Studies on Commercial Yields of Waste Cotton Pulp

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Waste cotton abtained from some textile mills were subjected to cooking by caustic soda, with a view to evaluate its pulp yielding potentials for a paper mill based on wheat straw and waste paper pulp. The paper mill was getting a pulp yield of only 35–40% based on the original material. By analysing the losses due to alkali cooking, pulp washing and pulp beating, it was ascertained that the maximum fibre loss was arising in the wash water. As a result of this analysis, means were suggested, and tried when the pulp yield increased to about 60%, thus making the material economically and technically viable.

Plants for the manufacture of Pulp & Paper, based on waste paper pulp and pulp from agricultural residues, such as straw etc., often necessitate the addition of long fibred strong pulp to improve the strength properties of the finished paper and machine runnability. The long fibred pulp component can be obtained from bamboo, old gunnies, linters, rags, waste cotton. etc. Waste Cotton obtained from textile industry has been found to be an economically and technically promising source of strong and long fibred pulp. The following results obtained from a mill scale trial in a plant based exclusively on waste paper, wheat straw and cotton pulp attest the above statement. The extent of addition of cotton pulp in the following experiments was confined in the first instance to 20% of the total furnish only as the mill was not adequately equipped to handle large quantum of cotton pulp:

TABLE I

	Normal Mill furnish.	Addition of 10% cotton waste pulp.	Addition of 20%cotton waste pulp.	Normal bamboo based paper.
Basis weight g/sq. m.	46	46	51	53
Burst factor	6.4	7.5	16.6	9.5
Breaking length : (Metres)				
M.D.	1700	2275	4180	2900
C.D.	1300	1525	3140	2100
Double Folds				
M.D.	4	5	10	4
C.D.	3	4	9	4
Tear factor	52	63	66	67

The investigations undertaken and reported here were for the purpose of studying appropriate pulping and beating conditions to obtain the maximum yields from the raw material consistent with the desired quality of the pulp and the end product.

FACTS OF THE CASE :

The factory, where these investigations were undertaken manufactures mostly "low gramme" writing & Printing papers, in the range of 35 to 47 g/m² from a furnish consisting mainly of waste paper and bleached wheat

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straw pulp. In order to improve the quality of the paper and increase production, the mill had installed a rag plant and started using waste cotton, caddies, gunnies etc. for the manufacture of stronger pulp. As cotton waste was available at a competitive price it was expected that the yield from this material would be similar to that from cotton based pulping materials, viz in the range of about 65–80%[1]

However, on long trials, it was observed that the yield almost never exceeded 40% — although the dust and moisture in the raw material were within tolerable levels. Mainly on account of the low yield of the pulp the raw material was considered to be uneconomic.

It was suspected that heavy fibre loss in the white water from paper machine might be the cause of the low yield and consequently the white water system was closed to even "critical level" with inherent risk of slime, high solid built up in the system etc. Inspite of this, there was no noticeable improvement in the yield.

The studies, were consequently, undertaken to ascertain the main causes of the low yield and then to adopt corrective steps to better its yield and economics—without going into the theoretical aspects of the low yield. Since waste cotton contained dirt, hulls and other undesirable impurities, it could possibly not be sufficiently purified by bleaching alone, it was, therefore, being cooked by 10–11% caustic soda on bone dry weight of the material, in a rotary digester and the cooked material washed and beaten in ordinary beaters with washing drum. It was bleached by hypo-chlorite in the beater itself and later on washed by the washing drum after a retention period for the bleach of about 1 to 2 hours.

Discussions :

The following factors are likely to have a major influence on the yield of the pulp from the Raw material :

(a) Losses due to alkali cooking

(b) Losses due to washing beating and bleaching.

(c) Losses from the pulp to the paper machine.

In the present study, attention will mainly be focussed to (a) and (b) only.

(a) **Losses due to Alkali Cooking :**

Losses in the raw material on account of the alkali cooking can arise due to delignification, alkali degradable components of the raw material, removal of fats greases, etc. It was therefore necessary to get some rough assessment of the soluble protion of the soda cooked cotton by adopting different alkali concentrations for the cooking. These soluble, colloidal and major portion of fines are normally not fully usable back into the system and could be taken as non recoverable loss.

The estimation of the solubles etc. was made by the following empirical procedure.

A weighed quantity of oven dried alkali cooked waste cotton corresponding to different concentrations of alkalies from the digester was subjected to thorough washing by water till a constant pH and clarity of wash water was obtained. The wash liquor was passed through a 100 mesh sieve to retain any fibrous material. The washed sample was again dried, weighed, and the washing loss due chiefly to solubles, colloids etc. determined. The losses were ascertained at the following alkali concentrations :

Table 2

Alkali concentration on B.D. Material.	**Washing Losses %.**
2%	16.90
5%	16.30
7%	30.00
11%	30.00

The results of variation of washing losses with different concentration of alkali are plotted in Figure 1.

