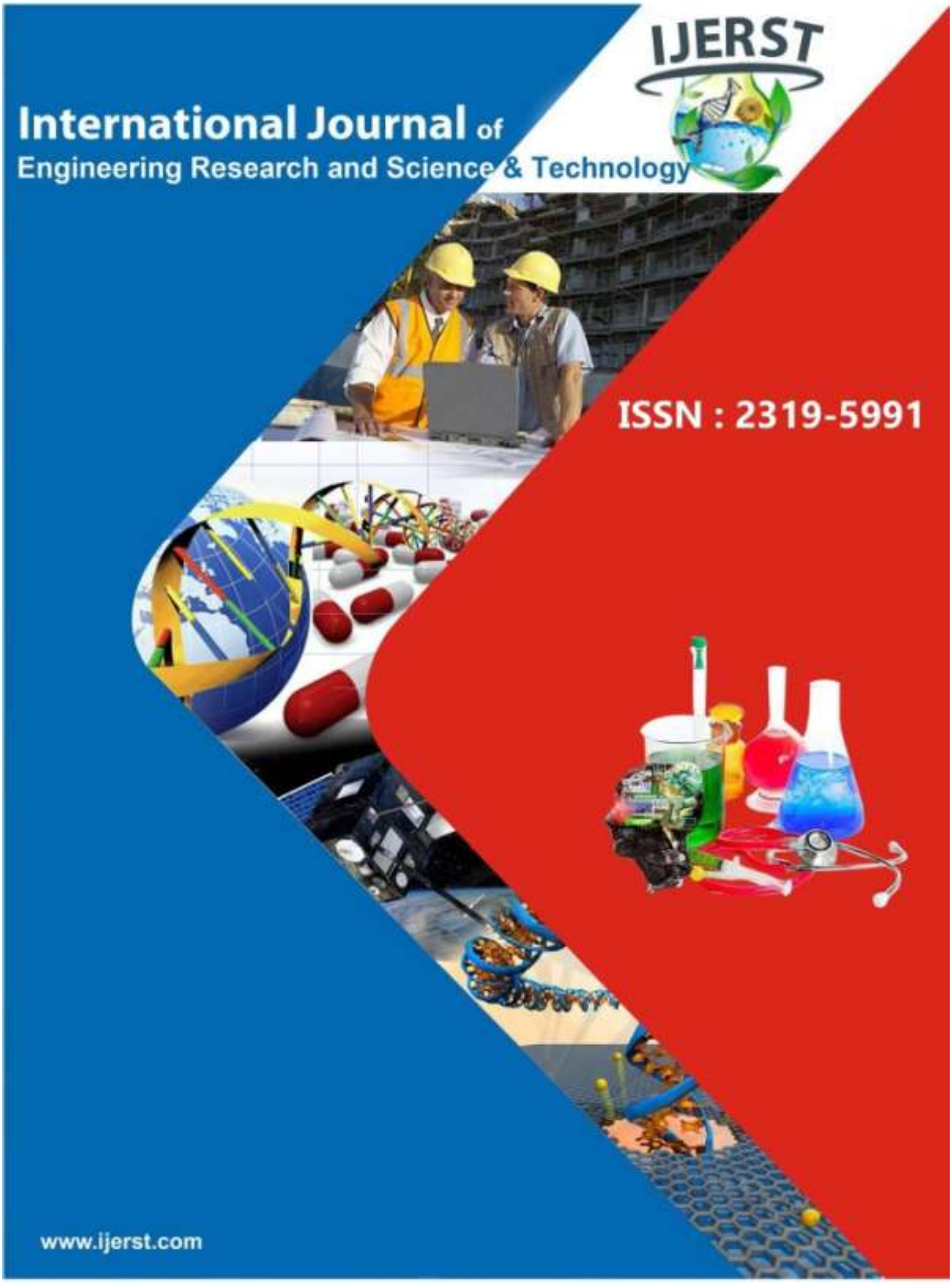
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RemovalofCoraleleNavyBlue3DDyefromActivatedCarbon Synthesized from Paper Mill Sludge

