Effect of Enzyme Treatment on Mix Agro Pulp Quality and Chemical Consumption.

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The awareness and the concern about AOX and its Control started in India in the last few years which forced the Industry to use the enzyme in pulping as well as in bleaching of Agro Pulp. The Various measures taken by the pulp and paper industry to maintain the desired pulp brightness with reduced chemical consumption during past few years yielded substantial improvement in pulp quality and reduction in chemical consumption in pulping and bleaching of Mix Agro pulp.

Detailed lab and plant scale biopulping and biobleaching trials have been carried out in mix agro pulp, like wheat straw and sarkanda, resulted in lowering of the Kappa number in pulping and reduction of chlorine during bleaching. Bleaching was carried out under C-E_p-H-H sequence alongwith enzyme for attaining the same level of brightness with reduced chlorine demand or improved brightness with same chemical dose.

The enzymatic pretreated pulp showed better strength properties, reduced P.C.No. and substantial reduction in chemical consumption and reduced AOX level in final effluent

INTRODUCTION

The past few decades of the twentieth century have witnessed spectacular advances and betterment of living standards due to the beneficial integration of novel and brilliant ideas with scientific progress and rapid translation of laboratory findings into practical technologies and commercial-scale manufacturing processes. In the field of chemical technology, where manufacture of a variety of products on large scale has resulted in serious effluent and hazardous waste disposal problems, the need for safer and 'environmental friendly' technologies have become imminent. This has resulted enzyme usage in pulping and bleaching and enabled new technologies for processing pulps and fibre.

The awareness and the concern about AOX and its Control started in India in the last few years which forced the Industry to use enzyme in pulping as well as in bleaching of Agro Pulp. Various measures are taken by the pulp and paper industry during past few years to maintain the desired pulp brightness with reduced chemical consumption, yielded substantial improvement in pulp quality.

Presently the emphasis of research and development has shifted more towards improving the pulping and bleaching process. Enzyme in pulping and bleaching is one such option which reduces the Kappa No. and chemical consumption in bleaching.

Viikari et al., (1986). were the first to demonstrate that xylanase prebleaching facilitates the subsequent chemical bleaching of Kraft pulps. After this further developments in laboratory studies were conducted with hard wood, soft wood and agro based pulps, using various type of enzymes.

Indian medium sized paper mills using agro residues as raw materials commonly practice soda pulping and conventional bleaching process for the production of bleached grade pulps and are discharging very high pollution loads in the environment. Our target in the present study was to develop enzymes aided prebleaching process in wheat straw and sarkanda to reduce Kappa number in pulping and reduction of chlorine during bleaching. with **improved** brightness maintaining same chemical dose.

MATERIAL AND METHODS

Raw Material:- Sarkanda collected from the Stock yard, is cut to 1.0 1.5 inch size in straw cutter and wheat straw is received in cut form. The raw material was prepared and dried to a moisture level of 10-12%. and then used for experimental work on oven dry (O.D) basis, after determining the bulk density.

Proximate Chemical Analysis:- The raw material (sarkanda and wheat straw) powdered in a Willey mill and a portion of this passed through 40 mesh and retained on 60 mesh was taken for

Table-1: Proximate Chemical Analysis of Sarkanda and Wheat straw.

Particulars	Value, % (w/w)	
	Sarkanda	Wheat Straw
Cold water Solubility	2.6	2.4
Hot water Solubility	11.2	8.5
1% NaOH Solubility	37.3	32.1
Alcohol- benzene Solubility	3.8	3.20
Pentosan	20.7	18.9
Holocellulose	70.4	67.2
Alpha cellulose	39.9	35.8
Ash content	7-8	8-8.5
Klason Lignin	21.0	20.30

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the study. The proximate chemical analysis was carried out as per Tappi Standard (14) Method. And results obtained are given in Table -1.

