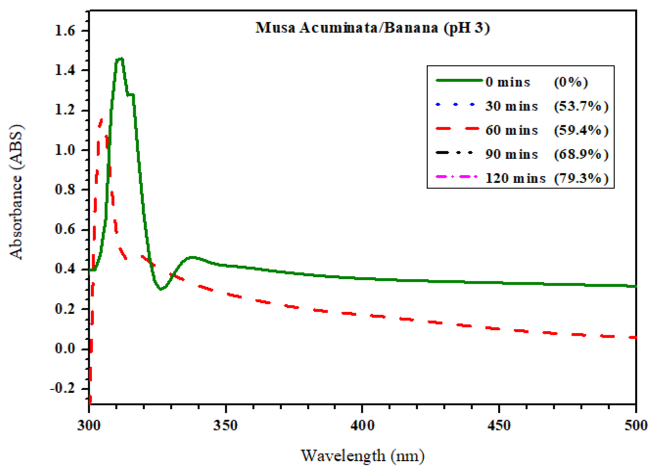


Fig 4: Absorbance Of Wastewater At Ph 3 For 60 Mins

The maximum peak of the graph is recorded as 1.216ABS. The pollutance removal efficiency at pH 3 with contact time of 60 mins is found to be 59.4%.

ABSORBANCE OF WASTEWATER AT pH 3 FOR 90 MINS

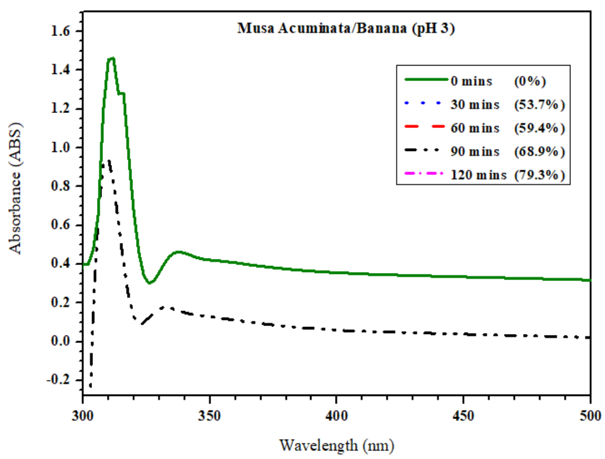


Fig 5: Absorbance Of Wastewaer At Ph 3 For 90 Mins

The above graph shows that the absorbance of wastewater treated at pH 3 with a contact time of 90 mins. The maximum peak of the graph is recorded as 1.145 ABS. The pollutance removal efficiency at pH 3 with contact time of 90 mins is found to be 68.9%.

ABSORBANCE OF WASTEWATER AT pH 3 FOR 120 MINS

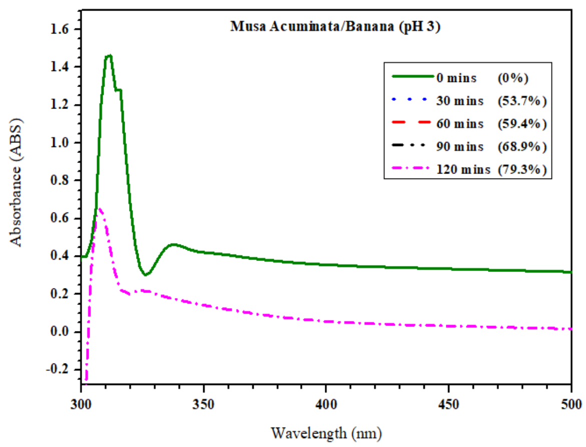


Fig 6: Absorbance Of Wastewater At Ph 3 For 120 Mins

The above graph shows that the absorbance of wastewater treated at pH 3 with a contact time of 120 mins. The maximum peak of the graph is recorded as 0.651 ABS. The pollutance removal efficiency at pH 3 with contact time of 120 mins is found to be 79.3%.

ABSORBANCE OF WASTEWATER AT pH 7 FOR 30 MINS

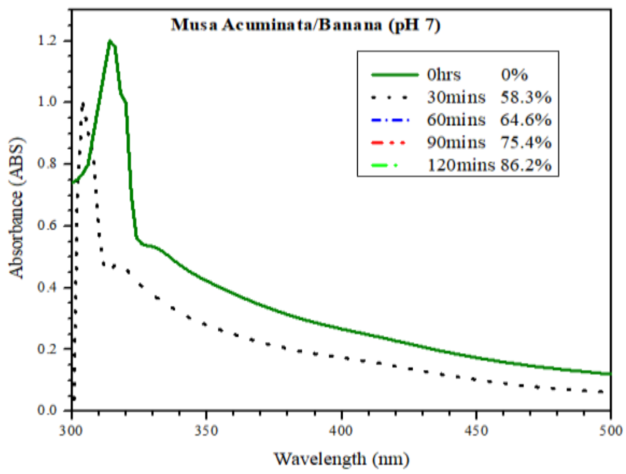


Fig 7: Absorbance Of Wastewater At Ph 7 For 30 Mins

The above graph shows that the absorbance of wastewater treated at pH 7 with a contact time of 30 mins. The maximum peak of the graph is recorded as 0.998 ABS. The pollutance removal efficiency at pH 7 with contact time of 30 mins is found to be 58.3%.