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Abstract: The adsorption capacity of activated carbon synthesized from sludge from paper mills is investigated. Converting of paper mill sludge to adsorbent like activated carbon is a significant process since it decreases environmental problems connected with disposal of waste sludge. The dye (Coralele Navy Blue 3G) adsorption on activated carbon generated from paper mill sludge from synthetic textile waste water (STW) was investigated. The experimental design and data analysis were done using four factors and a full factorial central composite design based on response surface methodology (RSM). Initial dye concentration: 40-120 mg/l, Adsorbent dose: 1-10gm/l, pH 3-9, and contact time: 0-150 minutes were used as input parameters, with percentage dye removal being the system's reaction. The ideal situation values of operational parameters are found to be initial dye concentration: 80 mg/l, Adsorbent dose: 5.5 gm,Contact time:150 minutes, and pH:6. Optimum dye removal is found to be 78.8%.The result indicated thatpapermillsludgecarboncanbeusedasanalternativeadsorbentfortreatmentofeffluentscontainingCoraleleNavy Blue3G dye.

I. INTRODUCTION

The presence of dyes in effluents is a cause for concern because of their negative effects on numerous forms of life. Dye emission in nature is a source of concern for both toxicological and aesthetic reasons [1]. Textile, leather, paper, plastics, and other businesses use dyes to achieve a certain aim, and they also use a lot of water. As a result, a lot of shaded wastewater is produced [2]. The shading is thought to have a substantial impact on water quality. Even little amounts of dyes in water – under 1 ppm for a few colours – are extremely noticeable and irritating [3,4]. The most commonly used substance for dyeing cotton, wood, and silk is MB. As a result, both humans and animals suffer from eye burns. It has the ability to move quickly. Various techniques have recently been considered for improving less expensive and practical adsorbents. A few labourers have proposed a variety of non-regular ease adsorbents, including normal materials, biosorbents, and waste materials from agriculture and industry. These substances could be used as adsorbents to remove colours from an arrangement.

TextileIndustries

Among the numerous engineering disciplines, Textile engineering is growing increasingly popular as the textile industry improves. Textile engineering encompasses all aspects of the environment. The textile industry is a large industry that deals with the design and manufacture of cloth and yarn. For fabric manufacture, the textile industry uses a variety of natural and synthetic fibres. The textile

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business often consumes a lot of energy and water. During the manufacturing process, this industry employs a variety of chemicals.

A. The finishing and dyeing activities consume 60% of the industry's resources. The majority of the environmental issues associated with the textile sector are tied to water pollution. The textile industry plays a significant role in the country's economy.

B. **LiteratureSurvey**

Torregrosa-Maciaetal.(2004),provides the impression that a solid adsorbent with a broader pore size distribution can be obtained only through chemical activation. Physical activation improves the pore structure of the adsorbent, while CO/CO2 causes partial oxidation of the carbonised. [12]

Yadav et al, (2012) studied Activated carbon obtained from the paper industry is used to remove colour from paper mill effluent. The effects of various operating variables such as pH, adsorbent dose, including effect of concentration, solution, contact time, and particle size were studied and investigated for optimum colour removal amounting to 60 minutes of contact time for adsorption equilibrium at a dosage of 2 g/L of activated carbon. The material had a maximum removal capability of 97 percent when adsorbent dosages were increased from 0.5 to 2.0 g/l, and the percentage removal increased from 28 to 97 percent. The removal rate of dye is also improved by reducing the size of the adsorbent material. [13].

II. **MATERIALANDMETHODS**

A. ChemicalsandGlassware

Analytical grade reagents were employed to prepare the solution work, and distilled water was used for research. Coralele Navy blue 3G dye was employed for the initial adsorption studies, and zinc chloride was used to chemically activate the adsorbent. Chemicals such as sodium hydroxide and hydrogen chloride were used to change the pH from acidic to basic. These compounds were obtained from the department's laboratory. The Borosil glassware used in the research included beakers, volumetric flasks, conical funnels, pipettes, measuring cylinders, and other items. The glassware was washed numerous times in water before being used, and then washed again in water. After that, distilled water was used for the final rinse.

B. **Instrumentation**

A rotary shaker was utilised to conduct the adsorption trials. The sludge was mixed with zinc chloride using a magnetic stirrer for activation. An ultraviolet spectrophotometer was used to determine the absorbance. An oven was used to dry the materials. A muffle furnace at 8000 C was employed to carbonise the material. Glass beakers were used to manage the solutions. A digital balance was used to weigh the samples.