This pilot analysis indicates that the losses due to concentation of alkali do not follow a linear pattern, but are constant from 2 to 4% and then show a steeper trend-indicating as per expectations, as in a general way, higher alkali concentrations increase the solubles and could adversely affect the yield. However, subsequent analysis showed

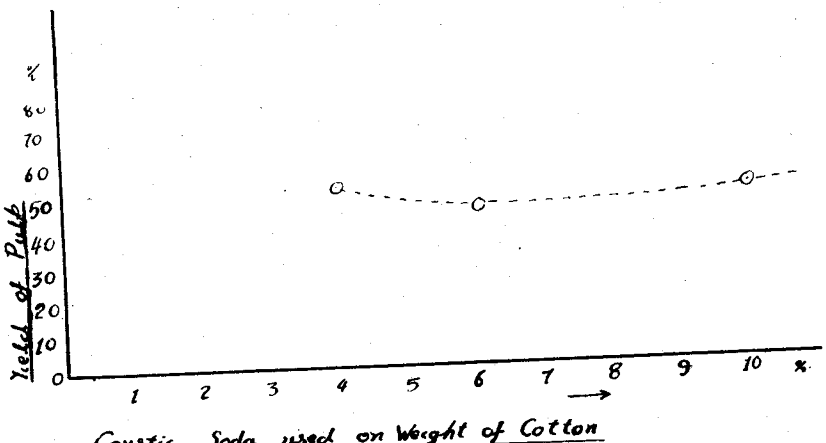

Figure 1—Relationship of cooking concentration of alkali and washing loss.

that the output was being affected more seriously by washing and beating than by alkali cooking alone.

Although during cooking with different concentration of alkali, cooking time varied from 7 to 9 hours, subsequent analysis showed that this variation range in cooking time did not influence the yield significantly. In fact, some previous basic studies undertaken by the author had revealed that inter fibre bond in wood was influenced maximum by the concentration of alkali[2] and less significantly by cooking time.

The yield of the pulp at different alkali concentration shown in table 4 and plotted in Fig. 2, revealed-surprisingly that, within the range of alkali usage studied, at least on the material under investigation, the influence of concentration of alkali on yield was not very prominent. However, the quality of the pulp at higher alkali concentration was noticeably better with less hulls and lower bleach requirement.

This pilot analysis further confirms that the major portion of the losses were probably taking place due to washing and beating and this aspect needs a closer study and control.

Losses due to beating, washing and bleaching :

Losses in washinag and beating were determined by the following procedure :

Weighed quantity of alkali cooked rags with predetermined moisture, were put into the factory beaters and washing started till the wash water showed a pH of about 8 and the wash water was almost clear. Measured quantity of hyposolution was put into the beater at a pulp consistency of about 5%. After a retention period of about one to two hours, the pulp was washed and beaten to 35°SR. The amount of pulp in each beater was ascertained at the end of the beating and washing operation from the trough volume and also the consistency of the pulp. From the quantity of the final pulp obtained, the yield was estimated both on the basis of the original material and input iato the beater — after deduction of losses due to solubles, colloids and other non-fibrous components. In order to further examine the losses, an hourly sample of beater wash water was taken for its pH and sediment determination.

The variation of sediments in the wash water and the change of

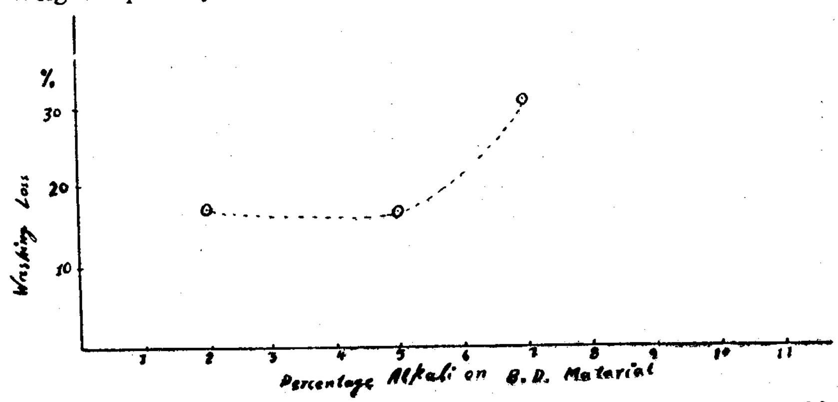

Figure 2—Correlation between caustic soda for cooking and yield of pulp.

pH as a function of washing/ beating time, is represented in figures 3 and 4. The figures reveal that the fines are being discharged continuously during washing of the fibres both before and after bleaching. The plot of pH versus beating / washing time indicates that possibly one could reduce the washing time to some extent and thus reduce the losses.