ABSORBANCE OF WASTEWATER AT pH 7 FOR 60 MINS

The Below graph shows that the absorbance of wastewater treated at pH 7 with a contact time of 60 mins. The maximum peak of the graph is recorded as 0.902 ABS. The pollutance removal efficiency at pH 7 with contact time of 60 mins is found to be 64.6%.

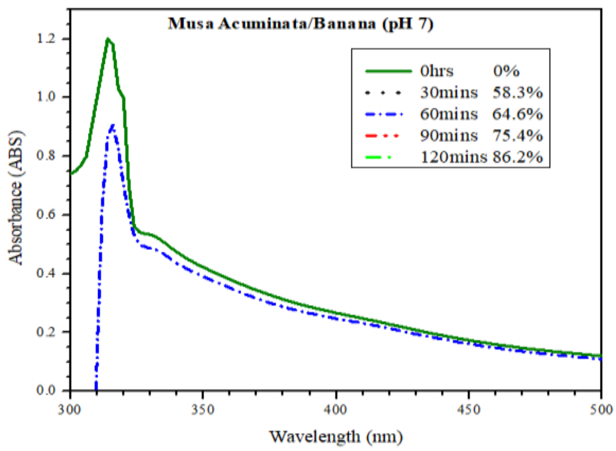


Fig 8: Absorbance Of Wastewater At Ph 7 For 60 Mins

ABSORBANCE OF WASTEWATER AT pH 7 FOR 90 MINS

The pollutance removal efficiency at pH 7 with contact time of 90 mins is found to be 75.4%.

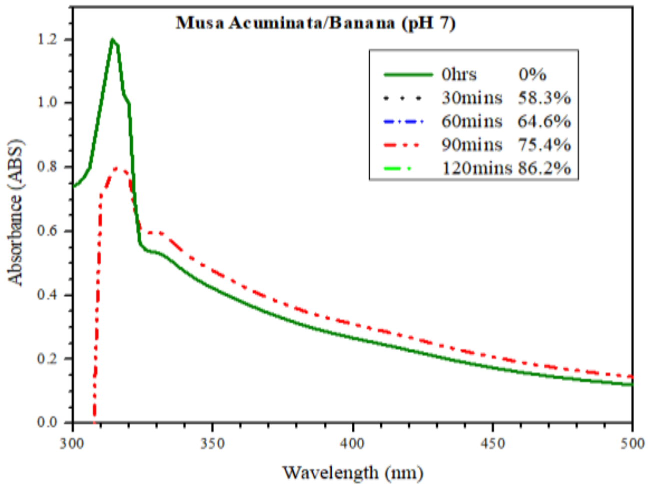


Fig 9: Absorbance Of Wastewater At Ph 7 For 90 Mins

The above graph shows that the absorbance of wastewater treated at pH 7 with a contact time of 90 mins. The maximum peak of the graph is recorded as 0.762 ABS.

ABSORBANCE OF WASTEWATER AT pH 7 FOR 120 MINS

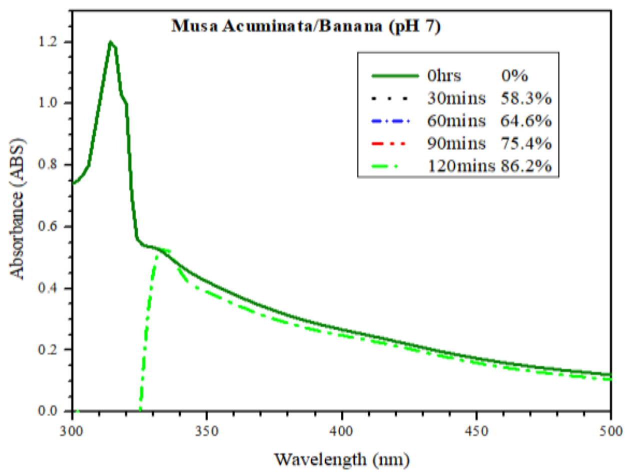


Fig 10: Absorbance Of Wastewater At Ph 7 For 120 Mins

The above graph shows that the absorbance of wastewater treated at pH 7 with a contact time of 120 mins. The maximum peak of the graph is recorded as 0.511 ABS. The pollutance removal efficiency at pH 7 with contact time of 120 mins is found to be 86.2%.

