# Improving the printing quality of cultural papers containing chemical bagasse pulp as major furnish component

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## ABSTRACT

Cultural papers containing higher percentage of chemical bagasse pulp in the furnish generally have lower opacity, bulk and hygrostability but higher print through tendency than papers having no bagasse pulp. All these cause serious printing problems like poor print quality, misregister and sheet creasing/rupturing on the offset printing machines. Studies on writing and printing grade paper samples with 80–90% bagasse pulp and remaining softwood pulp had shown that these papers had higher tensile stiffness (indicative of elastic modulus) than papers without bagasse pulp. This indicated that bagasse fibres on blending with other types of papermaking fibres will still be able to give stiff paper which is a property desirable for good printing and better runnability on the offset printing machine The opacity, bulk and print through of such papers can be improved by blending with either straw pulp (30%) or BCTMP (20%) or BTMP (20%). The print through could be reduced upto the extent of 53%, 59% and 62% with straw, BCTMP and BTMP pulp respectively and remarkable improvement in the specific scattering co-efficient values. Addition of straw pulp relatively was more effective as the scattering coefficient improved to 48.1 $m^2/kg$ from 32 3 $m^2/kg$ followed by BTMP (46 7 $m^2/kg$) and BCTMP (38 9 $m^2/kg$). Softwood and hardwood chemical pulps caused only marginal improvement in these properties The print through tendency of such paper samples was also reduced with the improvement in retention of fines, fillers and uniformity in the sheet formation China clay didn't give any benefit over soapstone in improving the print through tendencyof bagasse paper Blending of BCTMP and BTMP wood pulps in the furnish improved the hygrostability also of bagasse pulp containing papers.


## Introduction :

In countries with little or no wood resources, non wood Plant materials constitute an important fibre source for the pulp and paper industry. The pulp and paper industries in the Middle East, North Africa and central Asia are substantially using nonwood fibres and these industries are expanding rapidly at an annual rate of 5 1% as compared to the annual rate of 3% in developed nations which are mainly using wood as raw material (1). In our country, Bagasse, amongst all the non-wood Plants, is being considered one of the most promising raw material for the manufacture of different grades of paper. It has been observed that generally the cultural papers having higher percentage of chemical bagasse pulp in their furnish have relatively lower opacity, lower bulk and higher print through tendency. The higher print through results in poor print quality. In addition, such papers also sometimes are lesser hygrostable and give misregister problems during multicolour offset printing.

In the present investigations, writing and printing grade bagasse chemical pulp which had serious printing papers from mainly problems like high print

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through and misregister on multicolour offset printing were examined in detail to identify the causes and possible steps to improve the quality. These papers had 88% pulp and 12% filler, the pulp being a mixture of chemical bagasse and softwood in the ratio around 90:10.

### Results and Discussion :

To quantify the extent of print through, these paper samples (MG & MF grade) hence forth called the variety "Bag" were examined for the various characteristics and compared with other paper samples having no bagasse pulp in the furnish called "Con" in the subsequent discussions. It was observed that paper having bagasse in the furnish although well bonded as indicated by high tensile strength (Breaking length 2660 & 4090 in CD & MD respectively) and tensile stiffness (7 46 mNm/kg) had very high porosity. When compared at the same grammage level, its porosity was 1270 ml/min. as compared to the paper having no bagasse in the furnish whose value was 490 ml/ min (Table 1).

This appeared to be due to more flocs (thick bundle of fibres) and lesser filling material (fines and fillers) in the sheet. The Scanning Electron Microphotographs also showed that the former paper had relatively more void gaps (Fig. 1).

Relatively higher print through (0 14 units higher) probably due to this reason. It could also be attributed to the nature of fibres. Bagasse fibres collapse better in the sheet matrix than other straw fibres thus resulting in lower sp scatt. co-efficient value and lesser bulky sheet. Tensile stiffness which is indicative of initial linear portion of the tensile stretch curve was quite high for papers containing higher percentage of bagasse although thickness of these papers was lower. This implied that these papers had higher elastic modulus which in turn indicated that bagasse fibres blended with other types of papermaking fibres will still be able to give stiff paper which is always considered better for runnability on the printing press. The "Bag" paper had vary high print through (0 63) which was about six time higher as compared to the "Con" paper value (Table—2). For reducing the extent of print through use of lesser amount of ink could be one approah, however as the ink demands to get a particular value of print density (0.90 in case of good solid print) were found to be comparable for both the samples "Bag" & "Con" 5.6 & 6 0 respectively. Therefore for reducing the print through it could not be recommended that "Bag" paper should be printed using lower amount of ink (Table 2).

