

# Improving The Quality Of Newsprint From Recycled Fibers

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## ABSTRACT

Quality of newsprint from recycled fibers can be improved by optimization of furnish composition, deinking process, fines retention and calendaring operations of paper making. To manufacture good quality newsprint its furnish should preferably have at least 50% mechanical pulp component. Deinking of newspapers printed using ink having high amount of pigment vehicle can better be carried out using chemical with composition sodium soap of fatty acid containing copolymer based on ethylene propylene oxide plus emulsifier than commonly used sodium soap of fatty acid with sodium silicate. Better smoothness, gloss and printing characteristics in recycled fibers containing newsprint can be obtained by soft nip calendaring as compared to hard nip calendaring. Polyethylene amine type retention aid is more effective in retention of fines in paper as compared to alum or polyaluminium chloride commonly used in such mills. Retention of fines helps in improving surface characteristics of newsprint. Results show that linting problem of newsprint which is one of serious problems being faced by printer during printing can better be controlled by installation of wet end starch application system at press roll of paper machine than starch addition during stock preparation.

**Keywords:** Recycled Fibers, Newsprint, Deinking, Calendaring, Retention aid.

## Introduction

Large number of newsprint paper mills in India are using mixed variety of waste papers like old newsprint (ONP), old magazines (OMG), sorted office waste (SOW) and mixed colour cuttings (MCC), note books and other chemical pulp containing papers to manufacture newsprint. Generally 26–30% ONP and remaining old magazine (OMG), office waste and notebooks etc. are used depending on their availability and cost.

Different variety of waste paper have different furnish components. ONP has a high percentage of mechanical fiber, ground wood or thermo mechanical pulp along with additives such as starch, inorganic filler ranging from 3 to 12% by weight. Amount of ink is about 1 to 2% by weight. OMG is a highly variable raw material. Fiber component of magazine can range from 100% Kraft pulp to 100% ground wood. A single magazine may include coated free sheet, coated ground wood and uncoated mechanical fiber. Also, additives are highly variable in this grade. Fillers such as clay, alum, precipitated calcium carbonate (PCC) are present which had been added during the paper making process to improve sheet characteristics. In magazine stock, this inorganic portion

of furnish can range from 10 % in uncoated sheet to as high as 50% in a sheet which is coated on both sides. Adhesive associated with bindings, thermal plastics and hot melts are also present which contribute to stickies. Ultraviolet cured inks, common on magazine covers, are difficult to deink. Ink can range from 1 to 7% by weight in magazine grade of waste paper. Sorted office waste, mixed colour cuttings and notebooks contain mainly chemical pulp as pulp component. Chemical pulp component in indigenous waste papers contains mainly short fibred pulps like agricultural residues, bamboo and hardwood. Using such a wide variety of waste papers to manufacture newsprint is a typical practice in India, whereas abroad only ONP and OMG are the main components to manufacture newsprint. Quality draw backs in newsprint being manufactured by these paper mills are inferior surface smoothness, presence of ink specks, low stiffness and high tendency of linting<sup>1</sup>. Due to these shortcomings, printers consider such newsprint relatively poor in quality as compared to newsprint of big mills.

## Characteristics Generally Sought by Newspaper Publishers

Newspaper publishers desire newsprint with good press runnability, printability, appearance and low price. These requirements are described as under

### Runnability;

i.e. ability to run the web through the presses without break.

### Printability;

i.e. ability to accept and preserve the printed ink pattern with minimum rub off, set off, and show through.

### Appearance;

i.e. a reasonable brightness, whiteness, cleanliness & opacity.

### Price;

i.e. low price per unit paper area and grammage

Now a days, quality demands in newsprint by newspaper publishers have changed entirely due to changed requirements in print quality and press speed. Apart from latest news carrier, newspaper now a days is considered as an important advertising tool due to handsome revenue realization from advertisements. Most of the newspaper houses have installed offset presses with high operating speed of minimum 70,000 copies per hour. Also longer time prior wash up i.e. at least after 250,000 copies is preferred to get economical production. All these in turn require that newsprint should have sufficient surface strength to resist linting<sup>2, 3</sup>. Also water uptake during offset printing is important in newsprint especially as it takes few tenths of second to wet such paper. There is increased use of colour in newspapers for both editorial and advertising. Most

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new press installation now consist of press lines where many, if not all units, allow two-sided, four colour production on stacked tower units. The need for consistent colour between rolls and between mills to produce consistent print colour has become a major publisher's concern. Use of a large percentage of newsprint on four colour leads, where the sheet is printed in up to eight separate units, increases the wetting of the sheet. This results in increased concerns about dimensional stability of sheet that causes fan out during printing and sheet curl when the sheet redries. Keeping all these in view quality demands in newsprint have become typical now a days.