ABSORBANCE OF WASTEWATER AT pH 12 FOR 30 MINS

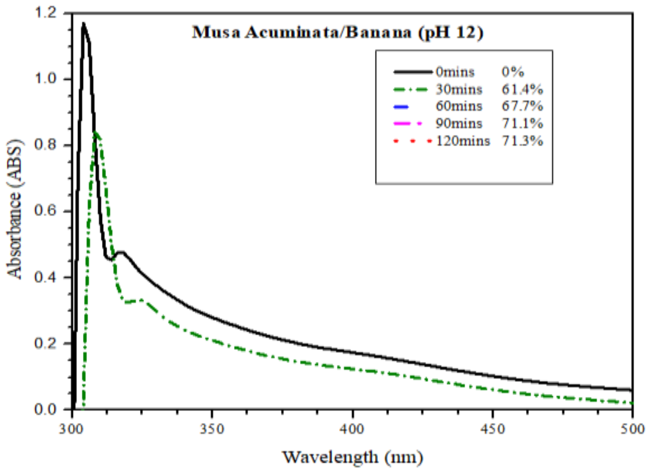


Fig 11: Absorbance Of Wastewater At Ph 12 For 30 Mins

The above graph shows that the absorbance of wastewater treated at pH 12 with a contact time of 30 mins. The maximum peak of the graph is recorded as 0.838 ABS. The pollutance removal efficiency at pH 12 with contact time of 30 mins is found to be 61.4%.

ABSORBANCE OF WASTEWAER AT pH 12 FOR 60 MINS

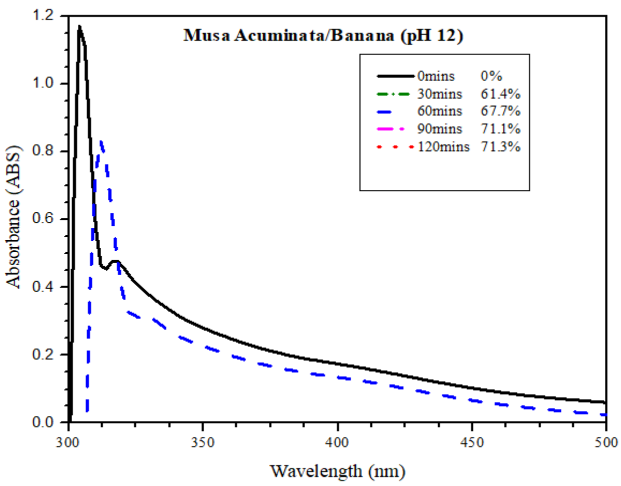


Fig 12: Absorbance Of Wastewater At Ph 12 For 60 Mins

The above graph shows that the absorbance of wastewater treated at pH 12 with a contact time of 60 mins. The maximum peak of the graph is recorded as 0.826 ABS. The pollutance removal efficiency at pH 12 with contact time of 60 mins is found to be 67.7%.

ABSORBANCE OF WASTEWAER AT pH 12 FOR 90 MINS

The graph shows that the absorbance of wastewater treated at pH 12 with a contact time of 90 mins. The maximum peak of the graph is recorded as 0.762 ABS. The pollutance removal efficiency at pH 12 with contact time of 90 mins is found to be 71.1%.

