Newsprint From Waste Paper, Its Quality and Requirements of The BIS 11688/1986 Standard

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ABSTRACT:- Recycling of waste paper for the manufacture of not only boards but various grades of paper is increasing rapidly. Few paper mills in India are manufacturing newsprint from waste papers and many others are planning. The quality of these newsprints varies depending upon the type of waste paper & process employed. There has been instances when the printer was satisfied with the newsprint quality, however that did not meet completely the standard specifications (BIS 11688/1986). Thickness, smoothness, porosity, tearing strength & speckiness were generally found to be short of the specifications. In few cases thickness requirement of 80 ± 3.2 micron was not met even by the imported newsprints and those manufactured by big Indian mills. Whereas the quality of newsprint manufactured from waste papers need quality upgradation through proper deinking and other measures, some flexibility in the standard specification also needs consideration.

INTRODUCTION

India has been a traditional importer of newsprint. The domestic production of newsprint started during the end of 1955 when the first mill was started in the public sector. Due to several constraints (main being scarcity of suitable fibrous raw material) indigenous newsprint production has remained at the level around 60 percent of the total demand, the shortfall being met by imports.

With the latest world wide trend of maximizing the recycling of waste paper for the production of not only boards but various grades of paper as well, few paper mills in India have already started manufacturing newsprint from mainly waste paper & others are planning.

The quality of such papers obviously can not match exactly with those made from virgin pulps & specially the imported newsprints. The BIS 11688/1986 standard (1) specifies certain quality parameters for newsprints. In the recent past there has been certain occasions when the printer was overall satisfied with the quality of newsprint manufactured mainly from waste paper though that did not completely meet the specifications of the BIS 11688/1986 standard. When the paper industry is faced with acute shortage of conventional fibrous raw materials, rising costs of imported pulp & even the judiciary taking very serious view of environmental considerations the importance of recycling waste paper to the maximum extent can not be undervalued. The modern printing technology has advanced enormously. On onr hand it requires rigid uniformity in the quality of paper for top quality prints at very high speed at the same time it has become more versatile & accommodating in certain aspects.

In view of all this there is a need to harmonize the end users' requirements, the quality of indigenous newsprints & the standard specifications. This paper is an attempt in this direction based on the

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results of the laboratory studies carried out on a variety of indigenous & imported newsprints.

DEFINITIONS OF NEWSPRINT

As per BIS 4661/1986, ISO/R-135-1959 & British Standard BS 3203 the term Newsprint means "Paper intended for the printing of newspaper". "The Dictionary of Paper" by the American Paper Institute, INC (1980) (2) defines the newsprint as - "A generic term used to describe paper of the type generally used in the publication of newspapers. The furnish is largely mechanical wood pulp with some chemical wood pulp. The paper is machine finished and slack sized and it has little or no mineral loading. It is made in basis weights varying from 28.5 to 35 pounds (24 x 36- 500), (as calculated this is equivalent to 46 to 56 gsm) the greatest preponderance being 38 pounds (48 gsm). The term includes standards newsprint and also paper generally similar to it and used for the same purpose but which may exceed to slight degrees the limitations of weight, finish, sizing and ash applicable to standard newsprint. It does not include printing papers of types generally used for purposes other than newspapers such as groundwood printing papers for catalog, directories etc.

THE END USERS' REQUIREMENTS

For the production of any quality of paper one should consider thoroughly the requirements that should be built into the product to meet the end users' requirements. The end users in case of newsprint are

- the printer
- the advertiser
- the reader
- the recycler.

Some of the important requirements of each of them are

PRINTER'S REQUIREMENTS

Uniform sheet

Printer requires uniform sheet for printing. The printing presses are either reel or sheet fed. The running cost of the former being cheaper as it involves less handling in printing however its capital cost is relatively higher. The printer always desires reels with break free operation. Breaks of one or two per hundred reel are acceptable for reel fed presses. Reels of uniform hardness from core to the periphery and in perfectly round conditions are preferred.

Printing speed

Printer desire high printing speed (more than 60000 copies per hour) for the printing of newspapers as all matters in newspapers are to be printed in a short duration. The sheet therefore should be strong enough to run at high printing speed and it must have sufficient absorbent characteristics to take up the ink quickly without smudging.

Free of Lint & Dust

The surface of paper should be free from dust and lint and should be strong enough to hold fibres in place so that they donot get lifted out of the web during printing and get struck to the printing plates/ blanket. Excessive presence of such material causes deposition on the printing plates compelling printers for frequent wash ups. Two washups per 8 hours are considered reasonably satisfactory but target should be of one wash up after 800,000 copies.