Newsprint with satisfactory surface characteristics is a main requirement of printers. In present investigation possibilities of improving quality of newsprint manufactured from recycled fibers have been studied. Following steps have been considered for improvement.

- Selection of proper furnish composition
- Proper deinking operations.
- Proper wet end control.
- Surface treatment in wet state.
- Proper calendaring operations

### Materials and Methods

Newsprint samples manufactured from waste paper by different Indian mills were collected. These samples were conditioned at temperature  $27 \pm 1^\circ\text{C}$  and relative humidity  $65 \pm 2\%$  prior to testing. Tests were made according to following standard methods:

Thickness ISO 534, Smoothness ISO 2494, Tensile Index ISO 1924, Brightness ISO 2470, Gloss TAPPI 480 OS 72.

Fiber rising test (LRC, SRA) was done using Fibro Fiber Rising Tester Model 1090. In this device the paper surface was moistened and dried. The fibers lifted off the surface while passing over a roller of small curvature were imaged with oblique lighting and images were counted as long rising component (LRC) and short fiber area (SRA)<sup>4,5</sup>.

Print uniformity index, Solid prints having print density 0.90 were made using IGT Printability tester (AIC2-5). The print uniformity index of solid print was measured using Paprican image analyzer.

Deinkability was assessed by two parameters namely deinkability factor and residual ink value after deinking. Deinkability factor DEM was calculated from ISO brightness of

unprinted deinked pulp (US) i.e. made from unprinted paper subjected to deinking process, printed undeinked pulp (BS) and deinked pulp (DS) using formula

$$\text{DEM} = \frac{(\text{DS}) (\text{BS})}{(\text{US}) (\text{BS})} * 100$$

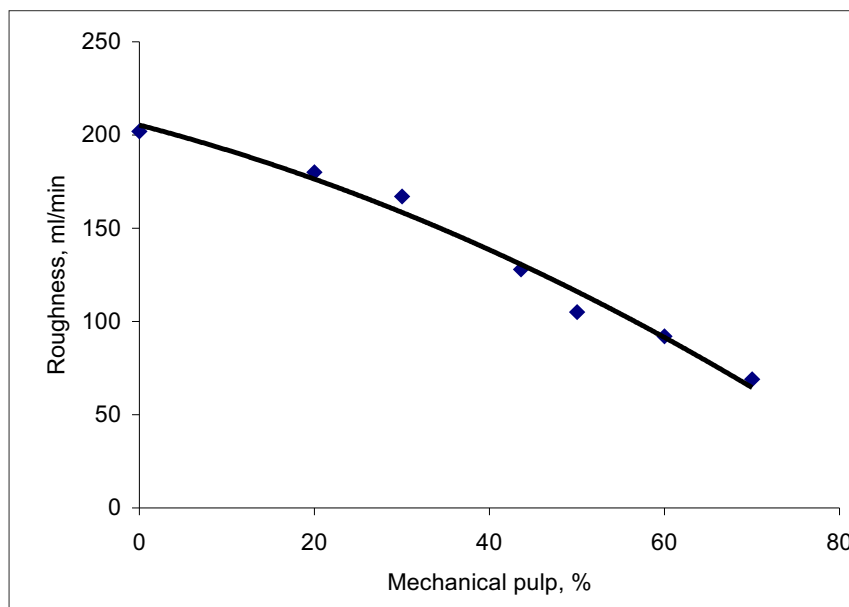
A value of 100% describes complete removal of the printing ink.