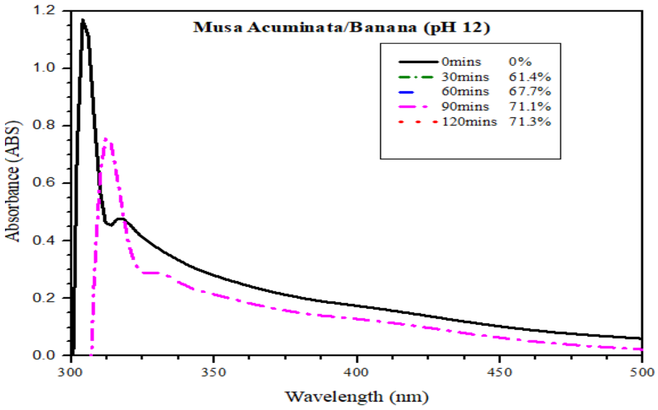


Fig 13: Absorbance Of Wastewater At Ph 12 For 90 Mins

ABSORBANCE OF WASTEWAER AT pH 12 FOR 120 MINS

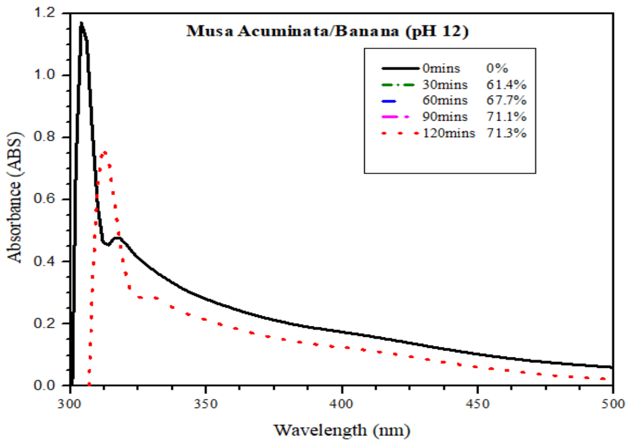
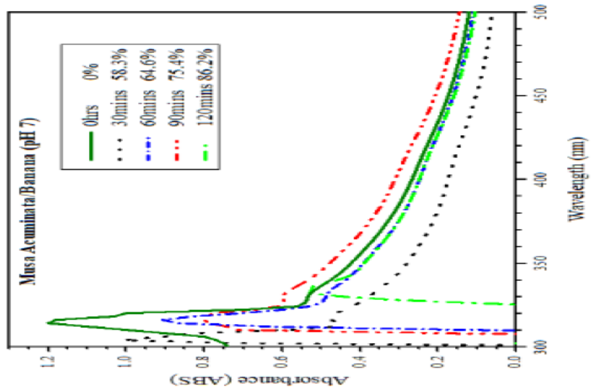


Fig 14: Absorbance Of Wastewater At Ph 12 For 120 Mins

The above graph shows that the absorbance of wastewater treated at pH 12 with a contact time of 120 mins. The maximum peak of the graph is recorded as 0.747 ABS. The pollutance removal efficiency at pH 12 with contact time of 120 mins is found to be 71.2%.

CONSOLDATED ABSORBANCE GRAPH

The consolidated absorbance graph for pH 3,7,12 with varying contact time of 0 min, 30 mins, 60 mins, 120 mins are shown.



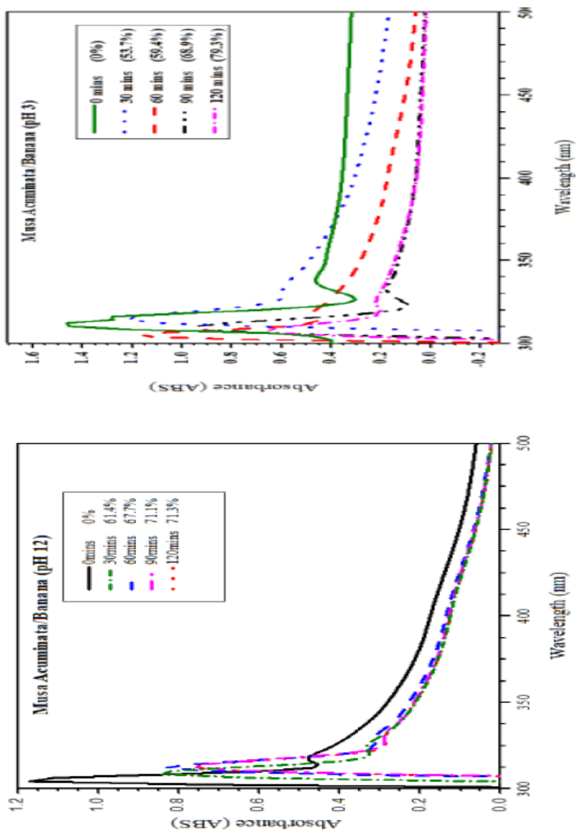


Fig 15: consolidated absorbance graph for pH 3,7,12 with varying contact time of 0 min, 30 mins, 60 mins, 120 mins

For plotting graph wave length is taken along X-axis with the unit nm, and absorbance is taken along Y-axis with the unit ABS.

DECOLOURIZING ABILITY

It is found that the adsorbent is not only good in removing pollutance, but also good in decolourizing ability. The treated sample with pH 7 for 120 mins is compared with the wastewater before its treatment.

4. CONCLUSIONS

High Dye Removal efficiency is 86.2 %. These experimental studies have indicated that the Banana peel has the potential to act as an adsorbent for the removal of the colour and pollutants from aqueous solutions. The effects of contact time and pH on the sample were determined using the experimental data. The adsorption data are plotted graph and the pollutance removal efficiency is calculated. The optimized data for the adsorbent is at pH 7 with a contact time of 120mins.

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