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PHOTODEGRADATIVE ADSORPTION OF DYE INDUSTRY EFFLUENT USING CHITOSAN, CARBOXYMETHYL CELLULOSE BLEND WITH ETHYLENE GLYCOL.

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Abstract

The mixes of chitosan, carboxymethyl cellulose and Ethyleneglycol were readied in diverse weight proportions in the vicinity of crosslinking specialists remediation studies have been conducted for Photodegradative adsorption of dye industry effluent using CS/CMC with EG.The outcomes are exhibited.

Keywords: *CS/CMC , EG, Adsorbent, ph.*

INTRODUCTION

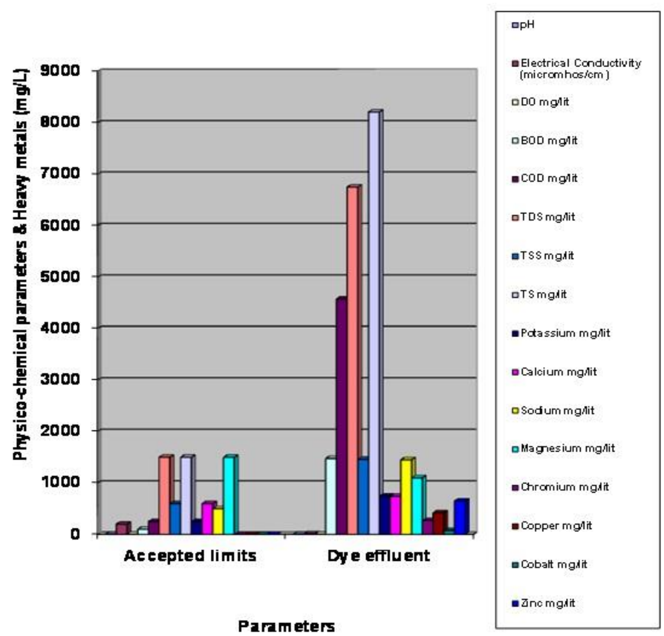
Chitosan has without a doubt been a standout amongst the most well known adsorbents for the expulsion of metal particles from fluid solutiont and is generally utilized as a part of waste treatment applications (Babel and Kurniawan, 2003). Notwithstanding its productive utilize, the adsorption capacity of chitosan has not been acknowledged to a fantastic level. As of late, consideration has been centered around different adsorbents that have metal-tying limits and high selectivity to expel undesirable overwhelming metals from polluted water. Further substance alterations of chitosan can be made to enhance the selectivity and the limits for metal particles. Henceforth in the present task work chitosan was mixed with carboxymethyl cellulose in the vicinity of ethylene glycol as cross connecting operators and utilized for the treatment of color expulsion from wastewater.

TREATMENT OF HEAVY METALS CONTAINING SOLUTIONS USING CS/CMC (EG) (1:1) BLEND

Table(1) Physico-chemical factors and heavy metal content in the dye industry effluent of Tirupur Industrial Area, India

Parameters	Accepted limits	Dye effluent
pH	7 – 8.5@	8.2
Electrical Conductivity (µmhos/cm)	75 – 200@	14.5
DO mg/lit	Not < 6.0@	3
BOD mg/lit	100@	1475
COD mg/lit	250@	4575
TDS mg/lit	850 – 1500@	6750
TSS mg/lit	100 – 600@	1460
TS mg/lit	500 – 1500@	8210
Potassium mg/lit	250@	745
Calcium mg/lit	200 – 600@	740
Sodium mg/lit	500@	1450
Magnesium mg/lit	1000 – 1500@	1100
Chromium mg/lit	2.0#	270
Copper mg/lit	3.0#	420
Cobalt mg/lit	0.01#	76
Zinc mg/lit	1.0#	650