Residual ink value (Deinkability); Residual ink value of undeinked pulp (BR) and deinked pulp (DR) was measured using Elrepho spectrophotometer and deinkability was calculated using following formula  $[\text{BR}-\text{DR}]/\text{BR} * 100$ . Higher the value, better is deinkability.

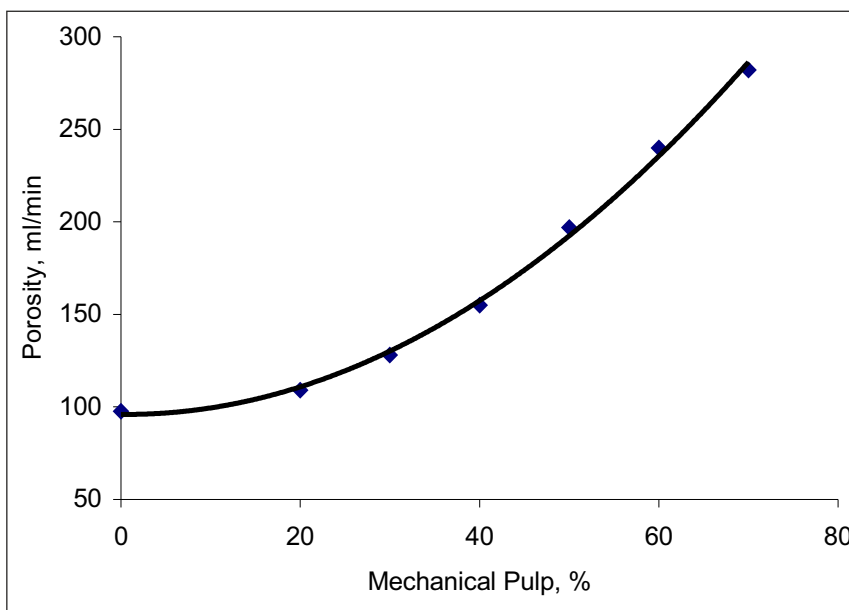
### Results and Discussion Proper Furnish Components

Over the past decade, there have been trends towards a greater amount of recycled fibers in newsprint furnish, lower grammage and the elimination of costly kraft pulp<sup>6</sup>. A careful selection of furnish components is needed due to end use requirements of newsprint i.e. good smoothness, porosity, opacity and bulk. These characteristics can best be obtained with usage of mechanical pulp. Increasing amount of mechanical pulp gives smoother and porous paper (Figs. 1 & 2). Improvement in

**Fig. 1- Effect of increasing mechanical pulp in a mixture with chemical pulp on roughness of newsprint**



**Fig. 2- Effect of increasing mechanical pulp in a mixture with chemical pulp on porosity of newsprint**



smoothness with increase of mechanical pulp content is probably due to reason that mechanical fiber is relatively lesser prone to horriffication than chemical pulp fibers<sup>7</sup>. Porosity improvement is due to increase of open sheet matrix by increased use of mechanical pulp fibers. To attain good bulk, sp. scattering co-efficient and smoothness along with porosity, furnish component of final newsprint should have at least 50% mechanical pulp. Probable cause of poor smoothness in Indigenous paper could be due to presence of excess proportion of chemical pulp fibers mainly coming from chemical pulp based waste papers i.e. office waste & note books etc.

### Proper Deinking Operation

Raw material quality plays an important role in performance of deinking. Composition of waste papers and age are most important factors affecting ink removal efficiency, yield and final pulp properties<sup>8-13</sup>. Paper with high ash content provides higher initial brightness, easier ink detachment and removal and less sensitivity to aging. Main drawback of raw material with high ash content is the low process yield due to selectivity of floatation towards fillers. Effect of ageing on brightness after deinking of offset printed newsprints having different ash contents (ranging 0.5 to 8%) is depicted in Fig 3. Storage of newspaper adversely affects deinkability as indicated by lower brightness values attained after deinking floatation. In India, paper mills are using old newspapers of Indian and foreign origin. During investigations it was observed that deinkability of foreign

newspapers is comparatively easier as compared to Indian newspapers especially for those printed in local languages. Those newspapers have been generally printed using ink with high amount of ink vehicle. Due to this, normal type of deinking chemical does not work satisfactorily. To get proper deinking in such case, it is important that the deinking chemical used should be of special nature. Deinking chemical with following chemical composition was tried.