C. PreparationofAdsorbent

1. Thematerialusedtopreparactivatedcarbonwascollectedfromthelocalpapermill.

Fig.2.1Papermillsludge

2. Thesludgewasthendriedinovenfor3daysandcrushedintosmallersize.



Fig.2.2sludgefordrying Fig. 2.3crushedsludge Fig.2.4sievedsludge

3. Zinc chloride was employed to chemically activate the sludge. A magnetic stirrer was used to mix 20 grammes of raw material that had been activated with 0.1 N $ZnCL_2$. The amount of $ZnCL_2$ needed to activate the material in a 1:1 ratio was estimated. The slurry was then held at 800 C for 8 hours on a magnetic stirrer.

4. The slurry was filtered out after 8 hours and dried in the oven for 24 hours.

5. The slurry was removed from the oven for pyrolysis after 24 hours. The slurry was held within a muffle furnace at 8000 C for 2 hours during pyrolysis. The raw material and $ZnCL_2$ slurry turned yellow.

6. The carbonization process was carried out with a nitrogen flow rate of 100 cm^3/min.

RESULTSANDDISCUSSION

A. Resultofproximateanalysisofthesludges

Fromtheproximateanalysisitwasclearlyverifiedthatthereisincreaseinfixedcarboncontentafteractivation.

Table3.1:-ResultsofProximateAnalysis

Component	Beforeactivation	Afteractivation
Fixedcarbon	12.932	18.786

B. AdsorptionStudies

1. CalibrationcurveofCoralelenavyblue3 Gdye

The adsorbance of solutions with concentrations ranging from 40 to 120 mg/l was measured using a UV spectrophotometer. The calibration curve was created by plotting these results, and it was used as a reference for all adsorption calculations throughout the project. The majority of the adsorbance values were maximal at 541 nm, hence this wavelength was used to study all of the adsorbance results.

2. ParametricStudyfortheAdsorptionofCoraleleNavyblue3GDye

Variousparameterssuchasinitialdyeconcentration,adsorbentdose,contacttimeandpHwereoptimizedbyusingcentralcompositedesign.Itreducedtheexperimentalworkto30trials.Theresultsfortrialsareshownin

C. **EffectofVariousParameters**

Basedontheadsorption valuesobtainedusingvariousexperimentalruns, theeffectofdifferentparametersisexplainedasunder:

1. **EffectofContactTime**

Figures 3.2, 3.3, and 3.4 depict the effects of altering pH, adsorbent dosage, and beginning dye concentration on the adsorption of coralele navy blue 3G dye, respectively. The adsorption rate increased with the passage of time, as indicated in the graphs. The adsorption percentage increases as the contact period increases from 0 to 150 minutes. At a contact time of 150 minutes, the maximum adsorption was investigated. It was discovered that if the contact period was increased beyond 150 minutes, the adsorption may be increased even more. There is always a limit to contact duration after which adsorption cannot be enhanced any further and instead begins to decrease as active sites become saturated over time.

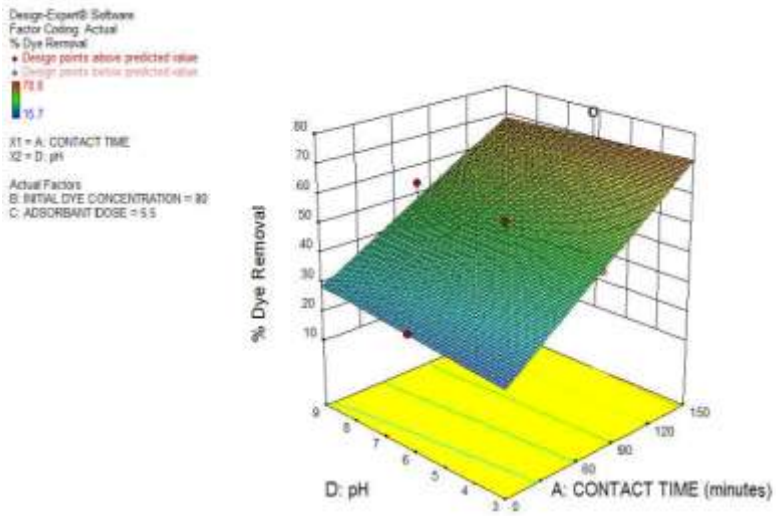
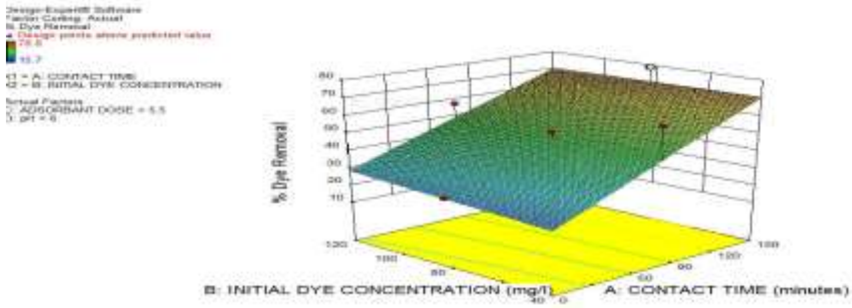


