Reuse Of Waste Water From Pulp & Paper Industries.

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ABSTRACT

An attempt has been made to treat waste water being discharged to river body from pulp & paper industry, so as to bring its parameters near by those as suggested by pollution control boards. Enormous amount of waste water from pulp & paper industry cannot be reused as it is discharged with high colour load, high BOD, COD, alkalinity etc. Treating this water with some chemicals such as alum, lime cat-floc (T), PAC & through sand & coal ash columns, colour is removed to appreciable extent & hence treated water can be further reused for land applications.

INTRODUCTION:

water is a primary need of human being & considering its population, per capita water consumption is much more higher in India being a tropical country as compared to other cold countries. With present water resources, we are unable to cope up with the demand & always there is scarcity of water particularly in summer. If the waste water being discharged in the rivers from paper industries is conserved through reuse, their cost of production shall also come down & they will require minimum quantity to pump out from rivers and/or wells.

Our water consumption per tonnes of newsprint is much higher as compared to Europian countries. The effluent from pulping section, soda recovery, caustic chlorine plant and stock preparation department is not being reused. The main hurdle in the path of recycling is its colour imparted during pulping process. At present for production capacity of 5 million tonnes of Newsprint per annum, we loose approximately 1500 million cubic metre of waste per year.

PULP & PAPER MAKING PROCESS

Studies have been made on the subject, the processes being used for making different grades of pulp are listed below:-

(1) Kraft Pulp from bamboo

(2) Cold soda pulping from Eucalyptus/Subabool

(3) Waste Paper/Imported TMP/CTMP

(4) Stock preparation

(5) Soda recovery plant

(6) Caustic Chlorine Plant

(7) Paper machine

The Nepa Ltd. has its own effluent treatment plant commissioned in 1980 depending upon the pollution loads, the effluent coming out from the different departments is segregated & prolonged treatment is given to the effluent having higher BOD & COD values. Though Nepa Ltd. is recycling the paper machine effluent after primary clarification & it is appreciable step towards conservation water, but effluent from other departments are discharged in to river after treatment. The quantity of effluent discharged is high & if we can reuse the above

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quantity it will be total effluent recycling & definitely be a revolution of its kind in pulp & paper industry.

EXPERIMENTAL

As Nepa Ltd. is reusing effluent from paper machine, we have not taken into consideration the machine effluent. The effluents from other pulping units, after its treatment were selected for experiments.

Pulp & Paper mill effluent have a characteristic brownish to black colour which is mainly due to lignin, tannins & other extractives bearing chromopharic groups. The magnitude of colour depends on the raw materials used, process employed & type of end products. Lignin & extractives are highly polymerised substances & are difficult to biodegrade. It is evident from the fact that effluent from cold soda plant, which is highly polluted, has been given extended treatment as compared to other effluent. The cold soda effluent after primary clarification is subjected to anaerobic treatments in lagoon where it gets five days retention. It is further diverted in to aerobic lagoon where 16 aerators are fitted with 25 HP motors, Sprinkle the water into air to get dissolved atmospheric oxygen in it. The effluent from chemical pulp mill after primary clarification is subjected to treatment in aerated lagoon directly.

Finally we have taken up the experiments on the treated effluent which is being discharged into river through a channel having length 2-3 kilo meters. The finally treated effluent sample was collected in a bulk quantity so that it may last for all experiments to avoid the variation in colour and other values. The following chemicals were selected for experiment.