- Sodium soap of fatty acid with sodium silicate commonly used by mills (A).
- Sodium soap of fatty acid with copolymer based on ethylene propylene oxide plus emulsifier specially got formulated by a chemical company (B).

It was observed that chemical of B type

gave best deinkability (Table 1). Probable reason is that besides action of soaps as droppers of ink and foam formation, copolymer in chemical B helps to kidnap the ink particles and make them float hence better elimination with foam. Clearly by usage of proper deinking chemical it will be possible to get better-deinked pulp from Indigenous newspapers. Final paper has lesser specks than obtained using normal deinking chemicals.

### Proper Wet End Control

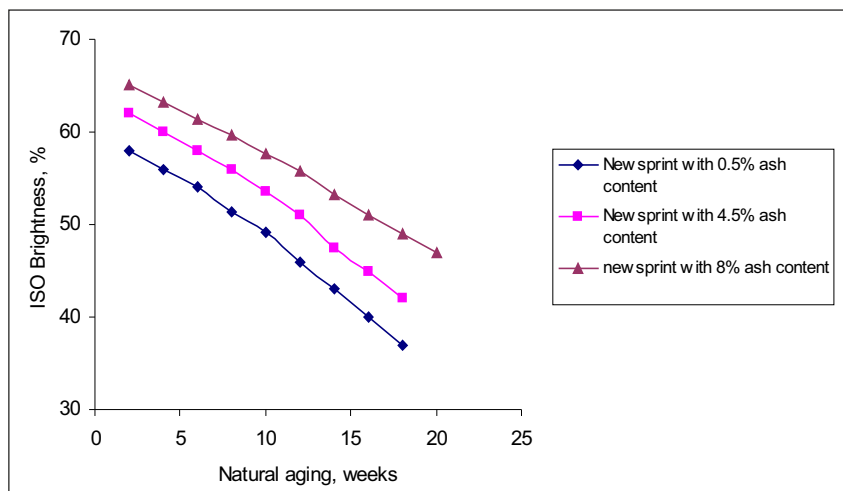
Generally it has been observed that mills manufacturing newsprint from waste paper are not paying serious attention to the retention of fines. Effect of retention of fines was observed on addition of alum, poly aluminum chloride (PAC) and polyethylene

Chemicals	Chemical dose %	Deinkability factor %	Deinkability by residual ink method %	Pulp appearance
A	0.01	80	85	Specky
B	0.01	94	93	Free from specks

Property	Blank	0.2 % Alum	0.6 % Alum	0.2 % PAC	0.6 % PAC	0.2 % Retention aid	0.6 % Retention aid
Bulk, cm <sup>3</sup> /g	1.69 (1.16)	1.70 (1.18)	1.72 (1.19)	1.73 (1.19)	1.73 (1.19)	1.74 (1.21)	1.74 (1.22)
Porosity, ml/min	883	832	836	835	806	761	605
Roughness, ml/min	171 (30)	164 (29)	155 (28)	155 (27)	151 (25)	151 (23)	144 (20)
Sp. scatt. coeff., m <sup>2</sup> /kg	53.5 (48.1)	54.1 (50.8)	54.8 (51.2)	54.7 (51.8)	55.1 (52.0)	56.6 (54.0)	57.9 (55.9)
Ash content, %	9.8	10.1	10.4	10.5	10.7	11.8	11.9

NB: Data in parenthesis are the values obtained after sheet calendaring

**Fig. 3- Effect on brightness after flotation deinking of newsprint with different ash content**



amine type retention aid. Results indicated that polyethylene amine type retention aid is most effective in retention of fines and filler as compared to alum and PAC. Even dosage of 0.2 % is giving better effect than dosage of 0.6% alum or PAC. Retention of fines also helped in improving smoothness, porosity and sp. scattering co-efficient. This improvement is maintained after calendaring operation also (Table 2).