Figure3.2:- Effectofcontacttimewithchangeinph HatAdsorbentdosage5.5g/landinitialdyeconcentrationof80 mg/l

Figure3.3:-Effectofcontacttimewithchangeininitialdyeconcentrationat Adsorbentdosage5.5g/landpH6



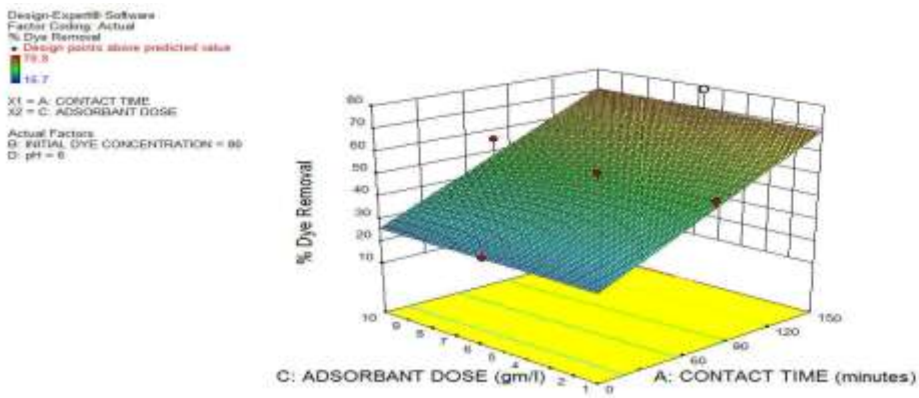
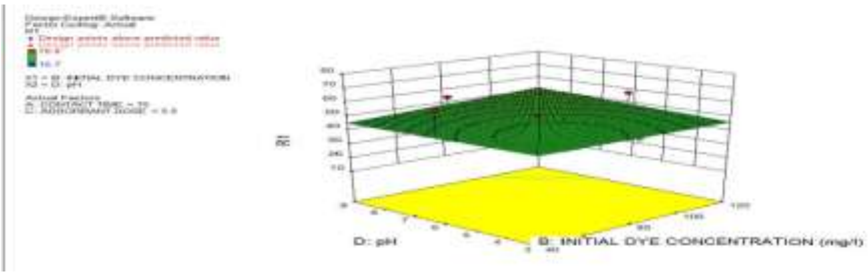


Figure3.4:- Effectofcontacttimewithchangeinadsorbentdoseatp H6andinitialdyeconcentrationof80mg/l

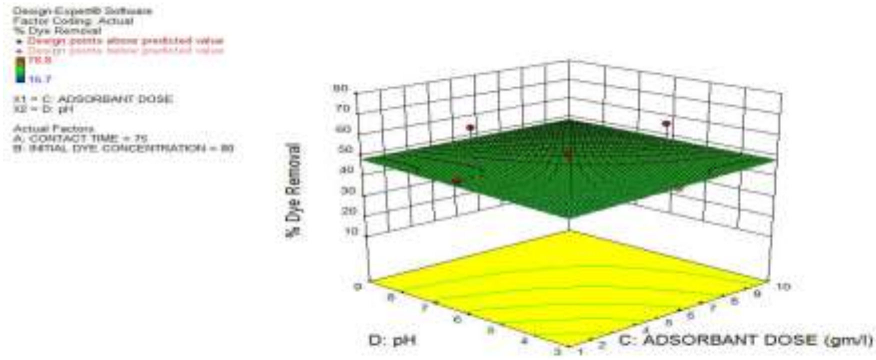
2. **EffectofpHofthesolution:**

The adsorbent's surface characteristics are strongly influenced by pH. It also has an impact on the dye molecules' ionisation degree. The effect of pH on dye adsorption utilising paper mill sludge-based activated carbon is shown in Figures 3.5, 3.6, and 3.7, respectively.