(1) Lime

(2) Alum

(3) Poly Aluminium Chloride

(4) Poly Electrolyte

(5) Activated Charcoal

(6) Sand

The above chemicals were added in the finally treated effluent to observe the reduction in colour. The maximum dosage were determined on the percentage reduction in colour. The further increase in dosage do not seems to be viable because the reduction in is not sharp as compared to the higher dosage. Therefore going on adding more quantity of costly chemicals to get minimum advantage is not advisable. Hence dosage of every chemical used in experiments were cut at optimum point. As given in the literature of poly electrolyte (Cat-Floc-T), its efficiency increases when it is used in combination of PAC or Alum. No experiment was carried with Cat-floc-T in isolation. It has been used in combination of PAC to get the maximum advantage of every costly chemical. However other chemicals were added separately barring charcoal and sand. In experiments with charcoal and sand, three columns of MS were made having 3 "dia & 18" height. The every column was having a inlet and outlet of 1/4" welded on the top and bottom. These columns were filled up with sand and charcoal and effluent water is passed and outlet from last column is collected for analysis. In case of charcoal, colour was reduced drastically when effluent was passed in two columns only but in case of sand all the three columns were used. However treatment with single column treatment in case of sand were also carried out to compare the results.

RESULTS & DISCUSSIONS

(1) There is no appreciable effect on alkalinity in case of the all chemicals used for decolourisation, except in case of lime it is in increasing order and in decreasing order in case of alum, which is expected also. In case of sand and charcoal, the alkalinity has decreased marginally, may be due to removal of colouring matters.

(2) There is no appreciable change in hardness. There is marginal reduction in hardness when cat-floc- (T) + PAC combination was used.

(3) Practically, there is no effect on chloride concentration in all the cases.

Table-1

Comparision of pH of various treated samples.

SR. NO.	SAMPLES (Dosses of chemical applied)	pH	SR NO.	SAMPLES (Dosses of chemical applied)	pH
1.	T.E. Original	7.31	5.	PAC CONST. (500 ppm)	
2.	Lime treated samples			CF (T) Variable	
	a. 1000 ppm	10.41		a. 1.0 ppm	7.80
	b. 1200 "	11.18		b. 1.2 "	7.10
	c. 1400 "	11.58		c. 1.4 "	7.3
	d. 1600 "	11.96		d. 1.6 "	7.5
	e. 1800 "	11.80		e. 1.8 "	7.2
3.	Alum treated Samples		6.	CF (T) const. (.8ppm)	
				PAC Variable	
	a. 500 ppm	6.84		a. 200 ppm	7.68
	b. 600 "	6.88		b. 400 "	7.20
	c. 700 "	6.59		c. 600 "	7.10
	d. 800 "	6.70		d. 800 "	7.04
	e. 900 "	11.80		e. 1000 "	6.68
4.	Activated charcoal tre.		7.	Sand Filteration	
	a. Through one column	7.40		a. Through one col.	8.2
	b. Through two columns	7.18		b. Through two col.	7.25
				c. Through three col.	7.32

Table-1I

Comparative Alkalinity study in various treated Samples.

SR. NO.	SAMPLES (Dosses of chemical applied)	Alkal-inity (as $CaCO_3$ mg/l)	SR NO.	SAMPLES (Dosses of chemical applied)	Alkal-inity (as $CaCO_3$ mg/l)
1.	T.E. Original	590	5.	PAC Constant (500 ppm)	
2.	Lime treated samples			CF (T) Variable	
	a. 1000 ppm	590		a. 1.0 ppm	430
	b. 1200 "	600		b. 1.2 "	410
	c. 1400 "	610		c. 1.4 "	410
	d. 1600 "	620		d. 1.6 "	390
	e. 1800 "	640		e. 1.8 "	380
3.	Alum treated Samples		6.	CF (T) constant (.8ppm)	
	a. 500 ppm	500		a. 200 ppm (Variable)	570
	b. 600 "	480		b. 400 "	540
	c. 700 "	450		c. 600 "	516
	d. 800 "	430		d. 800 "	460
	e. 900 "	400		e. 1000 "	400
4.	Activated charcoal trea.		7.	Sand Filteration	
	a. Through one column	320		a. Through one col.	440
	b. Through two columns	280		b. Through two col.	300
				c. Through three col.	240

Table-1II

Comparative hardness properties of various treated sample.