TABLE—1

Characteristics of MG Poster Paper Sample with 80-90% Bagasse Pulp (Bag Papers) And 'CON' Paper Having No Bagasse Pulp In The Furnish

| Property | Value obtained for sample | |
|---|---|---|
| | BAG | CON |
| Grammage ($g/m^2$) | 38.6 | 36.5 |
| Thickness (micron) | 62 | 66 |
| Bulk ($cm^3/g$) | 1.61 | 1.81 |
| Breaking length (m) | | |
| CD | 2660 | 1970 |
| MD | 4090 | 3380 |
| Stretch (%) | | |
| CD | 1.4 | 1.5 |
| MD | 1.3 | 1.4 |
| Tensile stiffness (mN.m/kg) | | |
| CD | 6 31 | 2 95 |
| MD | 8 60 | 6 60 |
| Avg. | 7 46 | 4 80 |
| pH | 5.7 | 6 2 |
| Ash content (%) | 5.3 | 11.6 |
| Oil absorbency (IGT stain length, mm) | | |
| Top | 37 | 41 |
| Wire | 34 | 40 |
| Porosity (ml/min. Bendtsen) | 1270 | 490 |
| Smoothness, (ml/min Bendtsen) | | |
| Top | 320 | 190 |
| wire | 1380 | 1180 |
| Print through (Macbeth density) | 0.91 | 0 77 |
| Opacity (%) | 75.0 | 90.3 |
| Sp Scatt. Co-eff. ($m^2/kg$) | 33 8 | 51 0 |

The hygroinstability tests indicated that expansion with relative humidity changes for "Bag" paper was very high as compared to "Con" paper. When compared at 90% relative humidity, the expansion was 44% and 132% higher in MD and CD directions respectively (Fig. 2).