Intheexperiment,100ml dye solutions with different doses of the adsorbent were investigated in the experiment, with pH ranging from 3 to 9. Litmus papers were used to analyse the pH, which was maintained from acidic to basic using 0.1 N sodium hydroxide and 0.1 N hydrochloric acid solution. The graphs show that adsorption increases from pH 3-6 to pH 9 and then decreases. At pH 6, the optimum adsorption It was



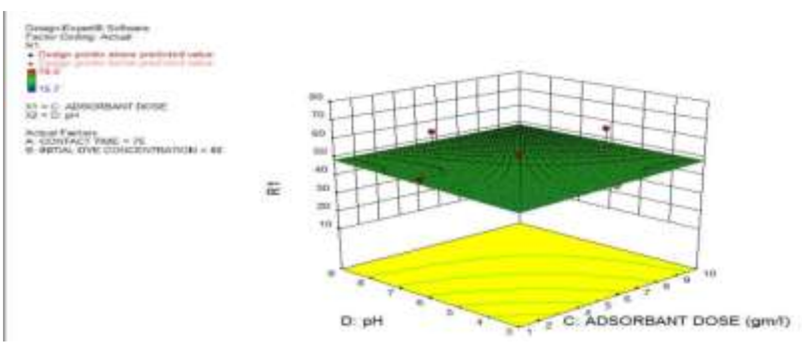
discovered what proportion. Figure 3.5: Effect of initial pH on initial dye concentration at 75 minutes contact time and 5.5 g/l adsorbent dosage



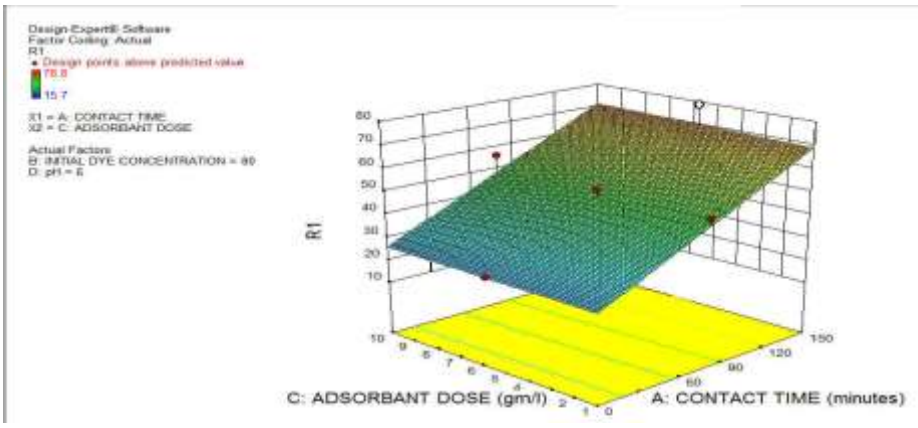
3. **EffectofAdsorbentDosage:**

The influence of the adsorbent dosage on dye removal was also investigated. The adsorbent dose was changed from 1 gm to 10 gm in 100 ml solutions during this study. According to the design expert, the three adsorbent dosages in 100 ml solutions were 1g, 5.5g, and 10 g. The research was conducted out in a controlled environment.

Figures 3.8, 3.9, and 3.10 indicate that as the adsorbent dose was raised, the adsorption % increased as well. At 5.5 g/l, dye removal was found to be optimal. After that, the adsorbent dosage has no discernible effect on dye removal. This was due to the fact that as the adsorbent dose was increased, the active sites increased as well, but beyond a certain point, the dye began to fade.