### Surface Treatment of Newsprint in Wet State

One of drawbacks with newsprint manufacture from recycled fibers is excessive linting, tendency of fibrous material to be transferred from the surface of paper to printing blanket during offset printing. Method of

controlling it is usage of starch/ or other chemicals during stock preparation or surface sizing. Installation of size press into an older and slower newsprint machine is an expensive undertaking. An alternative approach of application of starch at wet end of paper machine has been suggested under reference<sup>14</sup>. These two approaches, addition of cationic starch in stock and surface application when the sheet has 40-50% solid content were tried. Results are recorded in Table 3. Clearly starch

Starch addition	Long rising component, LRC (mm/m)
Blank	80
2% during stock preparation	70
Surface application (1% solution at press roll)	30

surface treatment has helped in controlling linting tendency more effectively than its addition in stock. Lower value of long rising component value of 30 mm/m could be obtained with much lower dosage of starch (1%) as compared to 60 mm/m obtained with 2% addition in stock. So at old machine possibilities of installing a wet end starch application on press needs to be explored.

### Optimum Calendaring to Get Proper Surface Characteristics in Newsprint

Newsprint is generally calendared on the paper machine with an on line calendar. Traditionally this is done using a 4 to 6 roll hard nip calendar with linear load 80–110 kN/m and 80 to 120 degree centigrade water temperature in thermo roll.

Newsprint manufactured from deinked pulp (DIP) normally has higher ash content coming from raw material resulting in low strength properties of newsprint, For such a pulp, steps to improve surface characteristics should be chosen in such a way that strength of paper be not adversely affected. Some indigenous recycled fibers containing newsprint samples with lower smoothness were subjected to two different types of calendaring i.e. hard nip calendaring and soft nip calendaring. It was observed that soft nip calendaring improves paper surface relatively more than hard nip calendaring. The adverse effect on thickness, tensile strength, specific scattering coefficient was relatively lower in soft nip calendaring. Smoothness level was improved and also linting tendency got reduced as

shown by lower value of long rising component (LRC) (Table 4). This is probably due to reason that pressure applied to the sheet in soft nip calendaring has helped in thermal bonding between the mechanical pulp fibres. Benefits of soft nip calendaring of newsprint can be divided into two main categories namely runnability and printability. A soft calendared DIP sheet will have a superior runnability in printing press due to following reasons

- A DIP based sheet is less affected by

- absorption is more uniform
- Print mottling is reduced
- Smooth sheet can be calendared at a high moisture level without blackening.

In hard nip calendaring process, web is processed together between hard, unyielding rolls. Because of the unyielding rolls, paper is callipered to an equal thickness. As a result flocs are more heavily densified than thinner area of the paper (Fig. 4). This induces local density variation which lead to the problems of mottling, strength losses and in extreme cases, blackening. In a soft nip or multi nip calendar the paper is calendared in the nips, which are formed by chilled iron and a resilient roll. While assign through nip, paper undergoes more equal densification due to elasticity of roll cover. This

Property	Un calendared	Values obtained for	
		Hardnip calendared	Softnip calendared
Thickness, micron	75	57	69
Roughness, ml/min			
Top	370	210	180
Wire	490	275	240
Tensile index, N.m/g			
CD	19.0	12.2	17.5
MD	48.5	29.5	41.5
Fibre rising test			
LRC, mm/m	48	30	10
SRA, mm <sup>2</sup> /m	14.1	9.0	6.0
Sp.scatt.coeff., m <sup>2</sup> /Kg	50.1	36.4	48.5
Brightness, %	55.7	52.5	54.8
Print uniformity index	36	40	60

changes in moisture compared to virgin fibre sheet as fibres swell less

- Strength of the soft calendared sheet is higher at the same smoothness level than a machine calendared sheet
- Soft calendared sheet has less linting

Also a soft calendared sheet has better printability than machine calendared sheet due to

- Sheet surface density as well as ink

means that soft cover distributes compressive stress in the nip more equally over thicker and thinner part of paper and mottling is distinctly reduced. Soft roll cover material has an effect on the uniformity of the compressive stress in the nip. This is due to the lower roll dynamic elastic modulus of the soft roll which results in more uniform calendaring. Today, technology for newsprint grade is progressively moving towards soft