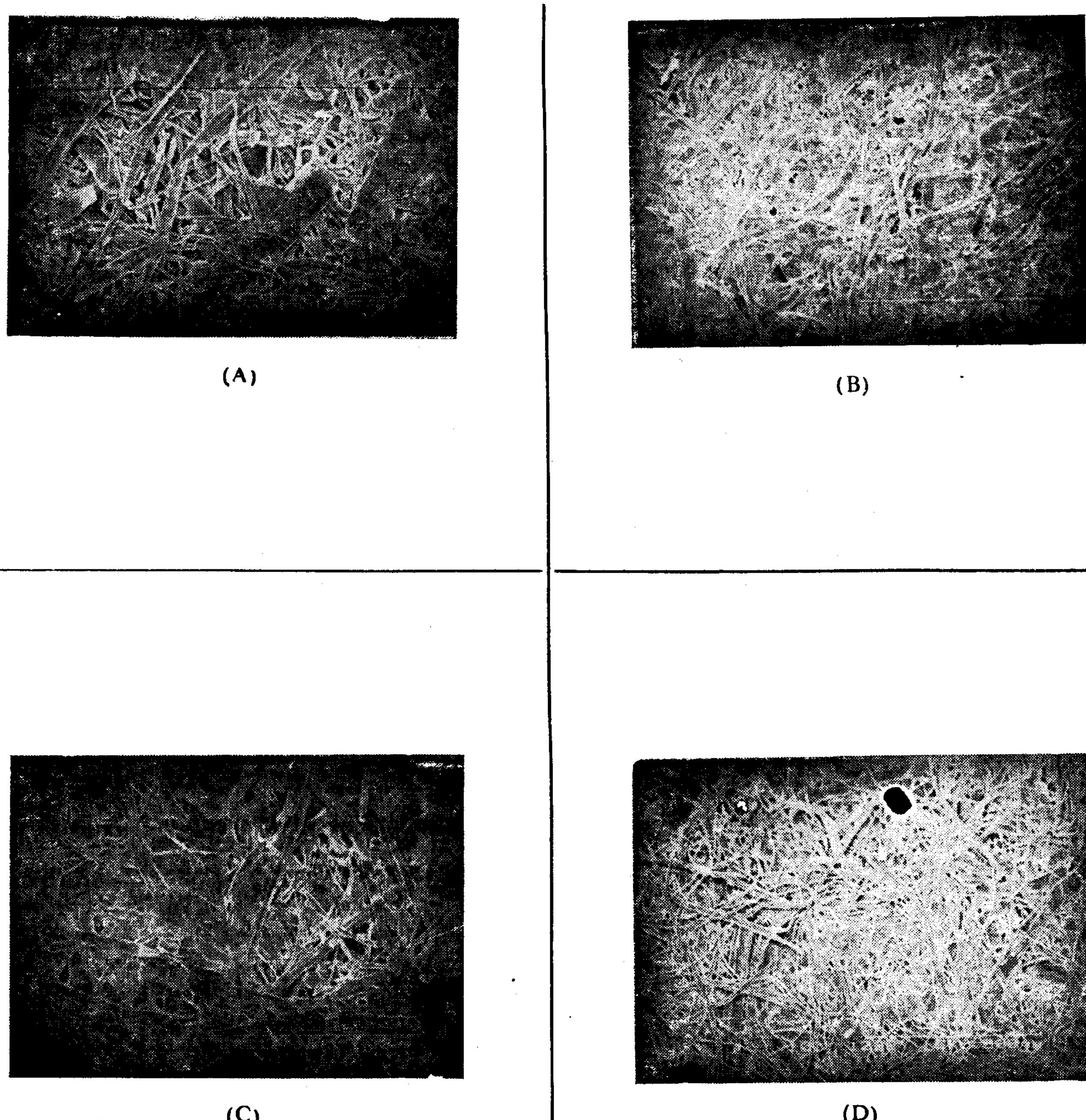


Fig. 1 : Electron Photomicrographs (X 100) of MG & MF White Printing Paper Samples with 80–90% Bagasse Pulp (Bag Papers) and Con Papers Having No Bagasse Pulp in the Furnish.
(A) MG BAG (B) MG CON (C) MF BAG (D) MF CON

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**Effect of Using China Clay Instead of Soapstone As Filler :**

China clay has relatively fines particles (0.5-1.0 micron) compared to soap stone (1.0–10 micron), the refractive index however being comparable (Table-5) (4, 5).

TABLE–3
Freeness values of the pulp samples from different sections of a mill

| Section | Pulp comprised of | Freeness, CSF |
|---|---|---|
| Chlorine washer | Bagasse | 510 |
| Hypo washer | Bagasse | 450 |
| Bleached Decker | Bagasse | 405 |
| M/C Chest | Bagasse, Broke, Softwood, sizing chemical, filler | 370 |
| S/R Box | Bagasse, Broke, Softwood, Sizing chemical, filler | 325 |

TABLE–4
Properties of handsheets (38 GSM, 55 GSM) prepared from mill pulp samples (90% bagasse+10% softwood)

| property | Head Box pulp | | Machine Chest pulp | |
|---|---|---|---|---|
| | 38gsm | 55gsm | 38gsm | 55gsm |
| Bulk cm³/g) | 1 37 | 1 32 | 1 40 | 1 37 |
| Breaking length (m) | 3920 | 4360 | 3490 | 4115 |
| Ash content (%) | 14.8 | 17 4 | 16.6 | 17.7 |
| Brightness (%) | 63.4 | 66.2 | 67.0 | 68 6 |
| Opacity (%) | 73.9 | 83.9 | 68.1 | 81.8 |
| Sp. Scatt. Co-eff. (m²/kg) | 27.3 | 29.1 | 27.3 | 28.4 |
| Print through (Macbeth density) | 0.71 | 0 47 | 0 88 | 0 42 |

Owing to its finer particles the china clay would scatter light more efficiently than relatively bigger soap stone particles. Therefore to assess the relative effectiveness of these two fillers on the improvement in opacity & print through of bagasse pulp, handsheets were prepared using both the fillers separately. Printing tests on handsheets containing china clay, contrary to expectations showed higher print through than soap stone. (Table-6)

This was probably due to relatively lower retention is case of china clay as indicated by ash content. China clay therefore was found to be having no advantage over soap stone.