EffectofadsorbentdosagewithchangeinpHatcontacttime75minutesandinitialdyeconcentrationof80mg

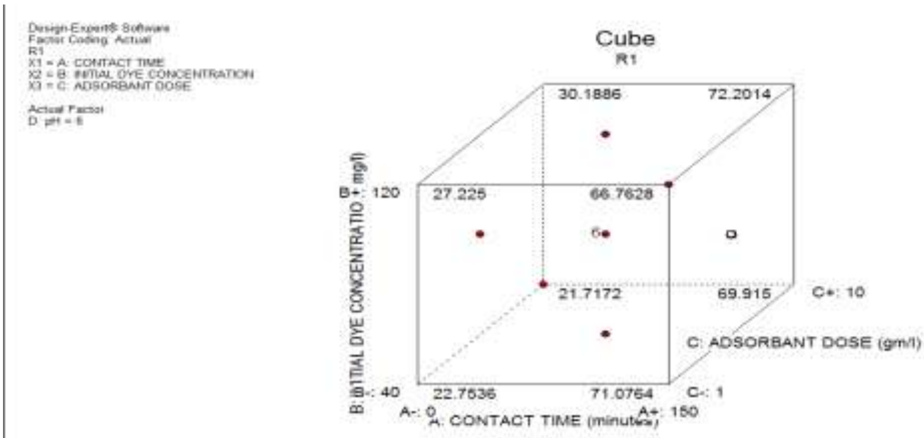


/l.

4. Effectofinitialdyeconcentration

By adjusting the dye concentration from 40 to 120 mg/l, the effect of dye concentration on percentage dye removal was investigated. The dye concentration was found to have a significant impact on dye removal. Figures 3.11, 3.12, and 3.13 show the effect of dye concentration, accordingly. Because a high dye concentration results in a high driving force for mass transfer, the adsorption capacity increases as the initial dye concentration rises. Due to the high concentration of dye, the active sites of the adsorbent are surrounded by a greater number of dye molecules, resulting in more efficient adsorption. The original dye concentration that worked best was 80 mg/l.

Cubicalrepresentationforeffectofcontacttime,pHandadsorbentdosekeepinginitialdyeconcentrationof



80mg/lisshownin Figure 3.14.

Figure3.14:-Effectofcontacttime,pH,andadsorbentdoseatinitialdyeconcentrationof80mg/l.

7.6Optimumparameters

The following are the optimum values for the operational parameters obtained from the central composite design: -

- 150-minute contact time • pH = 6
- 5.5g/l adsorbent dosage
- 80 mg/l initial dye concentration

A verification run was carried out with the optimised set of operational parameters in order to corroborate the outcome obtained through optimization. The expected response was 70.99, but after completing experiments on the identical optimum settings, the actual value was 78.8. Both numbers were found to be fairly close, indicating that the model was successful.

E. **Modelvalidation**

The reactions of paper mill sludge carbon as an adsorbent for the adsorption of coralele navy blue 3G dye from aqueous solution were measured. The percentage error between the actual and projected dye removal levels was determined to be less than 10% for each trial, as shown in Table 3.6, which shows the model's validation.

Table3.6:-Centralcompositedesignusedandresponsesofadsorption

S.No.	pH	Contact Timemi nutes	AdsorbentDo se g/l	InitialDye Conc. mg/l	%DyeRemoval		% error
					Predicted	Actual	
1	3	0	10	40	16.14	15.7	2.79
2	6	75	5.5	80	47.73	51.1	6.60
3	3	0	1	40	16.86	16	5.40
4	9	150	10	120	72.32	67.3	7.45
5	3	150	1	120	64.68	61	6.04
6	6	75	5.5	40	59.37	65	8.67
7	3	0	10	120	22.46	22.3	0.71
8	6	75	10	80	50.51	56	9.81
9	6	75	5.5	80	49.73	51.1	2.68
10	6	75	5.5	80	47.73	51.1	6.60
11	9	75	5.5	80	48.69	54	9.83
12	9	0	1	120	30.41	28.07	8.35
13	9	0	10	40	18.30	18.1	1.09
14	6	75	5.5	80	47.73	51.1	6.60
15	9	0	1	40	21.64	21.02	2.97
16	9	150	10	40	63.29	58	9.13
17	6	0	5.5	80	25.47	25.5	0.11
18	6	75	5.5	80	47.73	52	8.21
19	9	0	10	120	32.92	31	6.19
20	3	150	10	40	75.53	70	7.91
21	9	150	1	120	68.84	64.4	6.90
22	3	150	10	120	72.09	67.83	6.28
23	9	150	1	40	68.82	63.1	9.07
24	6	150	5.5	80	70.99	78.8	9.91
25	3	150	1	40	73.33	68.37	7.26
26	6	75	1	80	46.95	49.86	5.83
27	6	75	5.5	80	47.73	51.1	6.60
28	3	75	5.5	80	46.77	46	1.67
29	3	0	1	120	21.04	20.45	2.86
30	6	75	5.5	120	52.09	57.5	9.40

The above research has potential application because it addresses an environmental issue by adding a new dimension to the disposal of pulp and paper effluent and producing an useful adsorbent from this waste that may be utilised to remove carcinogenic dyes used in textile industries.