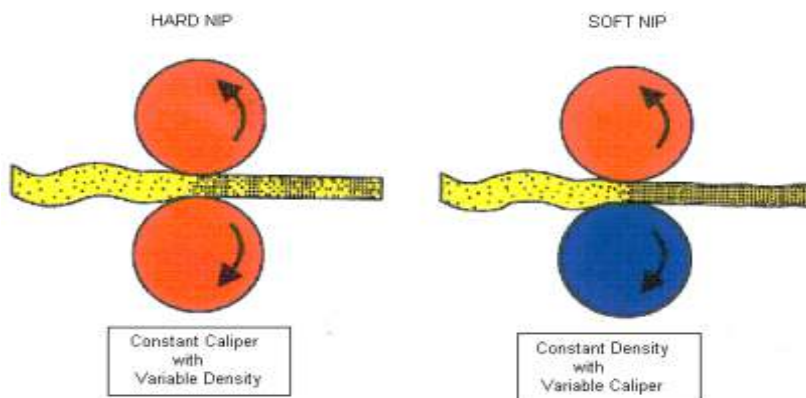


Fig. 4. Principle of machine calendaring with a hard (left) and a soft (right) nip.



calendaring. Typical running conditions for newsprint soft calendar that use a DIP base are from 20 to 80 kN/m in two soft nip at a temperature of 80°C–100°C. In some cases, even one soft calendar nip is enough depending on paper two sidedness.

### Possibilities of Improving Existing Hard Nip Calendaring Operation

As presently the soft nip calendaring arrangement is only available in one or two mills in India. Medium scale paper mills manufacturing newsprint from waste paper have hard nip calendars. Possibilities of improving surface characteristics of newsprint using hard nip calendaring were also studied in the laboratory. The parameters studied were

- Effect of loading pressure
- Effect of loading temperature
- Effect of moisture content

The moisture content of paper was increased by giving a fine spray of water over paper sheet. This increases the moisture content of paper by 1.5% from initial moisture content of 7.0 %. The calendar temperature was increased up to 120 °C. Results indicated (Table 5) that by increasing

and smoothness in recycled fiber based newsprint the proportion of different waste papers should be kept in such a way that its final furnish has at least 50 % mechanical pulp content. Smoothness, gloss, and printing characteristics of newsprint can be improved better by soft nip calendaring than hard nip calendaring. Deinking of stored newspapers is comparatively difficult than fresh ones. Higher ash containing newsprint has better deinkability than papers with low ash content. News papers with printed area of high oil content can best be deinked using deinking chemical sodium soap of fatty acid with copolymer based on ethylene propylene oxide plus emulsifier than commonly used chemical sodium soap of fatty acid with sodium silicate. Retention of fines is extremely important in improving the surface characteristics of newsprint. Retention aid of polyethylene amine type is quite effective as compared to alum or polyaluminium chloride. Linting problem of newsprint, one of the serious problems faced by printers during printing can better be controlled by installation of wet end starch application system at press roll of paper machine than starch addition during stock preparation.

Table 5- Hard nip calendaring of newsprint using different calendaring conditions

Pressure kN/m	Temp. °C	Bulk cm <sup>3</sup> /g	Roughness, ml/min	Tensile index N.m/g	Sp. scatt. coeff. m <sup>2</sup> /kg	Gloss %
Uncalendared sheet	Uncalendared sheet	2.38	1530	48.0	54.5	3.8
Case I						
80	60	1.71	290	35.0	51.8	6.5
120	60	1.54	175	28.0	51.5	7.2
160	60	1.48	165	18.0	50.5	8.0
Case II						
80	80	1.55	250	34.0	51.9	8.1
Case III Water spray on the sheet						
80	120	1.60	130	37.5	52.1	9.8

the calendaring pressure from 80 kN/m to 160 kN/m at constant calendaring temperature of 60 °C, roughness of newsprint decreased. However, tensile strength reduced by 63 % to the value of uncalendared sheet. When calendar temperature increased to 80 °C, smoothness improved further, however tensile strength got reduced further. Water spray over newsprint sheet and calendaring temperature of 120 °C and pressure load of 80 kN/m gave maximum reduction in roughness with minimum reduction in tensile strength (i.e. by 22 % to that of uncalendared sheet). Improvement in gloss was also observed in this mode of calendaring.

### Conclusions

To get proper bulk, opacity, porosity

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