Table-2 shows the addition of (Enzyme A).0.1 and 0.2% of pulp at 60^{0}C for 60 Minutes resulted in reduction of Kappa No Blank Kappa No. 25.0 whereas Kappa No. 24.4 and 24.0 enzymes treated pulp, reduction in Kappa No. by one degree after enzyme treatment. The unbleached pulps blank and enzyme treated pulp were bleached by C-E_P-H-H sequence. In alkali extraction stage blank has 3.2 kappa number whereas enzyme treated pulp has 2.8 and 3.0 kappa number. Also chlorine consumption is reduced as compare to blank and brightness is also improve 80.8 and 81.6 at 9.95%and 10.4% total Cl_2 demand as compare to blank brightness is 80.2 at 11.95% total Cl_2 demand. This shows there is reduction in chlorine demand, i.e. 15.3 to 16.1%.

The physical strength properties of with and without enzyme treated bleached pulps are recorded in Table-3.It may be seen breaking length is more in enzyme treated pulp, but ear factor is dropped slightly. Burst factor is slightly increased in enzyme treated pulp as compare to blank. Ash content almost same in blank and enzyme treated pulp.

Table-4 shows that Plant trial of Enzyme-B shows reduction in Cl_2 demand i.e 12.9% and kappa number of Decker washer, Cl_2 washer and Alkali washer is low as compare to blank. In the case of Enzyme-A pulps breaking length was lower but tear factor was slightly higher as compare to blank.

The physical strength properties of paper with and without enzyme treated pulps are recorded in Table-5 .It may be seen that similar type of results were obtained with Enzyme-A also.

Table-6 shows Bleach effluents collected after each stage of bleaching were mixed and analyzed for BOD, COD and AOX in the laboratory. Enzyme treated bleached pulp show reduction in AOX level as compare to blank. Marginal increase BOD and COD in enzyme treated pulp is due to removal of more lignin with enzyme pulp.

Pulping and Bleaching: Soda pulping (sarkanda and wheat straw at 50:50 ratios) was carried out in an electrically heated stainless steel digester with thermostat controlled system, keeping bath ratio 1:4. The digestions were carried at varying chemical concentration for 4 to 6 hrs including time to raise the temperature 165^0 ± 2^{0}C. The pulps after digester were thoughly washed and screened.

To get the real benefit of bio bleaching cooked pulp was treated with commercial xylanse (Enzyme A) with a dose of 0.1 and 0.2% of pulp at 60^{0}C for 60 Minutes which resulted in reduction of initial Kappa No. 25.0 by one degree after enzyme treatment. The unbleached pulps blank and enzyme treated pulp were bleached by C-E_P-H-H sequence. The results are recorded in Table-2. The strength properties & optical properties of bleached pulp were evaluated. The results are recorded in Table-3.

Plant trial of commercial xylanse (Enzyme B) is carried out after Laboratory studies. The results are recorded in Table-4 The strength properties & optical properties of bleached pulp were evaluated. As shown in Table-5.

Characterization of bleaching effluents: Bleach effluents collected after each stage of bleaching were mixed and analyzed for BOD, COD and AOX in the laboratory. The results are recorded in Table-6.

RESULT AND DISCUSSION: The result of proximate chemical analysis of Sarkanda and Wheat straw are recorded in Table-1. From the results it is evident that plant material of sarkanda contains 70.4 % holocellulose, 39.9 % alpha cellulose and wheat straw contains 67.2% and 35.8%. The pentosan of sarkanda is 20.7% and wheat straw is 18.9 and solubility in hot water & cold water solubility of sarkanda is 11.2 % and 2.6% & wheat straw is 2.4 & 8.5%. Alcohol benzene was 3.8 % in sarkanda & 3.20 in wheat straw 1% NaOH solubility of sarkanda is . 37.3% & 32.1 is wheat straw. The klason lignin of sarkanda and wheat straw is 21.0% & 20.30.