Discussion of the Results :

These investigations reveal that there was a sizable loss of the valuable fibres out of the wash drum even under light beating conditions. The yield and the extent of "preventable" losses were estimated in three simultaneous cooks, whose results are shown in table 3.

In the above experiments, while in the first cook beater was under load for most of the time when washing drum was working, in the subsequent experiments, washing was restricted when the beater was under refiner load.

The separation of washing and beating operation appears to have a noticeable effect on the yield indicating that the effect of alkali-at least within the range studied has less prominent effect than the washing of the pulp. Since washing losses were quite significant, it was evident that, as far as possible, one had to use the washing drum less liberally during the beating operation. The particular plant did not have separate breaker washers and finishing beaters,

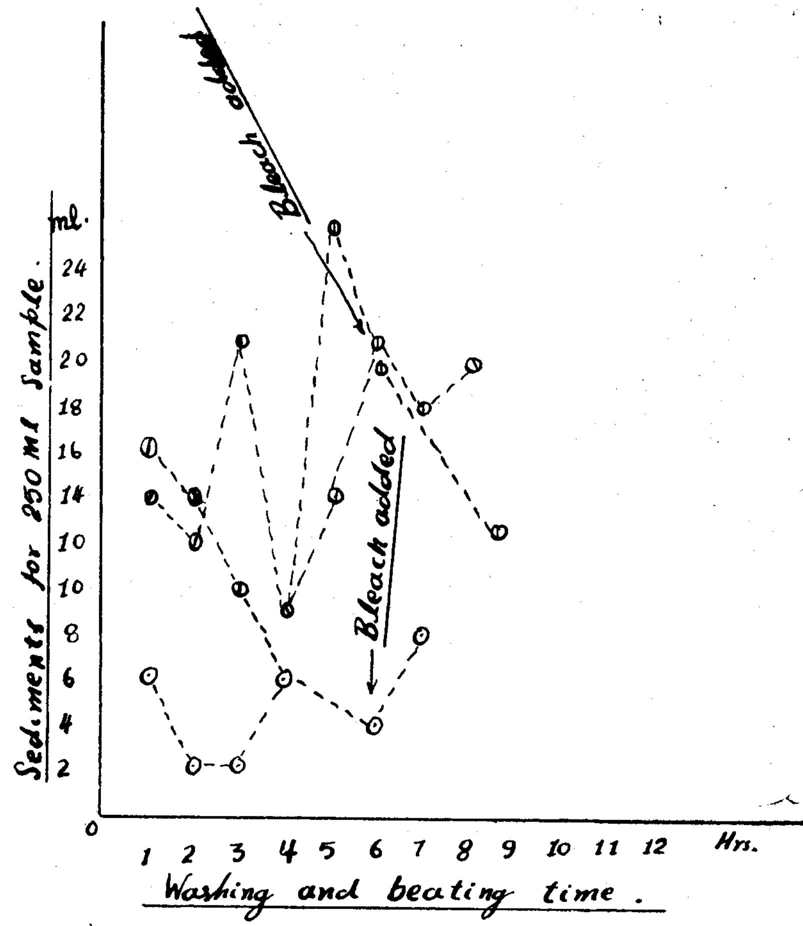

Figure 3—Washing and beating time versus fibre loss in beater.

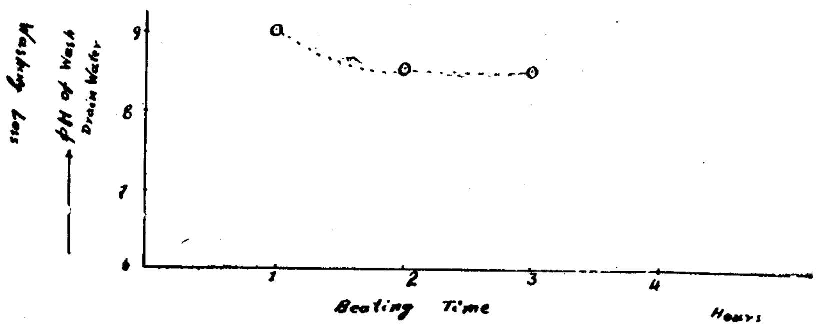

Figure 4—Relationship of pulp washing and pH of drain water.

both the operations were being done in the same machine. In case one had to do the washing and beating entirely separately, it would have increased the total operation time excessively, therefore as a first step, the wire of the wash drum was changed to that of finer mesh- as an experimental measure-so that less fines were washed out. As the subsequent step the mill was asked to try to beat with as far as possible, restricted washing while the beater was under load. A number of observations were

Table—3.