CONCLUSIONS

The influence of an industrial waste-based adsorbent, paper mill sludge carbon, on the adsorption of the dye, Coralele navy blue 3G, from aqueous solution was demonstrated in this work. The current study's findings demonstrated that paper mill sludge carbon has the potential to remove Coralele navy blue 3G colour. Various parameters such as contact time, pH, adsorbent dosage, and starting dye concentration were investigated. The reaction conditions were optimised using a central composite design. pH was set to 6, contact period was set to 150 minutes, adsorbent dose was set to 5.5g/l, and the starting dye concentration was set to 80 mg/l. The dye removal rate was found to be 718.8% under these conditions. The central composite design has proven to be a success.

REFERENCES

[1]H.Metivier-Pignon,C.Faur-Brasquet,P.L.Cloirec,Adsorptionofdyesontoactivatedcarboncloths:approachofadsorptionmechanismsandcouplingofACCwithultra-filtrationtotreatcolouredwastewaters,Sep.Purif.Technol.31(2003)3–11.

[2]K.Ravi,B.Deebika,K.Balu,Decolourizationofaqueousdyesolutionsbyanoveladsorbent:applicationofstatisticaldesignsandsurfaceplotsfortheoptimizationandregressionanalysis,J.Hazard.Mater.B122(2005)75–83.

[3]T.Robinson,G.McMullan,R.Marchant,P.Nigam,Remediationofdyesintextileseffluent:acriticalreviewoncurrenttreatmenttechnologieswithaproposedalternative,Biresour.Technol.77(2001)247–255.

[4]I.M.Banat,P.Nigam,D.Singh,R.Marchant,Microbialdecolourizationoftextile-dye-containingeffluents:areview,Bioresour.Technol.58(1996)217–227.

[5] D.Ghosh,K.G.Bhattacharyya,Adsorptionofmethyleneblueonkaolinite,Appl.ClaySci.20(2002)295–300.

[6] I.A.W.Tan,A.L.Ahmad,B.H.Hameed,Adsorptionofbasicdyeonhigh-surface-areaactivatedcarbonpreparedfromcoconuthusk:equilibrium,kineticandthermodynamicstudies,J.Hazard.Mater.154(2008)337–346.

[7] I.A.W. Tan, A.L. Ahmad, B.H. Hameed, Adsorption of basic dye using activated carbon prepared from oil palm shell: batch andfixedbedstudies,Desalination225 (2008)13–28.

[8] S.M.Ghoreishi,R.Haghighi,Chemicalcatalyticreactionandbiologicaloxidationfortreatmentofnon-biodegradabletextileeffluent, Chem.Eng. J.95 (2003)163–169.

[9] A.K.Jain,V.K.Gupta,A.Bhatnagar,Suhas,Utilizationofindustrialwasteproductsasadsorbentsfortheremovalofdyes,J.Hazard.Mater.B101(2003) 31–42.

[10]Y.S.Ho,G.McKay,Sorptionofdyesandcopperionsontobiosorbents,ProcessBiochem.38(2003)1047–1061.

[11]F.Derbyshire,M.Jagtoyen,R.Andrews,A. Rao, I.Martin-Gullon,E.Grulke, Carbonmaterialsinenvironmentalapplications,in:L.R.Radovic(Ed.),ChemistryandPhysicsofCarbon,vol.27,MarcelDekker,NewYork,2001,pp.1–66.

[12]Torregros-Macia,Sabale,Anjali;“BiosorptionofMethyleneBlueandMalachiteGreenfromBinarySolutionontoUlvalactuca”,Int.J.Curr.Microbiol.App.Sci.vol 3,pp 295-304,(2004)

[13]RanjanaYadav,KanjanUpadhyayandSavita Maru,“Colourremovalfrompapermilleffluentusingactivatedcarbon”,Journalofindustrialpollutioncontrol,vol28,pp45-50,(2012)