Factors Affecting Alum Consumption in Sizing

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ABSTRACT

Despite the enormous amount of work, very little is on record on the effect of various factors affecting consumption of alum in paper making We report in this paper the results of a detailed study both laboratory as well as plant trials of various parameters controlling alum consumption. The effect of process water quality. calcium content in pulp, carboxyl groups content of pulp etc. have been investigated in detail and the basic chemistry involved is also discussed.

INTRODUCTION

Large amounts of chemical additives are being used in paper making furnishes to achieve special effects : to render internal sizing, to improve drainage and retention and to effect improved fibre bonding etc. 'Alum' is one of the most widely used chemicals in the paper industry.

The rosin/alum sizing system is one of the well established and well studied systems. Although alum performs a number of functions in addition to the important one of precipitating the size, like those of retention aid, dye mordant, pitch control agent, it is being used sometimes rather indiscriminately. A literature survey has shown that very little is on record on the effect of various factors, and pulp characteristics on alum con-sumption in the manufacture of paper. We report in this paper, the results of systematic and detailed study of various process parameters and pulp characteristics affecting alum consumption. Both laboratory trials as well as the plant data over a longer period of time are analysed to arrive at the conclusions.

RESULTS AND DISCUSSION

i) **Effect of Calcium content in bleached pulp :**

It is well established (1—3) that the calcium content of the pulp is detrimental for sizing and in turn increases the consumption of sizing chemicals both rosin as well as alum. During the study period it was observed that the calcium content in raw bleached pulp varied widely from 0.9 to 2.5%.

TABLE—1

Process water quality and bleached pulp quality Vs Alum consumption

S. No.	Month	Raw water Turbidity Range PPM	Process Water		Calcium content in pulp as $CaCo_3$, %			Carboxyl content in pulp m.eq/100 g OD pulp			Alum consumption Kg/T of Paper
			Hardness as $CaCo_3$, ppm	Al_2O_3 ppm	Min.	Max.	Ave	Min.	Max.	Ave.	
1.	JUNE	50-2000	80	1.0	1.25	1.98	1.58	6.50	8.50	7.72	64.4
2.	JULY	500-4500	74	6.5	1.14	2.10	1.58	5.02	6.50	5.90	49.7
3.	AUGUST	350-3000	63	10.1	0.90	1.80	1.50	7.25	8.79	8.00	48.8
4.	SEPT.	65-300	106	11.7	0.92	2.16	1.77	6.53	8.50	7.10	50.6
5.	OCT.	60-200	90	10.0	1.36	2.45	1.80	6.70	1.60	7.30	57.0
6.	NOV.	50-75	103	7.9	1.62	2.28	1.89	5.94	8.55	7.16	55.2
7.	DEC.	50	82	4.8	1.10	1.97	1.55	6.00	6.35	6.17	58.0

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To certain extent, except for two months in a year, there was a correlation between the calcium content and alum consumption. The deviation in these two months could have been due to other parameters predominence over calcium content.

ii) **Effect of Carboxyl content in bleached pulp :**

Cellulose fibers are able to bind many ions and remove them from the solution. This "ion exchange capacity" is important to dielectric properties of papers as well as rosin sizing. Mc Lean[4,5] suggested that carboxyl groups are responsible for cation exchange properties. Ek Wall and Bruun[6] reported that the sorption of aluminium ion depends upon the number of carboxyl groups and pH. The ion exchange capacity can be determined from the p Ka of the carboxyl groups and system pH by use of Hendersen equation.

Ninck Blok[7] showed that retention of aluminium ion varies directly with the carboxyl content of the pulp. In one of our studies on the effect of alkali extraction on bleached pulp properties[8], it was observed, vide Table—2, that insufficient dosage of alkali results in pulps with higher carboxyl content and in turn those pulps consume more alum to get the same stock pH.

Hence, during the study period, the carboxyl content of the bleached pulps were determined and it was observed that there was a correlation between alum consumption and carboxyl content of the pulp.

