International Journal of Scientific Research in Engineering and Management (IJSREM)
Volume: 07 Issue: 07 | July - 2023 SJIF Rating: 8.176 ISSN: 2582-3930

Study on Adsorption of Synthetic Dye via Nano-Particles Sandwiched between Two Layers of R-Pet Aerogel

Mr. Ritul Bhatt[1], Mr. Mohmad Saif Kaladiya[2]

[1](Department of Chemical Engineering & Industrial Chemistry, Parul Institute of Technology/Applied Science, Parul University, Vadodara-391760) [2](Department of Industrial Chemistry, Parul Institute of Applied Science, Parul University, Vadodara-391760)

Abstract-Due to increase in demand of textile products, there is much increase in use of synthetic dyes used for the textile products. So it results into tones of waste dye bath water discharge into water bodies causing problems for aquatic & human life. Similarly, there is also increase in use of PET bottles in day to day life and these used PET bottles are not being recycled in required numbers, resulting into PET bottles ending into landfills for years. In this research, we were able to absorb synthetic dye from dye solution successfully with the help of nano-particles sandwiched between R-PET aerogel. Here R-PET aerogel was made from used PET bottles converting waste for its best use. The R-PET aerogel and nano-particles were synthesized in laboratory. Furthermore, this adsorption process with the help of R-PET aerogel used as substrate and nano particles sandwiched between R-PET aerogel showed satisfactory result in adsorption of synthetic dye from dye solution. It is highly hoped that this study would further help to understand adsorption of synthetic dyes via R-PET aerogel substrate and nano particles.

I.Introduction.

In recent years, due to fast fashion textile industries are rapidly growing & developing. Due to this rapid development and increase in consumption of textile articles dyestuff and auxiliaries are heavily used, which then lead to water pollution. In last year 2021, the amount of dye stuff used for producing textile articles is 60000 tons worldwide and within this enormous number 80% of dyes which are used are azo dyes [1].dye industry is an important part in textile, light industry, chemical industry and other fields. According to the data published by the National Bureau of Statistics, at present, China's fuel production and trade volume are ranked first in the world[2]. To produce required textile products, textile industries alone uses 100 billion cubic ton of water annually. A sing fabric mill uses 200 tons of fresh water to dye one tone of fabric[3]. Among all the water waste produced, 70-80 % waste water is produced by textile industries and out of which proper treatment is received only by 20% of waste water produced globally[3]. The waste water which is released from textile industries contains various organic toxic compounds which are carcinogenic, teratogenic and mutagenic[4]. The released waste water into water steams and land poisons the air, lowers the oxygen content in water, reduces soil fertility, and changes physical and chemical properties of soil & water [3]. Due to this change in properties of water and soil it leads to death of aquatic life, plants, humans, animals in fact it affects the whole surrounding environment. If the water is consumed by humans it causes cancer, dermatitis, effects central nervous system, skin and eye diseases, etc [3]. if used for agricultural use it leads to death to good micro organisms due to which the soil will become less fertile. So due to this type of physical, biological, chemical effect which is toxic & hazardous, we need to treat the waste water by proper procedure before we release it into environment. waste-water discharged by the dye industry, including dye production, and the mixing of various waste-water produced by the reprocessing of natural and man-made fiber materials by printing and dyeing plants, wool spinning plants, knitting plants, silk factories, etc. Printing and dyeing processing generally includes pretreatment (desizing, refining, bleaching, mercerization), dyeing, printing, finishing and other four processes [5]. The pretreatment stage (including the process of firing, desizing, boiling, bleaching, mercerizing, etc.) should discharge the desizing waste-water, cooking waste-water, bleaching waste-water and mercerizing waste-water, dyeing process discharge dyeing waste-water, printing process discharge printing waste-water and soap liquid waste-water, finishing process discharge finishing waste-water [3]. Printing and dyeing waste-water is a mixture of the above kinds of waste-water, but the main source of printing and dyeing waste-water is dyeing waste-water [3]. Nowadays there are various number of waste water treatments methods, among which the highly used treatment methods by industries are Coagulation, Advanced oxidation, Membraneseparation, adsorption.

Adsorption is a method in which the collection of substances from gas or liquid onto the interface of two phases, mainly onto solid. I.e. the desired substance from gases or liquids can be collected on surface of solid substrate. In this method the removal of contaminants is easy to design and operate. It do not require highly specific working conditions, works with mild operating conditions. Do not produce any toxic by-products, Requires low energy, It is highly efficient and cost effective[6].