Thickness or Bulk

The printing method used by the printer dictates the requirement of thickness of paper. Non impact printing can use a thin, dense paper. Heavy impact printing like letterpress can tolerate a low caliper dense paper whereas high speed offset printers prefer a thicker sheet. Low caliper results in more meters of paper in a reel and for printer it is an advantage as more copies are possible to print per reel change. Each reel change means lost quality, lost production time or both due to shut.

The paper should not have uneven thickness across the web i.e. not fluctuating more than $\pm$ 3 micron. This will improve runnability.

Stiffness

The printer prefers stiff paper as it feeds well in the printing press and does not get corrugated after printing.

ADVERTISER'S REQUIREMENTS

Brightness

The advertiser wants that his display should look good in the finished work. One sure way to get that is to have its printing on a brighter sheet. Pref-

erence of brighter newsprint is gaining more attention now a days. The brightness level of newsprint in Australia increased from 49 to 62% from 1950 to 1989. During the same period in west coast U.S.A. it changed from 52 to 59%.

Opacity

The advertiser wants his display to stand out and does not like the print from page three showing through his display on page one. So higher opacity is preferred.

Colour

The advertiser expects the paper to be able to accept good coloured printing.

READER'S REQUIREMENT

Reader expects different qualities in different products and does not expect the newspaper to look like a prestigious magazine. The printed material should be clear and easy to read. He desires good rigidity and resistance to creasing, a paper with a matt finish to make text easily readable, but which would give four colour pictures an attractive print gloss and whose surface should be scratch and smudge resistant as possible.

RECYCLER'S DEMAND

Now a days an increasing amount of paper is being recycled. As some printing processes, paper sizing and coating make this more difficult and a balance may be necessary between the use and final disposal. The paper should not contain any material which is hazardous to health as some of the waste newsprint may be recycled in the manufacture of food packaging grade papers. To avoid this paper should not contain any substance which could end up being a problem in the food chain.

RESULTS AND DISCUSSION

Quality of indigenous newsprints manufactured from waste paper and imported varieties:

Strength, optical & printing characteristics of various newsprints i.e.

- Newsprints produced mainly from waste paper by medium/ small paper mills (India).
- Newsprints manufactures by big mills (India).
- Imported varieties of newsprints.

are given tables I to IV.

Table-I

Strength and optical characteristics of newsprints from waste paper manufactured by few medium/ small size paper mills (Indian).

Property	IS : 11688/1986 specifications	Values obtained for the newsprint of S/M paper mills.				
		1	2	3	4	5
Grammage (g/m²)	48 to 52 ± 4%	48.2	52.3	49.4	49.5	50.4
Thickness (micron)	80 ± 4%	94	88	75	93	97
Brightness (%)	49.0 min.	61.7	52.4	57.8	49.0	52.4
Opacity (%)	90.0 min.	94.8	97.0	95.5	93.7	94.6
Bendtsen roughness (ml/min)						
Top	--	580	340	370	790	780
Wire	--	1040	490	450	1370	940
Avg.	300 max.	810	415	410	1080	860
Bendtsen porosity (ml/min)	800 max.	1280	2060	980	840	2120
Breaking length (m)						
CD	1500 min.	2490	1850	2120	2730	1980
MD	3000 min.	3390	3400	3760	3770	3180
Tear factor Elmendorf, CD	45 min.	39	39	41	40	37
In plane tear CD (N)	--	1.5	1.5	1.5	1.5	1.5
Oil absorbency (s)	60 max.	33	10	28	16	18
Specks	--	----------	----------	Specky	----------	----------
Stiffness MD (mN)	--	16	17	17	16	15
Gloss, 75° (%)	--	4.5	5.9	5.8	6.1	4.0

Table-II

Printing characteristics of newsprints from waste paper manufactured by few medium/small size paper mills (Indian).

Property	Values obtained for the newsprint of mills				
	1	2	3	4	5
Print through (Macbeth density)	0.58	0.56	0.55	0.63	0.70
Pinholes intensity (% Elrepho)	5.9	6.5	8.2	5.8	6.8
Print set off after (s)					
0.1	0.45	0.39	0.40	0.45	0.42
1.0	0.37	0.33	0.33	0.33	0.31
5.0	0.28	0.26	0.26	0.31	0.26
15.0	0.24	0.24	0.20	0.28	0.22
60.0	0.18	0.19	0.17	0.22	0.18
Speckle at print density 0.90 (IGT Std. scale)	6-7	6-7	6-7	6-7	6-7
Ink requirement to get print density of 0.90 (micron)	8.8	8.0	8.0	8.8	8.8

Table-III

Strength and optical characteristics of newsprints of big mills (Indian) and foreign newsprint samples.