SR. NO.	SAMPLES (Dosses of chemical applied)	HARDNESS. (as $CaCO_3$ mg/l)	SR NO.	SAMPLES (Dosses of chemical applied)	HARDNESS. (as $CaCO_3$ mg/l)
1.	T.E. Original	740	5.	PAC Constant (500 ppm)	
2.	Lime treated samples			CF (T) Variable	
	a. 1000 ppm	720		a. 1.0 ppm	720
	b. 1200 "	700		b. 1.2 "	720
	c. 1400 "	560		c. 1.4 "	710
	d. 1600 "	500		d. 1.6 "	710
	e. 1800 "	470		e. 1.8 "	710
3.	Alum treated Samples		6.	CF (T) constant (.8ppm)	
				PAC Variable	
	a. 500 ppm	740		a. 200 ppm	710
	b. 600 "	740		b. 400 "	710
	c. 700 "	740		c. 600 "	710
	d. 800 "	740		d. 800 "	700
	e. 900 "	740		e. 1000 "	700
4.	Charcoal treated Samp.		7.	Sand Filteration	
	a. Through one column	690		a. Through one col.	720
	b. Through two columns	680		b. Through two col.	700
				c. Through three col.	640

Table-1V

Comparision of Na content is various treated sample.

SR. NO.	SAMPLES (Dosses of chemical applied)	SODIUM as (Na) in ppm	SR NO.	SAMPLES (Dosses of chemical applied)	SODIUM as (Na) in ppm
1.	T.E. Original	320	5.	PAC Constant (500 ppm)	
2.	Lime treated samples			(CF (T) Variable)	
	a. 1000 ppm	268		a. 1.0 ppm	320
	b. 1200 "	268		b. 1.2 "	320
	c. 1400 "	272		c. 1.4 "	320
	d. 1600 "	264		d. 1.6 "	320
	e. 1800 "	272		e. 1.8 "	320
3.	Alum treated Samples		6.	CF (T) constant (.8ppm)	
				PAC Variable	
	a. 500 ppm	300		a. 200 ppm	320
	b. 600 "	288		b. 400 "	320
	c. 700 "	288		c. 600 "	320
	d. 800 "	288		d. 800 "	320
	e. 900 "	288		e. 1000 "	320
4.	Charcoal treated Samp.		7.	Sand Filteration	
	a. Through one column	305		a. Through one col.	300
	b. Through two columns	300		b. Through two col.	310
				c. Through three col.	300

Table-V

Comparision of Chloride content in various samples.

SR. NO.	SAMPLES (Dosses of chemical applied)	CHLORIDES (as Cl^- mg/l)	SR NO.	SAMPLES (Dosses of chemical applied)	CHLORIDES (as Cl^- mg/l)
1.	T.E. Original	550	5.	PAC Constant (500 ppm) Variable (T) CF	
2.	Lime treated samples			a. 1.0 ppm	550
	a. 1000 ppm	545		b. 1.2 "	550
	b. 1200 "	550		c. 1.4 "	550
	e. 1400 "	550		d. 1.6 "	550
	d. 1600 "	550		e. 1.8 "	550
	e. 1800 "	555	6.	CF (T) constant (.8pm)	
3.	Alum treated Samples			a. 200 ppm (Variable PAC)	550
	a. 500 ppm	550		b. 400 "	575
	b. 600 "	550		c. 600 "	600
	c. 700 "	545		d. 800 "	620
	d. 800 "	545		e. 1000 "	660
	e. 900 "	545	7.	Sand Filteration	
4.	Activated charcoal tre.			a. Through one col.	550
	a. Through one column	500		b. Through two col.	545
	b. Through two columns	545		c. Through three col.	530

Table-VI

Comparision of suspended solids.