The increase in use of plastic like HDPE, LDPE, PE, PET, etc, the plastic waste is also increasing along with the waste water. The plastic waste generated by household, commercial, industrial uses, etc are vent into environment [7]. Improper handling of such waste results into hazardous environmental consequences [7]. The consequence has already reached to severity in urban and suburban areas, as the intensity of disposal management lags as compared to the amount of waste that is gets produced. Finding large piles of unorganized garbage in every snugs and bays of cities and towns is a common phenomenon [7]. In India annually, roughly around dozens of million tonnes of plastic articles are used, which has been predicted to increase in future. It is a well stated fact that 55- 60% of its consumption is transformed into vain and ends up in landfills stays there for years [7]. So due to this I also decided to recycle the PET bottles and convert them into aerogel and will use it as a substrate in my experiment work. Having properties: Porous network structure, Ultra light, Ultra low density, Hydrophobic, High elasticity, Can be recycled [7].

Nanotechnology is a developing science, it involves matters smaller than 101 nano meter in at the minimum 1-D, at this level atoms work in a different way resulting into a greater size relying properties (chem, phy, and bio) which differs from its bigger equivalent [8]. Usually the research about NM's has been always focused on its multi-faceted purposes such as petrochemical, pharma, and agro industries [8]. Nanoparticles has fast adsorption rate. Due to its fast adsorption rate it is widely accepted for treatment of waste water [8]. The two key properties of NP's as good adsorbers are: i. on a mass basis, they have higher surface areas than bulk particles. ii. They can be modified with various chemical groups to increase their chemical affinity towards target compounds. Batch experiments are given priority to find out most efficient NP's for adsorption of dye from waste water [8]. Due to this objective of adsorption various parameters like pH, temp, concentration, and time is checked [8]. Effective utilization of such parameters will help to develop big scale dye removal and treatment of waste water. Although the numbers of studies are done on adsorption, still we don't have required data for it [8]. NP's have high-potential for treatment and also for removal of other organic, synthetic chemicals present in water.

II.Experimental section.

Synthesis: R-pet Aerogel.

Step:- 1[9]

Cut PET bottles into small pieces as shown in figure 1 and wash them properly toremove all dirt. Treat them with NaOH to produce carboxyl and hydro gel groups on their surface. Fully immerse PET fiber in aqueous solution of NaOH (4.0% wt. %concentration) using 1g: 10 ml ratio.

Step: - 2[9]

Heat resulting mixture in oven at 80 C for one hour to accelerate hydrolysisprocess. After 1 hr wash all the fiber strains with di-water to remove remaining NaOH.

Step: - 3[9]

Immerse PET fibers into mixture of PVA, GA and di-water at ratio of 10:1:0.02respectively. Maintain Ph at 3 by HCl (37%) to boost cross linking reaction.

Step: - 4[9]

Sonicate the resulting mixture from step-3 for 30 minutes at 220-230 W forhomogenation and removal of bubbles. Then again carry out cross linking reaction in oven for 3 hrs at 80C.

Step:- 5[9]

After cross linking in oven for 3hr place it in freezer for 6-8 hr . Then put frozen R-PET aerogel sample in freeze dryer to remove all solventand produce aerogel.

Experiment

Materials: Aerogel, nanoparticles, dye solution, stand, separating flask, funnel, tripod, beaker, dropper, test tubes.

Method: First of all wash all glassware properly so they don't have any impurity present in them to alter our result. Take a stand and attach a separating flask with it properly at maximum height. Below the end of separating flask put a tripod with a glass funnel in between and a glass beaker underneath it to collect all the discharge from separating flask. After arranging all the apparatus properly, take our prepared R-PET aerogel and in two circle shapes. After that spread prepared nano particles on one R-PET aerogel circle and make them in to a sandwich by putting both to gather and put in on the upper part of glass funnel (as shown in image below) . After all the preparation for the experiment pour the stock solution of dye in the separating flask and adjust the flow of discharge such that it flows drop by drop. The drop falling from the separating flask must fall on the surface of the RPET aerogel fixed on the surface of the glass funnel. To find out the adsorbance rate of the obtained dye solution at 1hr, 5hr, 10hr, 15hr, & 24 hr at this time interval all the samples were collected with help of dropper into test tubes. (as shown in figure 3)