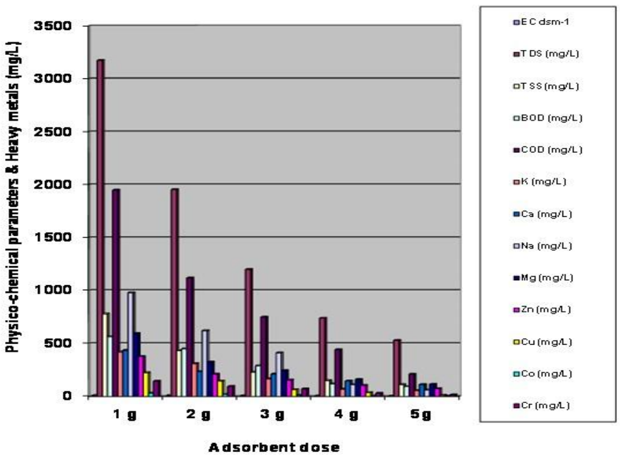
Values expressed as mean of 6 individual values
@ ISI Standards for disposal of industrial wastewater.
# USPHS standards for disposal of Industrial waste water



Fig(1) Physico-chemical factors and heavy metal content in the dye industry effluent of Tirupur Industrial Area, India

The wastewater was gathered from the coloring unit in Tirupur, Tamil Nadu India. The profluent was profoundly shaded and the physico – chemical parameters were high or more as far as possible. Thus it the readied CS/CMC – EG (1:1) mix was utilized for the treatment reason. Batch adsorption study was done and the adsorption was finished by changing the conditions like change of adsorbent measurement, pH and Time of adsorption. The outcomes are displayed underneath.

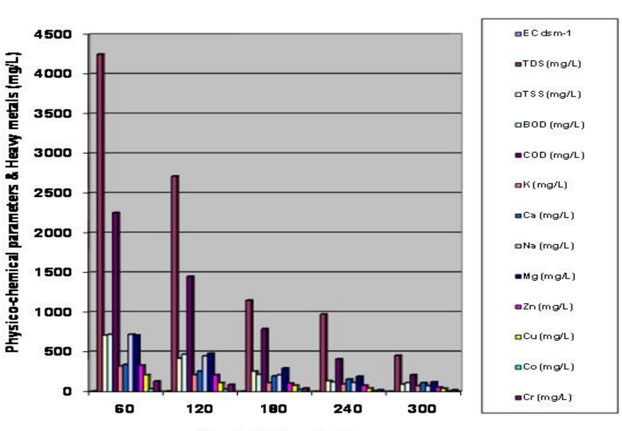
The bunch adsorption investigation of CS/CMC (1:1) – EG mix was done by changing the adsorbent measurement from 1 gm to 5gms. After every treatment the physicochemical investigation and metal examination were done. The parameters, for example, electrical conductivity, chemical oxygen request, biochemical oxygen interest, aggregate broke up solids, absolute hardness, magnesium, calcium hardness, alkalinity, chloride, all out nitrogen, sodium and potassium were found to lessening as the adsorbent measurements was expanded from 1 gm to 3 gms (Table – 2 and Figure – 2).



Fig(2) Effect of adsorbent dose of Chitosan/CMC (EG) on the physico-chemical factors and metals of the dye industry effluent

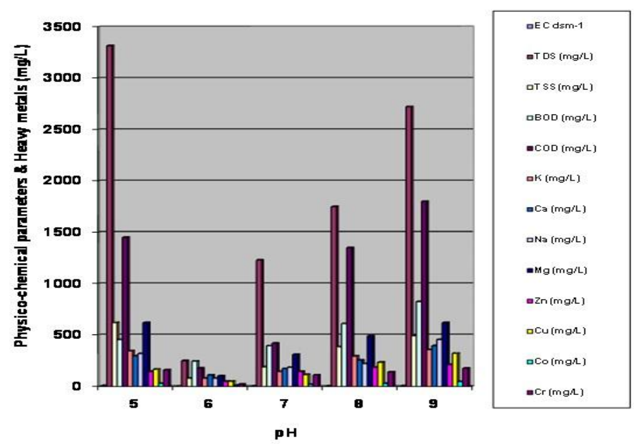
The outcomes demonstrated an enduring reduction in the parameters for the initial three grams and there was very little change in the components after 3 gms upto 5 gms. Most extreme adsorption occurred at adsorbent dosage of 3 gms. At first the adsorption was quick which may be because of accessibility of more number of adsorption destinations (Mahendra Kumar et al., 2009).