SR. NO.	SAMPLES (Dosses of chemical applied)	Suspended Solids (mg/l)	SR NO.	SAMPLES (Dosses of chemical applied)	SUSPENDED SOLIDS (mg/l)
1.	T.E. Original	96	5.	PAC Constant (500 ppm) Variable (T) CF	
2.	Lime treated samples			a. 1.0 ppm	85
	a. 1000 ppm	86		b. 1.2 "	80
	b. 1200 "	82		c. 1.4 "	71
	c. 1400 "	74		d. 1.6 "	60
	d. 1600 "	72		e. 1.8 "	55
	e. 1800 "	44			
3.	Alum treated Sample		6.	CF (T) constant (.8ppm) Variable PAC	
	a. 500 ppm	66		a. 200 ppm	80
	b. 600 "	60		b. 400 "	72
	c. 700 "	62		c. 600 "	70
	d. 800 "	50		d. 800 "	60
	e. 900 "	30		e. 1000 "	49
4.	Activated charcoal tre.		7.	Sand Filteration	
	a. Through one column	20		a. Through one col.	32
	b. Through two columns	15		b. Through two col.	26
				c. Through three col.	18

Table-VII

Comparision for COD

SR. NO.	SAMPLES (Dosses of chemical applied)	COD (mg/l)	SR NO.	SAMPLES (Dosses of chemical applied)	COD (mg/l)
1.	T.E. Original	313.34	5.	PAC Constant (500 ppm)	
2.	Lime treated samples			Variable CF (T)	
	a. 1000 ppm	122.8		a. 1.0 ppm	123
	b. 1200 "	104.4		b. 1.2 "	43
	c. 1400 "	79.8		c. 1.4 "	99
	d. 1600 "	58.3		d. 1.6 "	92
	e. 1800 "	49.1		e. 1.8 "	71
3.	Alum treated Samples		6.	CF (T) constant	
	a. 500 ppm	119.8		a. 200 ppm (variable)	166.7
	b. 600 "	95.2		b. 400 "	108
	c. 700 "	70.6		c. 600 "	102
	d. 800 "	52.4		d. 800 "	117
	e. 900 "	47.2		e. 1000 "	31
4.	Activated charcoal tre.		7.	Sand Filteration	
	a. Through one column	28.4		a. Through one col.	164,6
	b. Through two columns	22.7		b. Through two col.	102
				c. Through three col.	82.3

Table-VIII

Comparision for BODs

SR. NO.	SAMPLES (Dosses of chemical applied)	BODs (mg/l)	SR NO.	SAMPLES (Dosses of chemical applied)	BODs (mg/l)
1.	T.E. Original	33	5.	PAC Constant (500 ppm)	
2.	Lime treated samples			Variable CF (T)	
	a. 1000 ppm	7.5		a. 1.0 ppm	9.9
	b. 1200 "	7.0		b. 1.2 "	8.0
	c. 1400 "	1.5		c. 1.4 "	7.5
	d. 1600 "	1.0		d. 1.6 "	6.0
	e. 1800 "	1.0		e. 1.8 "	5.9
3.	Alum treated Samples		6.	CF (T) constant	
				Variable PAC	
	a. 500 ppm	4.5		a. 200 ppm	12.9
	b. 600 "	4.0		b. 400 "	10.2
	c. 700 "	3.5		c. 600 "	9.9
	d. 800 "	3.0		d. 800 "	9.5
	e. 900 "	2.0		e. 1000 "	9.0
4.	Activated charcoal tre.		7.	Sand Filteration	
	a. Through one column	3.9		a. Through one col.	9.16
	b. Through two columns	1.6		b. Through two col.	7.5
				c. Through three col.	6.8

