Role of Alkali Extraction in Multi-Stage Bleaching

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The utility of alkali extraction in multistage bleaching has been controversial ever since the three stage bleaching technique was employed in our country. While economic consideration and simplicity in operation may favour the C-H-H- process, the C-E-H- technique enables to produce the better quality of pulp and thereby better paper. In alkali extraction the chlorolignin formed during the chlorination stage is made soluble in alkali and removed thereby making the remaining lignin more accessible at hypostage. This also helps in the removal of resin and carbohydrates of low D. P. Optionum conditions like pH. temperature, retention time and alkali dosage, based on experiments results to yield of good quality pulp are discussed.

Introduction :

Bleaching of Pulp as known in Paper Industry is a process by which the dark brown colour of pulp is made white to suit the requirements of paper making.

Till the end of 19th century bleaching process was carried out in single or two-stage calcium hypochlorite bleaching. Though by that time the affinity of elemental chlorite towards lignin resulting in better quality of pulp was known, it is only during World War I, the commercial transportation of chlorine was established. As a result, around 1930 the pulps which were formally considered as unbleachable could also be bleached. The effect on this type of pulps was improved by intermed ate alkali extraction.

In India, till around 1945 bleaching was being done in a series of towers or chests, adding about 80% of the total chlorine requirements as bleach liquor in first tower and circulating it in the same tower till reaction is over. This stuff is pumped to the second tower with necessary bleach liquor addition. gets circulated and then pumped to the third tower and so on. Around 1950, first time in our country three-stage bleaching was put into commission, but soon the alkali stage of it gave way to a second 'hypo' stage and instead of a CEH system CHH system prevailed. Rather than technical reasons economy was the guiding factor for such a trend. As Indian paper market grew more and more, quality-conscious and competitive, alkaline extraction has again come in to picture and new mills have taken it for granted its importance and necessity. Still in bamboo pulping this stage remains a controversial issue in India, and here a detailed study of the problem in plant scale guided by laboratory experiments is given.

Chemistry of Alkali Extraction :

Kraft lignin contains phenolic groups but they are not hydrophilic enough for dissolution in water. It is estimated that only about 30% of kraft lignin after chlorination goes into water whereas the remainder is to be removed through alkali extraction. Experiments of pulp chlorination after swelling in alkali had shown no particular improvement proving that water dissolution of lignin in chlor nation stage is limited not because chlorine fails to reach lignin imbedded in cell wall but the chlorolignin fails to squeeze out when this chloro-lignin is dissolved in alkali extraction stage, it brings the remaining lignin more accessible to further chlorination or hypostage. This theory is further substantiated by the fact that lignin content after extraction is dependant very much on alkali concentration, once again spot lighting the relation of lignin accessibility to its solubility. In alkali extraction, it is supposed that the first reaction is the hydrolysis

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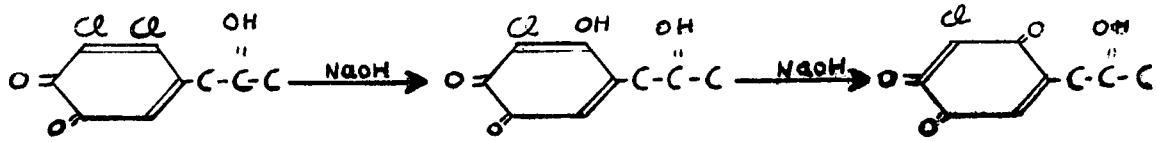
of chlorine atom of benzene nucleus in fifth position into 'OH' group of considerable acid strength, which is then neutralised by alkali causing the lignin dissolution, without degrading the ring system.



Instead of alkaline treatment if hypochlorite is added, much of the oxidant is used to disrupt the ring system of chloro-lignin rendering it soluble. Another drawback of this system is the steep fall of pH, as the initial pH of chlorinated pulp remains low (4-5). As hypo chlorous acid is the predominent constituent in the lower pH range, and as it acts vigorously on cellulose much of the pulp strength loses here. This degraded cellulose is one of the main causes of marked colour reversion of CHH series bleached pulp.

Another important function of alkali is removal of resin and carbohydrates of low D.P. range. Both of the above said functions are very important for brightness stability. It has been found that removal of lower D.P. carbohydrates improves brightness stability and helps to get homogenious chain length distribution. As resin deposits on machineries and causes specks in paper its removal in alkali stage is equally important. These two functions are not carried out in a substituting Hypo treatment stage.

A laboratory study of pulp bleached with CEH system and CHH system reveals the superiority in strength qualities and brightness stability of former.

TABLE NO. 1

Sl. No.	Particulars		CEH	CHH
1.	Brightness	..	78	80
2.	Burst Factor	...	33.6	30.0
3.	Breaking length	...	5770	6270
4.	Tear Factor	...	95	70
5.	Copper Number	...	3.4	4.0

Experiment :

Pulp chlorinated with 5.5% of Chlorine on B.D. pulp was taken, extracted with 2.5% of alkali at 50°C, washed and bleached with 3% of bleach liquor in the CEH system, and in the CHH system a portion of the above chlorinated pulp was bleached with 2.5% of bleach liquor in the first stage, washed, and further bleached with 3% of bleach liquor. Retention time for first and second stages were 2 Hrs. and 4 Hrs. respectively for both experiments.