These perceptions likewise demonstrate that the adsorption of metal particle in the wastewater is identified with the surface range of the adsorbent. Differential adsorption limits of the adsorbent rely on upon the degree of surface alteration. At certain measurements of adsorption crest was come to after which, no adsorption of metal particle to the adsorbent occurred. Likewise the measure of free particles in solution stayed steady (Nomanbhay and Palanisamy.



Fig(3) Effect of contact time of Chitosan/CMC (EG) on the physico-chemical factors and metals of the dye industry effluent

The impact of contact time on the overwhelming metal particles adsorption by CS/CMC – EG (1:1) was explored for 6 hours. From the Table - 3 and Figure - 3 it is clear that the rate of adsorption was most extreme at first and began diminishing with time. Most extreme adsorption was conceivable as the contact time came to five hours. Contact time is a vital parameter on the grounds that this variable decides the adsorption energy of an adsorbate at a given starting convergence of the adsorbate. After beginning adsorption of adsorbate, the accessible destinations in the adsorbent would be diminished and along these lines the rate of adsorption further diminished which achieved a constraining quality at harmony (Jin and Bai, 2002). Rate of adsorption is of incredible centrality for building up the adsorbent based water innovation. In this manner, the capacity of composite to assimilate greatest sum inside of 4 hrs showed its suitability as a powerful adsorbent (Saeed et al., 2005).

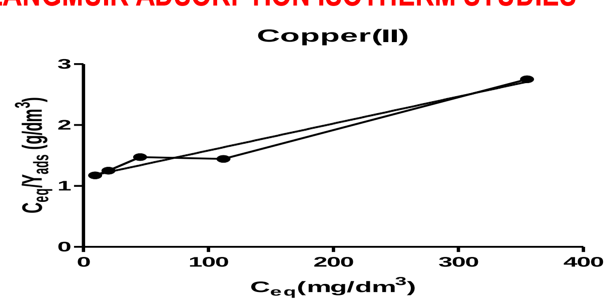


Fig(4) Effect of pH on the physico-chemical factors and metals of the dye industry effluent - Chitosan/CMC (EG)

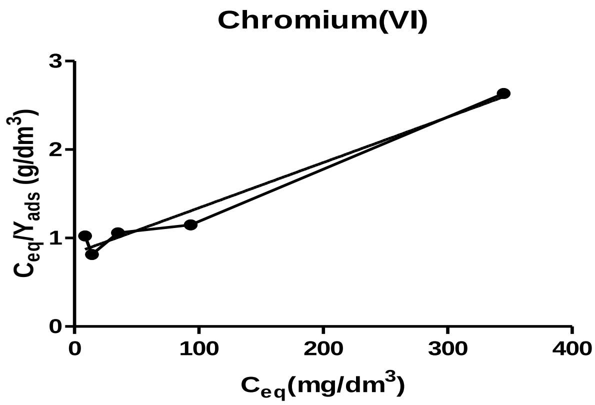
pH is a noteworthy element for deciding the metallic's type species in watery media. At the point when deciding different metal species, harmony models for some metals are built utilizing the arrangement of mathematical statements utilized for basic acid base counts. At low pH values adsorption is low where surfaces have solid positive charge like that of the particles. However there is still adsorption even though there is aversion in the middle of surfaces and metal particles.

This may show a restricted commitment of concoction adsorption that is brought on by the unpaired electrons of nitrogens at amino utilitarian gatherings of chitin and chitosan. Bu this impact is highly decreased because of the crosslinking so as to mix of CS with CMC furthermore with ethylene glycol. In the present study pH 6 was observed to be ideal for adsorption.