**Blending with other types of Pulps :**

Since most of the other wood & straw pulps are superior to bagasse pulp from opacity view point, therefore these were taken for blending in order to improve opacity as it is an additives property. Softwood, hardwoods, straw, BCTMP softwood and BTMP softwood pulp were blended with the bagasse pulp furnish (90% bagasse pulp + 10% softwood pulp) taken from the head box. It was observed that addition of straw pulp (30%) or BCTMP (20%) or BTMP (20%) caused substantial improvement in the print through and sp. scatt. co-efficient. The print through reduced form 0 78 to 0.37, 0.32 and 0.30 in case of straw, BCTMP and BTMP respectively and sp scatt, co-efficient improved from 32.3 to 48.1, 38.9 and 46 7 m²/kg respectively. Addition of chemical hardwood pulp (20%) showed marginal improvement on these properties. Addition of softwood pulp showed only slight improvement in the print through alongwith sp. scatt. co-efficient. Addition of BTMP however showed remarkable improvement in the print through alongwith sp scatt. co-eff. The print through reduced from 0.78 to as low as 0 30 and sp. scatt. co-efficient improved from 32.3 to exceptionally a good value 46 7 m²/kg Straw pulp although gave higher improvement in sp. scatt. co-eff. but the effect on the print through was relatively lesser than BCTMP and BTMP pulp (Table 7).

TABLE–5
Refractive Index of some common paper making Pigments (Ref. 5)

| Filler | Refractive Index |
|---|---|
| Clay | 1.55 |
| Talc | 1 57 |
| Calcium carbonate | 1.56 |
| Zinc oxide | 2.01 |
| Zinc Sulphide | 2.37 |
| Titanium dioxide | |
| Anatase | 2.55 |
| Rutile | 2 70 |
| Calcium sulphate, anhydrite | 1.58 |
| Asbestine | 1 56 |

TABLE-6
Effect of using china clay and soap stone on the properties of bagasse pulp

| Property | Pulp with 20% filler addition | |
|---|---|---|
| | Soap Stone | China Clay |
| Bulk $cm^3/g$) | 1 29 | 1 29 |
| Breaking length (m) | 945 | 960 |
| Ash content (%) | 14 2 | 10 2 |
| Brightness (%) | 74.0 | 73 8 |
| Opacity (%) | 88 3 | 86.9 |
| Sp. Scatt. Co-eff. | 52.7 | 51.2 |
| Print through (Macbeth density) | 0.43 | 0.73 |

The dimensional stability also improved by the addition of BTMP or BCTMP (Table-8).

## Experimental :

Prior to testing all the paper & handsheet samples were conditioned at temperature 27±1°C and 65±5% relative humidity. The printing tests were carried out using IGT printability tester (6, 7, 8).

## Print Density and Ink Requirement :

Paper strips of 35 mm width and 250 mm length in the machine direction were taken. Prints were made on the wire side of paper using different ink layer thickness of IGT striking in ink on the printing forme. The printing conditions used were—

| | | |
|---|---|---|
| Speed | : | Constant, 350 cm/s |
| Printing pressure | : | 196 N |
| Printing disc | : | 2 cm. wide (aluminium) |
| Blanket | : | IGT Paper blanket |

The prints were allowed to dry overnight and the optical density of the printed area in reference to optical density of the blank paper was measured using Macbeth densitometer RD 514 Graphs between print density and ink layer were plotted and ink layer thickness required to get print density of 0.90 was determined.

## Determination of Print Through Value :

The strips were printed using 16 micron thick layer of IGT striking in ink. The printing conditions employed were—

| | | |
|---|---|---|
| Type of ink | : | IGT striking-in-ink |
| Amount of ink | : | 2 $cm^3$ on the inking rollers |
| Blanket | : | IGT paper Blanket |
| Speed | : | Constant, 20 cm/s |
| Pressure | : | 686 N |
| Disc | : | 2 cm wide (aluminium) |

The density of the print visible on the reverse unprinted side was measured after allowing the printed sheets to dry overnight which was taken as print through value.