Fig: 1 Experimentation Setup **Fig: 2** Experimentation Setup

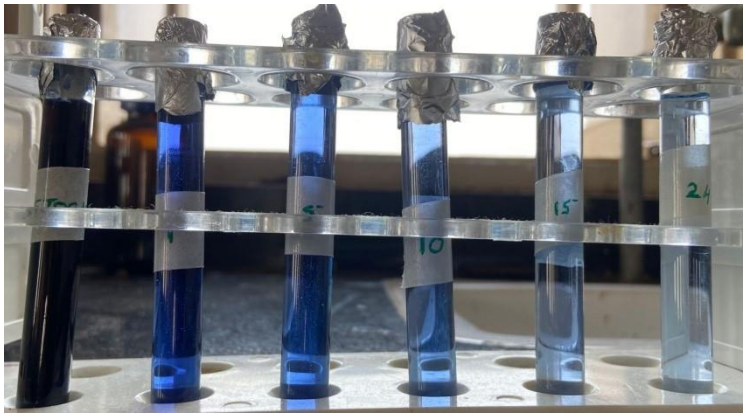
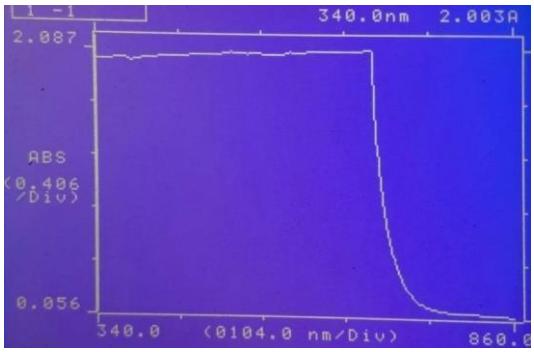


Fig: 3 Collected Samples

III.Result and discussion.

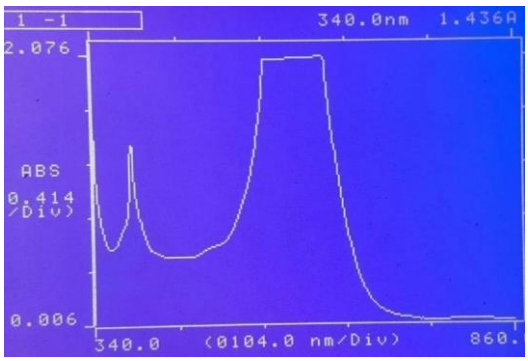
UV Analysis: This analysis is used to differentiate and recognize the principle main components present, to find adsorbance etc. UV analysis is the most useful, having best linearity. UV analyzers cannot be used for compounds having low chromophores present. It means no color or virtually blunt because they cannot absorb light at low range. This analysis is widely preferred among other available due to its low cost analysis report. Here, in project for analysis, we have used syntronics UV-VIS double beam spectrophotometer 2205. All the graphs of adsorbance vs. wavelength were obtained from using this above mentioned instrument.

Here in this experiment, the result obtained via UV analysis has shown gradually decrease in concentration of the dye present in collected samples. The absorbance of UV light from the sample is decreased from 1.674 to 0.112 at constant wavelength 385.1 which means the successful adsorption of dye is done via nanoparticles sandwiched between two layers of R- pet aerogel.



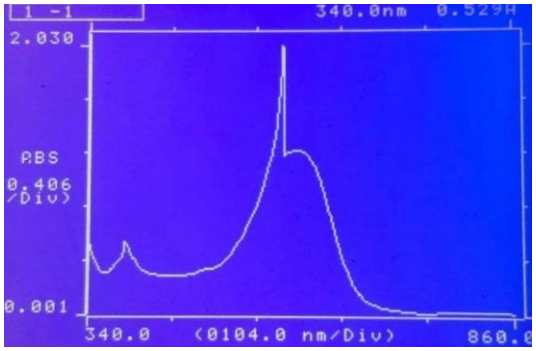
Time:0hr
Absorbance:0

Fig:1 Stock solution graph



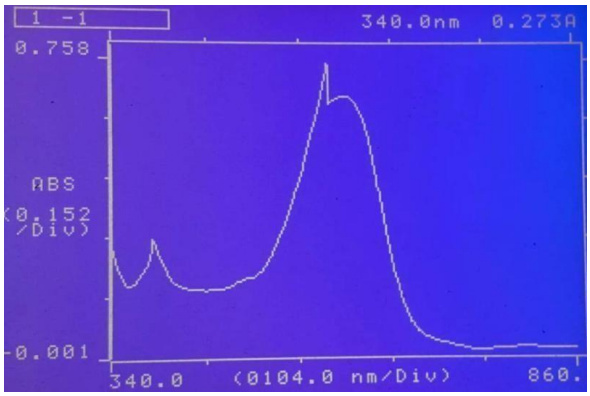
Time:1hr
Absorbance:1.674
Wavelength:385.1