LANGMUIR ADSORPTION ISOTHERM STUDIES



Fig(5) Langmuir isotherm for Copper



Fig(6) Langmuir isotherm for Chromium

Figures – 5 and 6 confirmed the applicability of the Langmuir adsorption isotherm. From the values of the slope and intercept of the straight lines, the Langmuir constants b (dm^3. mg), K_L $dm^3.g^{-1}$ and maximum saturation sorption capacity C_{max} ($mg.g^{-1}$) were calculated. The results of the Langmuir constants and the C_{max} are presented in Table - 7.

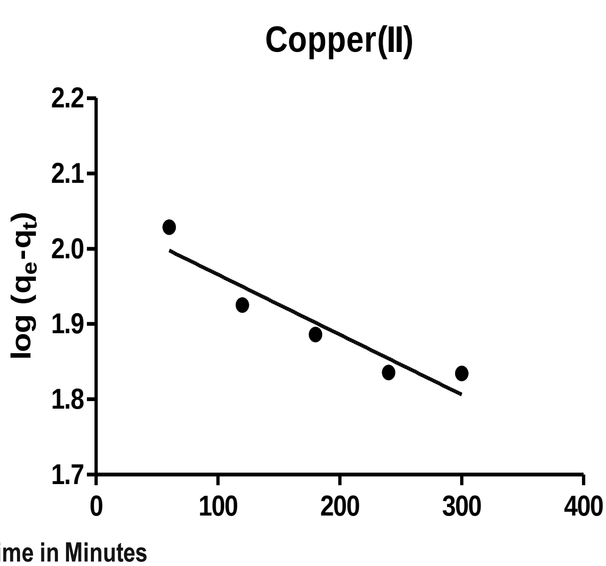
Table(7) Adsorption isotherm constant, C_{max} and correlation coefficients

Metal ions	Langmuir constants			
	K_L (dm^3/g)	b (dm^3/mg)	C_{max} (mg/g)	R^2
Cu(II)	1.139	0.004426	257.34	0.9659
Cr(VI)	0.8276	0.005127	161.42	0.9725

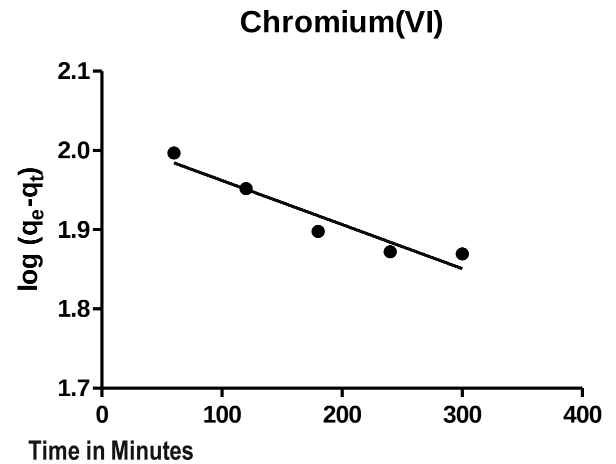
Table(8) Effect of separation factor on isotherm

R_L value	Type of isotherm
$R_L > 1$	Unfavourable
$R_L = 1$	Linear
$0 < R_L < 1$	Favourable
$R_L = 0$	Irreversible