Cook Number	(1)	(2)	(3)
Weight of the material	2712 Kg	2900 Kg	2862 Kg
Dry weight of the cooked material including alkali and other accompanying material	2568 Kg	2548 Kg	2600 Kg
Alkali concentration used for cooking	10 %	10 %	10 %
Estimated non-recoverable soluble material (approx. 25% of the B. D. weight)	642 Kg	510 Kg	650 Kg
Expected input soda free B.D. fibre	1926 Kg	2038 Kg	1950 Kg
Dry fibre yield based on input.	71 %	70.2 %	61 %
Actual Dry output	1119 Kg	1519 Kg	1440 Kg
Approximate fibre loss due to washing and Beating	807 Kg	519 Kg	510 Kg
Yield based on Fibre added in Beater	58 %	74 %	74 %
Yield on original material	41.30 %	53.0 %	57.0 %

taken under the above system. The values recorded in table 4 show that there has been a considerable increase in the yield of the pulp, as a result, of these measures.

Since washing of the pulp was apparantly more responsible for the fibre losses, the installation of a fibre necovery unit even after adopting restricted washing etc., separately for this valuable pulp was investigated.

For this test one hundred litre hourly sample of the wash liquor was collected from the beater washing drum drain both under separate and simultaneous operations of wash drum and beater. The retention of fibres was estimated by passing the wash liquor sample through a 200 mesh S S. wire and determining the B.D.

Table 4

	Raw cotton used Kgs.	Rejects	Accepted material	Cooking chemicals percentage NaoH	Hpyo consumption.	Material to liquid Ratio.	Cooking time House.	Steam prcssure Kg/cm²	Yield %
1.	1611	17%	1336	12 %	3 %	112	2	5	62.5
2.	3015	22%	2330	7.7 %	3.8%	,,	9	,,	57.4
3.	3058	19%	2478	4.9 %	9.7%	,,	9	5	59.9
4.	3000	17%	2490	12.5 %	3.6%	,,	9	5	35.0

Wasing with coarse wire on the washing drum and simultaneous washing and beating.

*** Based on B. D. weight of cotton.**

weight of the fibre collected on the mesh. The hourly sample under both the operating conditions are illustrated in fig. 5. As expected the fibre losses were more when washing drum operated with beater under refining load. Another observation noted was that when the sample of wash water collected under refining load was passed through the fine wire, it chocked more frequently, indicating that the outgoing material consisted mostly of fines and colloideal particles some portion of which could possibly pass through the fourdriner screen also in case the recovered material was used back into the system. This was confirmed by passing the wash water sample through 60 mesh wire also. The retention on the better wire was less than $\frac{1}{4}$th that on 200 mesh wire.

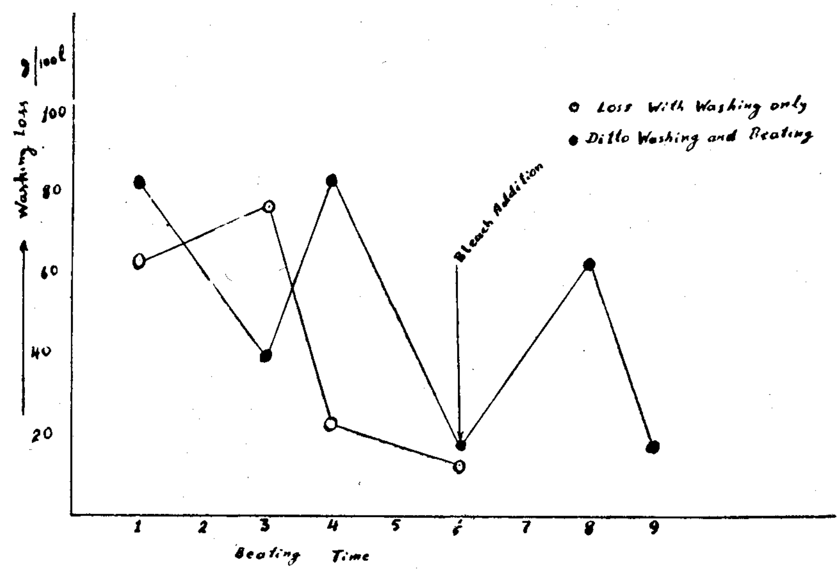

Figure 5—Beating time versus washing loss for (a) washing only (b) washing and beating together.

The fibre retention computation revealed that the maximum quantity of recoverable and effectively usable material be around 60 to 100 No/day/beater. This would further enhance the yield by about 2 4%.

Reference—

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(2) Kumar V.B., Holz als Roh– and warkrtoff 198, 309 (1961)