Conditions affecting the Extraction Reaction :

By selecting suitable extraction conditions pulp of desired quality can be obtained. Different factors like pH and consistency of chlorinated pulp, temperature and time of extraction and alkali charge on pulp are the main ones responsible for the efficiency of the alkali extraction stage.

pH and Consistency of Chlorinated Pulp :

After the chlorination, pulp is generally of 3-4 pH. With efficient washing the pH can be conveniently brought to the level of 5-6. The efficiency of the wash is very important as otherwise the acid going along with the pulp consumes alkali immediately for neutralisation decreasing the effective alkali cahrge, evidently. Thus every increase in pH means a considerable saving of the caustic soda.

Consistency of the pulp is another important factor affecting the efficiency of extraction, as it is directly related to the effective alkali concentration. Along with the lowering of consistency of pulp much water adds upto the system, reducing the effective concentration of alkali. Another adverse effect of lower consistency is the comparatively huge amount of heat required by water while temperature of the

extraction stage is raised as specific heat of cellulose is much lower than water. This means a colossal wastage of steam along with a decrease of consistency which tells on the economy of bleaching. Taking the limitations of equipments, the generally accepted consistency is 10% for a balanced operation.

The lignin content after the extraction of pulp depends greatly on concentration of alkali too. A higher concentration of alkali effects better swelling of pulp which is important for the outward diffusion of chloro-lignin, and, for practical purposes a concentration of 100 g/l has been found quite suitable.

Temperature and time of Extraction :

Temperature of the extraction stage can be varied according to the requirements ranging from chloro-lignin removal to carbohydrate removal. For Rayon Grade Pulp, temperature is kept at about 90-95°C. while for the paper pulp a temperature of 50-60°C is good enough. Table II gives the effect of varying temperature on the final quality of pulp, keeping other factors like pulp consistency, pH and time of extraction a constant.

A rise in temperature from 29°C to 50°C considerably improved the folding endurance of pulp, and, burst factor and breaking length also registered an increase. While a slight increase obtained in brightness development, brightness stability on heat ageing also improved meaning an overall improvement in pulp qualities. A further rise in temperature resulted in a high alpha content pulp and reduction in hemicellulose fraction. For paper making, hemi-cellulose being an important constituent, for better sheet formation higher temperature is not preferred. The above experiments indicate that a temperature of 50°C in the extraction stage in the most suited for production of paper pulp.

Time of extraction can be varied from 1 hr. to 3 hrs. For paper grade pulp 1 to 2 hrs. is quite sufficient. For Rayon where the high alpha cellulose content is essential and carbohydrates to be removed, higher temperature, higher concentration and longer time is needed.

TABLE II

Experiment No	Temperature of Extraction	NaOH on B.D. Pulp	Chlorine for Bleaching	Brightness °PV	Burst Factor.	Breaking Length	Double Folds	Brightness after ageing
1	29°C	2.5%	2.5%	74.5	34	4140	280	61.5
2	50°C	2.5%	2,5%	75	39	4790	451	62.0

Varying Alkali Charges :

The way, variation in alkali charges effects the strength qualities of Pulp, it is a most important variable of extraction stage.

From Table No. 3 it can be seen that when 1% alkali is used, under similar bleaching conditions, for extraction the brightness does not develop to the required level of 78-80 °PV, indicating higher requirement of bleach liquor. It can be understood if this pulp is bleached to the same standard as in other cases of extraction, strength properties will definitely go down.

By using 3% alkali in extraction it is seen that the strength properties as well as brightness improves as compared to the experiments where 2% alkali has been used for extraction, thus indicating that an optimum alkali charge lies between 2 to 3%.

TABLE NO. III

Expt. No.	Particulars	Temp. of Extraction	pH		Brightness PV	Breaking Length (M)	Burst Factor	Tear Factor
			Initial	Final				
1.	1% alkali on BD Pulp	50°C	8·0	6.0	74	5291	35.7	105
2.	2% %	50°C	10.0	8.0	77	5000	33.3	93
3.	3% ,,	50°C	11.0	8.5	80	5683	32.8	98
1.	1% ,,	30°C	9.0	7.5	75	5000	35.7	83
2.	2% ,,	30°C	10·0	8.5	76	5222	27.5	77
3.	3% ,,	30°C	10.5	9.0	79	5000	28.5	93

Conclusion :

From the various studies it can be concluded that by controlled alkaline extraction, limited quantity of hemi-cellulose and pentosans are removed to produce pulp for paper making process. Certain desirable properties such as absorbency, opacity and bulk also enhance and physical characteristics improve.

Study of the economic aspect on the face may recommend CHH process, but the improved paper machine working and competitive market for better quality of papers will definitely favour the alkali extraction stage.

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