Property	IS : 11688/1986 specifications	Indigenous				Foreign			
		Mill 1	Mill 2	Mill 3	Mill 4	Canadian	Norwegian	Finish	Swedish
Grammage (g/m²)	48 to 52	49	49	50	49	49.5	49.6	49.5	48.4
Thickness (micron)	80 ± 4%	72	75	80	73	82	75	75	74
Brightness (%)	49.0 min.	55.4	52.8	54.1	57.0	58.1	60.5	62.1	59.5
Opacity (%)	90.0 min.	99.6	93.9	94.3	91.8	94.3	94.1	94.4	93.6
Bendtsen roughness (ml/min)									
Top	--	--	--	--	--	150	120	110	130
Wire	--	--	--	--	--	170	170	140	150
Avg.	300 max.	80	140	225	150	160	145	125	140
Bendtsen porosity (ml/min)	800 max.	330	475	500	270	320	240	210	180
Breaking length (m)									
CD	1500 min.	2180	1870	2370	1820	2310	2010	1840	1760
MD	3000 min.	5560	5990	4080	5750	4750	4720	5130	6210
Tear Factor CD	45 min.	53	58	45	57	54	49	57	66
In plane tear (N) CD	--	2.0	1.5	1.5	1.5	1.5	1.5	2.0	2.0
Stiffness (mN) MD	--	29	23	27	24	27	26	34	27
Gloss, 75° (%)	--	8.0	8.1	9.3	8.0	10.7	10.5	12.2	10.1

Note: Some data for indigenous papers had been taken from Reference-15.

Table-IV

Printing characteristics of newsprints of big mills (Indian) and foreign newsprint samples.

Property	Indigenous				Foreign			
	Mill 1	Mill 2	Mill 3	Mill 4	Canadian	Norwegian	Finish	Swedish
Print through (Macbeth density)	0.32	0.53	0.42	0.47	0.19	0.23	0.21	0.17
Pinholes intensity (% Elrepho)	4.3	5.3	4.7	5.2	0.8	0.8	0.7	0.6
Print set off after (s)								
0.1	0.19	0.18	0.24	0.30	0.18	0.19	0.20	0.19
1.0	0.11	0.10	0.20	0.26	0.15	0.16	0.18	0.16
5.0	0.07	0.06	0.13	0.24	0.11	0.11	0.13	0.12
15.0	0.04	0.04	0.06	0.22	0.08	0.09	0.08	0.09
60.0	0.02	0.03	0.03	0.12	0.03	0.04	0.03	0.03
Speckle at print density 0.90 (IGT Std. scale)	5-6	4-5	4-5	4-5	3-4	3-4	3-4	3-4
Ink requirement to get print density of 0.90 (micron)	6.2	5.6	5.6	5.1	4.8	4.8	4.0	4.8

STRENGTH & OPTICAL CHARACTERISTICS

The properties of newsprint manufactured by small paper mills using waste paper as the main furnish component are given in Tables I & II. When compared with BIS requirements these papers meet all other requirements except thickness, smoothness, porosity and tearing strength. All these papers were highly specky mainly due to the ink particles left due to insufficient deinking.

Tensile Strength:

Good runnability is a fundamental property of newsprint ensuring that the newspapers can be printed without delay caused by web breaks or reduced printing speed in order to keep proper register. Tensile strength is one of the main parameters which affects press runnability. The tensile strength values of these newsprints are sufficient and should not pose press runnability problem as web tension in web newsprint printing is quite less than other printing presses (Fig.). The total web tension in newsprint printing press is generally 150 N/m (3) which corresponds to about ten percent of the tensile strength of newsprint.

Tearing Strength:

Elmendorf tearing strength of these newsprints (tear factor in CD 39 to 41) is lower than BIS requirement (tear factor CD 45 minimum). But this type of tearing test is not that important for newsprint as most of the newsprint is printed on web fed presses. More precisely it is the in-plane tearing

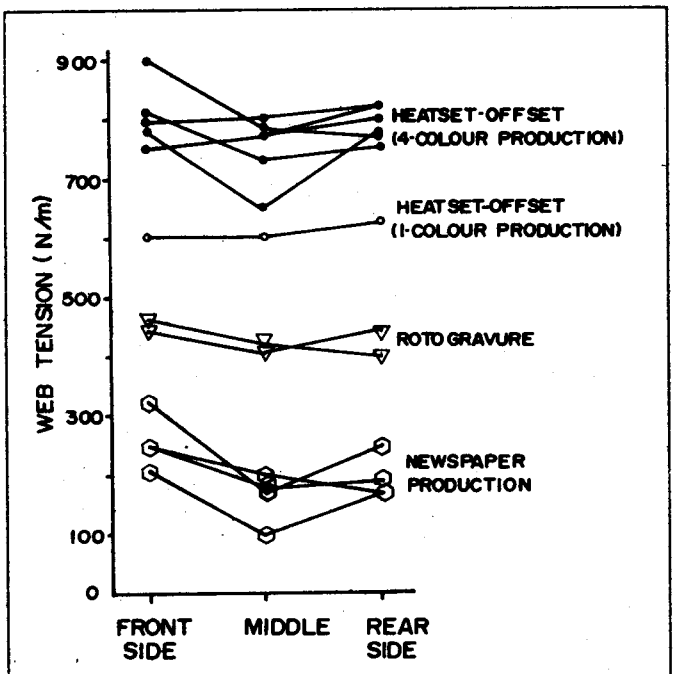

FIG. , WEB TENSION PROFILES IN DIFFERENT PRESS LINES. (Ref. 3)