Table-IX

Comparision of sludege volume setelled

SR. NO.	SAMPLES (Dosses of chemical applied)		SLUDGE VOL. (in 250 ml)	SR NO.	SAMPLES (Dosses of chemical applied)		SLUDGE VOL. (in 250 ml)
1.	T.E. Original			5.	PAC Constant (500 ppm) Variable CF (T)		
2.	Lime treated samples						
	a. 1000 ppm	....	5ml		a. 1.0 ppm	....	70ml
	b. 1200 "	....	10ml		b. 1.2 "	....	73ml
	c. 1400 "	....	10ml		c. 1.4 "	....	75ml
	d. 1600 "	....	20ml		d. 1.6 "	....	80ml
	e. 1800 "	....	25ml		e. 1.8 "	....	90ml
3.	Alum treated Samples			6.	CF (T) constant (.8 ppm)		
	a. 500 ppm	....	10ml		a. 200 ppm (Variable)	......	10ml
	b. 600 "	....	20ml		b. 400 "	....	40ml
	c. 700 "	....	25ml		c. 600 "	....	80ml
	d. 800 "	....	40ml		d. 800 "	....	110ml
	e. 900 "	....	60ml		e. 1000 "	....	120ml
4.	Activated charcoal tre.			7.	Sand Filteration		
	a. Through one column				a. Through one col.		-
	b. Through two columns				b. Through two col.		-
					c. Through three col.		-

Table-X

Comparition of colour removal.

SR. NO.	SAMPLES (Dosses of chemical applied)		COLOUR Pt-co Unit	SR NO.	SAMPLES (Dosses of chemical applied)		COLOUR Pt-Co Unit
1.	T.E. Original		876	5.	PAC Constant (500 ppm) variable CF (T)		
2.	Lime treated samples						
	a. 1000 ppm	....	320		a. 1.0 ppm	....	75
	b. 1200 "	....	284		b. 1.2 "	....	75
	c. 1400 "	....	254		c. 1.4 "	....	62.5
	d. 1600 "	....	224		d. 1.6 "	....	40
	e. 1800 "	....	186		e. 1.8 "	....	35
3.	Alum treated Samples			6.	CF (T) const.		
	a. 500 ppm	....	309		a. 200 ppm	(variable)	225
	b. 600 "	....	240		b. 400 "	....	155
	c. 700 "	....	130		c. 600 "	....	87.5
	d. 800 "	....	110		d. 800 "	....	65.0
	e. 900 "	....	70		e. 1000 "	....	40.0
4.	Activated charcoal tre.		35	7.	Sand Filteration		
	a. Through one column		20.8		a. Through one col.		300
	b. Through two columns				b. Through two col.		50
					c. Through three col.		30

(4) The effect on COD is very encouraging. The reduction is practically same in case of lime and alum at 1800 & 900 PPM respective dossages but BOD reduction is more in case of lime on the above said dossages.

(5) BOD & COD reduction in case of sand is not that much appreciable as compared to lime and alum, even through the results obtained are very much lower than that of the original sample.

(6) When PAG + Cat-floc- (T) combination is used keeping one of them constant and other variable even after changing the constant & variable with each other results of BOD and COD obtained are nearly at par at the same dossing levels. Various combinations can more be utilized for optimisation of best combination for more effective and economic treatment but it will need more time.

(7) Out of all chemical/agents used in experiments, best result (BOD & COD) are obtained with activated charcoal. The reduction in BOD & COD is highest in this case.

(8) The only draw back in use of lime and alumnis one increases the pH. While other decreases. Therefore pH has to be corrected before the reuse/discharge of effluent, which further increased the treatment cost. While in case of other chemicals/agents, there is no need for correction of pH.

(9) The sodium content remained practically unchanged in all the cases.

(10) Most effective colour removal is observed with charcoal and sand but only draw back is slow filteration rate. Therefore more area and time shall be needed on plant scale basis but it has advantages over the other chemicals due to low cost of treatment-only what is needed is that initial investment.

(11) Colour removal in case of other chemicals is also acceptable and effluent can totally be recycled by one negative aspect is high treatment cost.

(12) Suspended solids reduction is also good and may not be a hurdle in path of recycling in case of all chemicals/agents used in experiment.

(13) The other drawback observed in all experiments is that more sludge has to be handled but in case of charcoal & sand, thorough periodical washing of filteration bed will serve the purpose & it will last years together before it needs to be changed after observing closely the performance.

CONCLUSION

From the results, we may conclude that we must adopt the decolourisation even though it is costlier with chemicals or we may use sand filter or charcoal filter beds for the treatment to rectify the cost factor.

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