Fig:2 Sample1graph



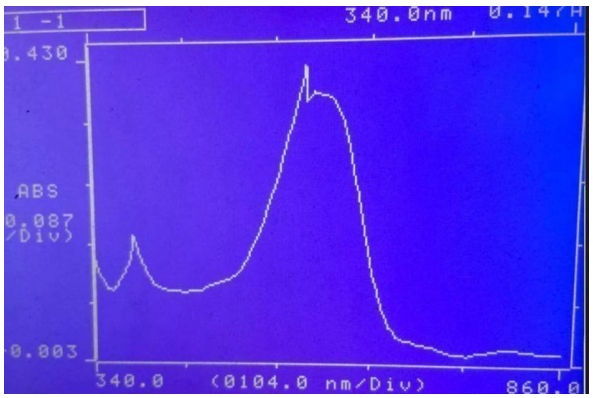
Time:5hr
Absorbance: 0.554
Wavelength:385.1

Fig:3 Sample2graph



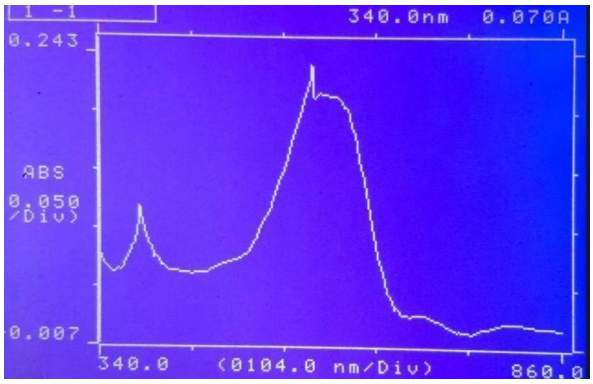
Time:10hr
Absorbance:0.301
Wavelength:385.1

Fig:4Sample3graph



Time:15hr
Absorbance:0.184
Wavelength:385.1

Fig:5Sample4graph



Time:24hr
Absorbance:0.112
Wavelength:385.1

Fig:6 Sample5graph

IV.Conclusion.

According to the performance and result obtained from this study on adsorption of synthetic dye via nanoparticles sandwiched between R-PET aerogel showed satisfactory result in adsorption of synthetic dye from prepared dye solution. , the result obtained via UV analysis has shown gradually decrease in concentration of the dye present in collected samples. As shown in graph & result, the absorbance of UV light from the sample has decreased from 1.674 to 0.112 at constant wavelength 385.1 which means the successful adsorption of dye is done via nanoparticles and R-PET aerogel. As we all know that nano-technology is a developing science and it is not fully developed yet, due to this the mechanism of adsorption via nano-materials is very hard to understand. as we all know that nano technology is very promising for adsorbtion and many other purposes, as of this project I was unable to study the mechanism of adsorption using nano particles, I hope that this project theses will be helpful in further research for same type of work and in further understanding of adsorption of synthetic dyes via nano particles.

V.Reference

[1] Cheng Y, Zhou QX, Ma QY. Advances in Dye waste-water Treatment Technology [J]. Environmental Pollution Control Technologies and Equipment, 2003, (46): 56- 60.

[2] Xu Weichang. Current Situation and Prospect of waste-water Treatment in Dye Industry [J]. Dye Industry, 2002, 39(6): 35- 39.

[3]QiangLiu. PollutionandTreatmentofDyeWaste-Water.
https://iopscience.iop.org/article/10.1088/1755-1315/514/5/052001/pdf

[4] Zhang Yufeng, Teng Jie, Zhang Xueying. Advances in Technology of Printing and Dyeing waste-water Treatment [J]. Industrial Water Treatment, 2003, 23(4): 23- 27.

[5]Li Xudong, Yang Yun. Application of waste-water Treatment Technology and Engineering [M]. Beijing: Machinery Industry Press, 2003.

[6]https://en.wikipedia.org/wiki/Adsorption

[7]Annual Report 2019-20 on Implementation of Plastic Waste Management Rules, 2016**https://cpcb.nic.in/uploads/plasticwaste/Annual_Report_2019-20_PWM.pdf**

[8] ZhengqingCai,Youmin Sun ,Wen Liu, Fei Pan, Peizhe Sun, Jie Fu.
An overview of nanomaterials applied for removing dyes from wastewater. https://doi.org/10.1007/s11356-017-9003-8.

[9] Duyen Khac Le , Gek Nian Ng , Hong Wei Koh , Xiwen Zhang , Quoc Ba Thai , Nhan Phan-Thien , Hai Minh Duong. Methyltrimethoxysilane-coated recycled polyethylene terephthalate aerogels for oil spill cleaning applications.
https://doi.org/10.1016/j.matchemphys.2019.122064