CONCLUSION:

Today the environment issues particularly control of AOX are the major challenges before the pulp and paper industry. With the pressure rising

Table-3: Strength Properties of bleached (with and without enzyme treated) pulp

Enzyme A

Strength Properties			
	Enzyme A (0.1%)	**Enzyme A (0.2%)**	**Blank**
B. Wt	55.0	60.5	60.1
Breaking Length	2895	3041	2500
Tear Factor	29.0	29.7	33.2
Burst Factor	11.8	13.8	10.8
Bulk	2.54	2.51	2.49
Ash content %	1.4	1.8	1.7

Table-4: Control parameters of pulp before and after enzyme plant trial

Enzyme A

Before Enzyme											
Decker		Enzyme A (gm/T)	D/W soda losses		Kappa No.			Pulp Brightness	Strength Properties		
pH	Temp		D/W	Cl_2 Con	D/W	Cl_2 Con	A/W		B.L	B.F	T.F
9.1	40.0	-	8.1	11.59	27.7	10.9	6.2	77.4	3381	20.4	54.5
After Enzyme A											
9.2	40.0	165.0	8.2	10.09	27.4	10.6	5.04	77.9	3230	20.4	57.5

Table-2: Bleaching of cooked pulp (with and without enzyme) under C-E_P-H-H Sequence.

Particulars		Enzyme A		Blank
Doses	%	0.1	0.2	-
Consistency	%	10	10	-
Temperature	^{0}C	60	60	-
Time	Min	60	60	-
Kappa Number		**24.4**	**24.0**	**25.0**
Chlorination Stage				
OD pulp	Gm	100	100	100
Cl_2 Added	%	7	6	7
pH (Initial)	-	2.48	2.46	2.48
Retention Time	Hrs	45	45	45
pH (Final)	-	2.28	2.21	2.24
R-Cl_2	Gpl	0.0852	0.05396	0.0426
Cl_2 Consumed	%	6.77	5.86	6.88
pH washed	-	4.22	4.20	4.21
Alkali Extraction Stage				
Temp	^{0}C	60	60	60
Alkali Added	%	2	2	2
H_2O_2	Kg/Ton	8	8	8
pH (Initial)	-	10.99	11.00	10.98
Retention Time	Hrs	2	2	2
pH (Final)	-	9.58	9.60	9.54
Washed pH	-	8.20	8.22	8.20
Kappa No	-	3.0	2.8	3.2
Brightness	%	60.5	63.5	60.0
H-I Stage				
Temperature	^{0}C	40	40	40
Hypo Added	%	2.5	3.0	3.5
pH (Initial)	-	8.00	8.10	8.11
Retention Time	Hrs	2	2	2
pH (Final)	-	7.62	7.70	7.72
R-Cl_2	Gpl	0.00142	0.00142	0.00142
Cl_2 Consumed	%	2.49	2.99	3.49
H-II Stage				
Temperature	^{0}C	40	40	40
Hypo Added	%	0.7	1.2	1.5
pH (Initial)	-	7.80	7.86	7.89
Retention Time	Hrs	2	2	2
pH (Final)	-	7.40	7.46	7.50
R-Cl_2	Gpl	0.00213	0.00213	0.00284
Cl_2 Consumed	%	0.699	1.19	1.49
Total Cl_2 Charged	**%**	**10.2**	**10.2**	**12**
Total Cl_2 Consumed	**%**	**9.95**	**10.04**	**11.86**
Brightness	**%**	**80.8**	**81.6**	**80.2**

Table-5: Strength Properties of Paper Before and after enzyme. Enzyme -B

Particulars		Before Enzyme	After Enzyme-B
B.Wt		58.5	59.9
Moisture %		4.48	4.47
Ash content%		21.7	22.0
Breaking Length	**MD**	3842	3710
	CD	2638	2530
Burst Factor		15.5	15.4
Tear Factor	**MD**	39.9	40.3
	CD	42.7	43.3
Cobb Value	**WS**	27.6	27.4
	TS	26.4	26.2
Brightness %		78.4	79.8
Opacity		87.3	87.0
Porosity		93	85.2

Table-6 Characteristic of effluent generated by bleaching of Pulp

Pulp Type	Parameter (Kg/T)			
	BOD	**COD**	**BOD/COD**	**AOX**
Blank	9.62	41.13	0.233	4.1
Treated Pulp	11.40	42.0	0.271	3.0

to limit the discharge of chlorinated organic compounds due to increased environment awareness and imposition of stringent discharge norms the Indian pulp and paper industry is likely to face problems due to its high level of AOX generation. The usage of enzyme will be a great help to control AOX level and reduction in chemical consumption.

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