## Dimensional Hygroinstability :

Dimensional hygroinstability of paper was measured using PIRA paper expansion measuring apparatus. Paper specimen of length 200 mm was fastened between two clamps, preloaded and measuring device was set to zero. The specimen was then subjected to atmosphere of different relative humidity values for sufficient length of time so that there was no expansion or contraction occurring & the strips had stabilized in length. The amount of expansion was measured by

TABLE—7
Effect of Blending Bagasse Pulp* (From Head Box) with other Types of Pulps

| Property | Bagasse pulp(B) | 70%B 30% Straw | 80%B 20% S. wood | 80%B 20% H wood | 80% B 20% BCTMP | 80%B 20% BTMP |
|---|---|---|---|---|---|---|
| Bulk ($cm^3/g$) | 1.19 | 1.24 | 1 20 | 1 22 | 1 25 | 1.35 |
| Breaking length (m) | 2430 | 2005 | 2320 | 2280 | 2420 | 2410 |
| Opacity (%) | 88 3 | 97.1 | 89.5 | 92.5 | 93.7 | 95.9 |
| Sp. Scatt. Co-eff. ($m^2/kg$) | 32.3 | 48.1 | 32 8 | 36 9 | 38.9 | 46.7 |
| Print through (Macbeth density) | 0.78 | 0.37 | 0.76 | 0.75 | 0.32 | 0.30 |

* : Bagasse pulp taken from head box actually comprised of 90% bagasse pulp+10% softwood pulp.

dial micrometer gauges provided in the instrument. The percentage expansion was calculated and reported as hygroinstability.

TABLE—8

Hygroinstability of different pulp blends

| Pulp | % Expansion for (Relative humidity change from 30% to 94%) |
|---|---|
| Head box (H B pulp)* | 0 25 |
| H B pulp plus 20% Hardwood pulp | 0 21 |
| H B pulp plus 30% straw pulp | 0 22 |
| H B pulp plus 20% BTMP (SW) | 0 14 |
| H B pulp plus 20% BCTMP (SW) | 0.13 |

* : Head box pulp (H B pulp) consisted of 90% bagasse pulp+10% softwood pulp.

**Other Tests :**

| | | |
|---|---|---|
| Grammage | : | ISO 536 |
| Thickness | : | ISO R 534 |
| Tensile strength | : | ISO 1924 |
| Tearing strength | : | ISO 1974 |
| Ash content | : | ISO 2144 |
| Brightness | : | ISO 2470 |
| Opacity | : | ISO 2471 |
| Sp Scatt. Co-eff. | : | SCAN C 27:69 |
| Tensile stiffness | : | Tensile stiffness was measured using L & WAlwetron THI microprocess control tensile testing instrument. |

**Conclusion :**

1. 'Bag' papers (referred in the foregoing text as papers having bagasse pulp as the main furnish component) had higher elastic modulus than papers without bagasse pulp (referred as 'Con' papers). This means that bagasse fibres on blending with other types of papermaking fibres will still be able to give reasonably stiff paper, which is a requirement for better runnability of paper on the offset printing machine.

2. 'Bag' papers were less hygrostable than 'Con' papers especially when relative humidity exceeded 70%.

3. The opacity, bulk and print through of 'Bag' paper can be improved by blending with either straw pulp (30%) or BCTMP (20%) or BTMP (20%) in the furnish. The print through could be reduced upto the extent of 53%, 59% & 62% with straw BCTMP & BTMP pulps respectively. Blending of these pulps showed improvement in sp.scatt. co-efficient also. Straw pulp gave exceptionally good value (48.1m²/kg) followed by BTMP (46 7m²/kg) & BCTMP (38.9 m²/kg). Softwood and hardwood pulps improved these properties only marginally.

4. The print through tendency of paper improved with the retention of fines, fillers and better sheet formation.

5. China clay didn't give any additional benefit over soapstone in improving the print through tendency of bagasse paper.

6. Addition of BCTMP and BTMP wood pulps improved the hygrostability also of the 'Bag' papers.

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