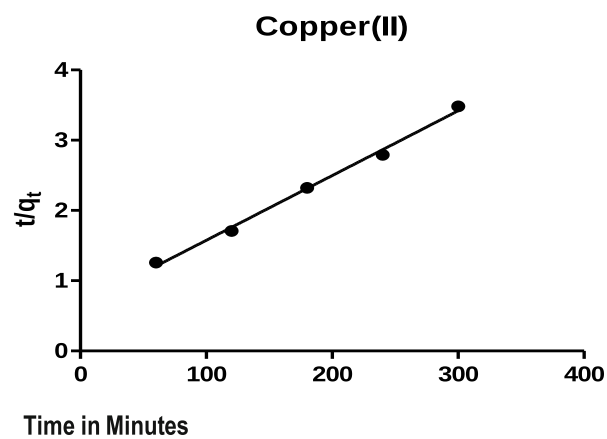
Adsorption kinetic studies



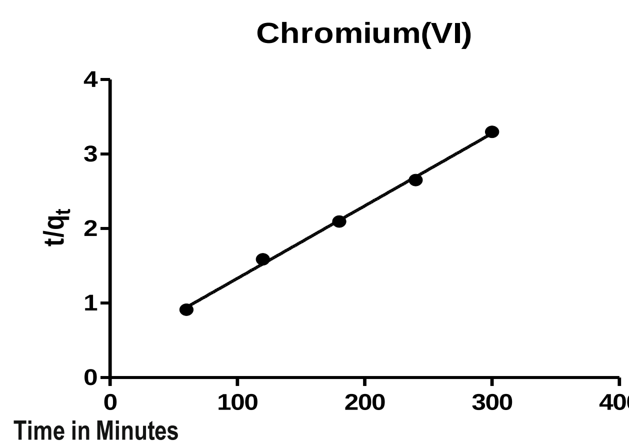
Fig(7) Pseudo-first-order sorption kinetic plot of Cu(II)



Fig(8) Pseudo-first-order sorption kinetic plot of Cr(VI)



Fig(9) Pseudo-second-order sorption kinetic plot of Cu (II)



Fig(10) Pseudo-second-order sorption kinetic plot of Cr (VI)

Adsorption of Cu (II) and Cr (VI) onto CS/CMC (1:1) - EG follows pseudo second order. Hence the type adsorption of factors and metals on the adsorbent should be chemisorption than physorption.

CONCLUSION

The prepared polymer blends with crosslinking agents ethylene glycol was used for the removal of colour from a dye under the influence of UV light. Experiments were conducted by changing the adsorbent dose from 1gm to 5gm/L and the contact time was modified from 60min, 120min, 180min and 240 min, 300 min and 360 min respectively. The effect of pH on the adsorption and degradation efficiency of the polymers was evaluated.

From the results it is evident that an adsorbent dose of 2 gms/L is enough to treat the wastewater with a contact time of 120-180 minutes. The results indicate that highly coloured wastewater can be treated with suitably prepared polymer blends.

It is also suggested that the prepared polymer blends can be further analyzed using other sophisticated analytical tools such as optical microscopy and TEM to understand the type of interaction between the polymers in the blends and to study the morphology and inner structure of the blended films.

Also the appropriate blend with maximum treatment efficiency can be prepared. Also the extent to which the adsorbent can be regenerated and reused should be evaluated which will reduce the cost of production of the blend.

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Table (2) Effect of adsorbent dose of Chitosan/CMC (EG) on the physico-chemical factors and metals of the dye industry effluent

Parameters	Effluent	Adsorbent dose				
		1 g	2 g	3 g	4 g	5g
EC dsm^{-1}	14.5	9.2	8.1	6.9	5.7	4.2
TDS (mg/L)	6750	3175	1955	1200	740	530
TSS (mg/L)	1460	780	433	230	150	112
BOD (mg/L)	1475	565	450	290	120	95
COD (mg/L)	4575	1950	1120	750	442	210
K (mg/L)	745	421	311	167	70	56
Ca (mg/L)	740	436	235	212	147	112
Na (mg/L)	1450	980	621	412	112	61
Mg (mg/L)	1100	595	326	245	161	115
Zn (mg/L)	650	379	211	155	105	74
Cu (mg/L)	420	224	145	65	37	11
Co (mg/L)	76	31	21	11	7.1	5
Cr (mg/L)	270	145	95	71	31	15

Values expressed as mean of 6 individual values

Table(3) Effect of contact time of Chitosan/CMC (EG) on the physico-chemical factors and metals of the dye industry effluent