Recently it was observed during our laboratory studies[9] that the amount of alum required to get the same stock pH with high brigntness (80—84%) softwood and bagasse pulps, bleached with chlorine dioxide, for the same rosin addition, was less than the amount of alum required with bamboo-tropical mixed hardwood (60:40) blend pulp, bleached by conventional CEH sequence. This could be traced to the fact that the carboxyl content of the chlorine dioxide bleached pulps is of the order of 2.06 to 2 60 milli-equivalents per 100g pulp while it isnormally 6.0 to 8.0 milliequivalents for 100 g pulp for the bamboo and tropical mixed hardwood blend pulps bleached by conventional CEH sequence. Thus, it is evident that the carboxyl content of bleached pulp is one of the important factors controlling the alum consumption and sizing.

TABLE—2

Bleaching conditions Vs Alum consumption (Laboratory Study)

S. No.	Particulars	Sht I		Set II	
		A	B	A	B
1.	Chlorinated Pulp K. No.	11.4	11.4	13.0	13.0
2.	Alkali dosage as NaOH %	3 05	1.52	3.00	1.50
3.	Hypo dosage, %	2.00	4.00	3.00	4.00
4.	Pulp Brightness, % Elrepho	73.50	73.20	75.70	77.00
5.	Viscosity, cps	9.80	9.60	8.49	8.00
6.	Calcium content as $CaCO_3$, %	1.74	1.92	1.77	1.91
7.	Carboxyl groups, m eq/100 g OD pulp	5.9	6.8	6 4	7.5
8.	Rosin Added, %	0.8	0.8	0.8	0.8
9.	Alum Consumption to get stock pH 5.0, %	6.62	7.55	7.83	8.17

A : Normal alkali dosage. B : Reduced alkali dosage

iii) **Effect of extractive components of pulp :**

In our earlier studies on bamboo and tropical mixed hardwoods pulps[10] it was observed that the nature and amount of extractive components of pulps also play an important role in sizing. It was found that the removal of extractive components by extracting with diethyl ether, improves sizing for the same dosage of rosin soapsize and at the same time the consumption of alum to get the same stock pH also comes down.

v) **Effect of process water quality :**

As the hardness of water is going to affect the reaction between alum and rosin soap size, the presence of small amount of alum in process water is helpful to forestall the formation of alkaline earth resinates in the size precipitate. Further, the aluminium present in the process water is first taken up by the carboxyl groups in the pulp and this will result in reduced ion exchange capacity of the pulp and hence lower aluminium take up for this purpose from alum.

TABLE—3

Effect of Ether Extraction on Sizing and Alum Consumption

Sl. No.	Bamboo				Tropical Mixed Hardwood			
	A		B		A		B	
	Alum %	Sizing Sec.	Alum %	Sizing Sec.	Alum %	Sizing Sec.	Alum %	Sizing Sec.
1.	4 2	106	3.5	185	5.1	118	4.1	160
2.	4.2	100	3.7	129	4.7	109	3.5	138
3.	4.0	108	3.1	161	4.7	100	4.1	121

Note:— Basis Weight — $100 \pm 2 g/m^2$
A = Unextracted pulp.
B = Extracted pulp.

This is to be attributed to the presence of fatty acics like, oleicacid stearic acid etc. in the extractives and these fatty acids react with the alum to form aluminium salts. These can be removed in the alkaline extraction stage of bleaching by forming water soluble sodium salts.

iv) **Effect of fines in the system:**

Joseph Marton[11] has reported that fines content in the stock, which results in lower first pass retantion, is detrimental to sizing, because they capture an amount of size and alum disproportionate to their weight percentage due to their higher surface area. As the fines content in the stock is also are of the factors that is going to affect the alum consumption. the determination of the through-put fraction (Back water consistency. Head box consistency), which gives an indication of fines retention helps in controlling the alum consumption.

During the study period, it was observed that when the alumina content in process water is high, there is a decrease in alum consumption fir sizing. However, it is to be viewed with some reservation as other factors also play role in alum consumption.

The difference in alumina content in process water during different periods (vide Table 1) is to be traced to the fact depending upon the season the turbidity of raw water varies and thereby the alum addition to remove the turbidity. The turbidity of river water is high during the flood season. Hence, regular check up of process water alumina content also helps in investigating the reasons for high alum consumption.

CONCLUSIONS

Effective deresination and lowering of carboxyl content to a reasonable level by effective alkali extraction during bleaching, efficient washing of final bleached pulp and controlling of fines content in the system by increasing the first pass retention are some of the desirable stratagems to reduce the alum consumption without hampering sizing efficacy.

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