Parameters	Effluent	Contact time				
		60	120	180	240	300
EC dsm^{-1}	14.5	9.2	6.2	3.9	2.1	1.7
TDS (mg/L)	6750	4250	2714	1150	975	454
TSS (mg/L)	1460	710	420	255	135	91
BOD (mg/L)	1475	720	470	215	120	110
COD (mg/L)	4575	2254	1450	790	410	210
K (mg/L)	745	320	211	110	95	72
Ca (mg/L)	740	340	257	195	155	110
Na (mg/L)	1450	720	450	210	113	72
Mg (mg/L)	1100	710	480	295	192	120
Zn (mg/L)	650	332	210	105	78	55
Cu (mg/L)	420	210	110	78	41	40
Co (mg/L)	76	35	29	22	10.1	9.2
Cr (mg/L)	270	130	87	41	21	19

Values expressed as mean of 6 individual values

Table (4) Effect of pH on the physico-chemical factors and metals of the dye industry effluent - Chitosan/CMC (EG)

Parameters	Effluent	pH				
		5	6	7	8	9
EC dsm^{-1}	14.5	8.1	2.2	3.9	4.8	5.9
TDS (mg/L)	6750	3317	250	1230	1750	2722
TSS (mg/L)	1460	620	78	190	385	492
BOD (mg/L)	1475	455	245	395	610	825
COD (mg/L)	4575	1450	178	420	1350	1800
K (mg/L)	745	345	79	144	295	357
Ca (mg/L)	740	296	109	172	255	396
Na (mg/L)	1450	319	79	185	221	456
Mg (mg/L)	1100	620	102	310	490	620
Zn (mg/L)	650	145	49	145	186	212
Cu (mg/L)	420	166	49	115	235	322
Co (mg/L)	76	29	10.2	19	29	46
Cr (mg/L)	270	159	21	110	140	176

Values expressed as mean of 6 individual values

Table(5) Langmuir adsorption studies of copper on CS/CMC - EG

Initial concentrations of Cu(II) mg/L	1000	500	200	100	50
Initial amounts of Cu(II) in 200 ml sol	200	100	40	20	10
Eqbm adsorption in 1gm of Sorbent(Ye)	129	77.6	30.89	16	8.1
Amount of Cu left in soln	71	22.4	9.11	4	1.9
Eqbm conc in 1000 ml (Ce)	355	112	45.55	20	9.5
Ce/Ye	2.7519	1.4433	1.4746	1.25	1.1728

Table(6) Langmuir adsorption studies of chromium on CS/CMC - EG

Initial concentrations of Cr(VI) mg/L	1000	500	200	100	50
Initial amounts of Cr(VI) in 200 ml sol	200	100	40	20	10
Eqbm adsorption in 1gm of Sorbent(Ye)	131	81.3	33	17.2	8.3
Amount of Cr left in soln	69	18.7	7	2.8	1.7
Eqbm conc in 1000 ml (Ce)	345	93.5	35	14	8.5
Ce/Ye	2.6336	1.1501	1.0606	0.8139	1.0241

Table (9) R_L values based on Langmuir adsorption

Metal ions	Initial concentration C_0 (mg/dm^3)	Final concentration C_f (mg/dm^3)	R_L values
Cu(II) ion	1000	355	0.388919
	500	112	0.668578
	200	45.55	0.832221
	100	20	0.918679
	50	9.5	0.95965
Cr(VI) ion	1000	345	0.361165
	500	93.5	0.675961
	200	35	0.847856
	100	14	0.933029
	50	8.5	0.95824

Table(10) Comparison between Lagergren pseudo-first-order and pseudo-second-order kinetic models for Cu (II) and Cr (VI) sorption by CS/CMC (1:1) - EG

Metal ion	Pseudo-first-order kinetic model			Experimental value	Pseudo-second-order kinetic model		
	qe (mg/g)	k_1 (min^{-1})	R^2	qe (mg/g)	qe (mg/g)	k_2 ($g\ mg^{-1}\ min^{-1}$)	R^2
Cu(II)	2566	0.0007969	0.8855	154.45	70.97	0.009214	0.9951
Cr(VI)	4681	0.0005559	0.9149	165	36.85	0.009729	0.9979