strength and the tensile strength of newsprint which are indicators of the potential runnability of newsprint webs in a printing press (4,5). The in-plane tearing strength of these papers (1.5 N) is comparable to newsprints of big Indian newsprint mills and foreign newsprint samples tested, whose values are in the range 1.5-2.0 N (tables III, IV).

Further, more carefully made cores and good wrapping of reels ensure still better runnability.

Thickness:

The limit specified for thickness in BIS standard 80 ± 4% micron needs careful review as bulkier sheet is preferred for offset printing and dense sheet for letter press as explained earlier. Some of the newsprints manufactured even by Indian big newsprint mills and foreign newsprints (Table III) had failed to meet BIS specifications for thickness.

Porosity, Roughness & Stiffness:

The newsprints produced using waste paper are quite porous, have rougher surface and about half stiffness values than that of virgin papers. The high roughness and porosity values will give poor print quality. Presently all over the world the demand is for smoother newsprint.

Brightness, Opacity & Gloss:

The brightness values 49.0 to 61.7% obtained for the newsprints manufactured by medium/ small mills from waste paper comfortably meet BIS requirement of 49% minimum and are comparable to newsprints of four big Indian newsprint mills (52.8 to 57%) though slightly lower than foreign papers (58.1 to 62.1%). The opacity is more than 90% and comparable for all samples. One of the general features being the papers manufactured from waste paper are highly specky. The gloss of these samples (4.0 to 6.1%) is about half the value observed for other newsprints (8.0 to 12.2%).

Printing Characteristics:

For newsprint grade paper the most important are the printing characteristics. In BIS standard the only parameters specified which affect printability are smoothness and porosity which are hardly enough to define completely the printability of paper. The best way to evaluate printing quality of paper would be to conduct actual printing tests under controlled printing conditions and evaluate them.

Ink Demand & Print Set Off:

One of the most important printability evaluation parameter is ink requirement as it determines ink consumption for printing of the paper. Printing tests carried out using IGT printability tester which simulates the press conditions to a reasonable degree (6-11) indicated that the ink demand to attain 0.90 print density was found to be higher (range 8.0 to 8.8 micron) in the case of newsprints from waste paper as compared to indigenous newsprints of big Indian newsprint mills (5.1 to 6.2 micron) & foreign newsprint (4.0 to 4.8 micron). This is probably due to higher roughness and porosity which always affect the uniform transfer of ink. The print set off values were comparatively higher for newsprints manufactured from waste papers. This is probably due to high ink demand for these papers and reduced absorption capacity of recycled fibres.

Print Through:

Print through (0.55 to 0.70) was very high for newsprints from waste paper as compared to newsprints of big Indian newsprint mills (0.32 to 0.53) and foreign newsprints (0.17 to 0.23). As the print through is affected by the penetration of pigment on impression and is mainly a function of movement of the oil vehicle into pores with in the paper web would otherwise scatter light (12, 13), the higher print through is probably due to bigger pores in the surface of paper as paper having finer pores generally exhibit lower print through due to confinement of oil migration to the surface layer by higher capillary suction forces. The other factor responsible is higher roughness which increases ink requirement.

Speckle Tendency:

Speckle tendency which is indicative of the extent of white spots left unprinted in solid print at same print density. This value is quite high (range 6 to 7) in case of newsrprints from waste papers as compared with big newsprint mills (4 to 6) and imported ones (3 to 4). This indicates that print uniformity will be relatively poor. The probable cause may be high roughness. Another factor responsible for this is uneven ink absorption due to comparatively poor formation. Madsen and Aneliunas had observed that light and heavy basis weight spots in newsprint webs had different printing characteristics after calendering (14).

To improve the quality of newsprint from waste paper produced mainly by the medium/small paper mills the efforts should be to improve smoothness, reduce porosity, improve stiffness and to reduce the extent of specks. This can be achieved to a large extent by proper refining and blending with virgin stiff fibred pulps. To reduce the extent of specks optimization of deinking operation is necessary which in turn will also help to reduce ink demand, improve readability and the printing quality.

EXPERIMENTAL

Newsprint of five medium/small paper mills, four Indian big newsprint mills and imported from Canada, Norway, Finland and Sweden were evaluated. Before testing, all the samples were conditioned at 27 $\pm$ 1°C and 65 $\pm$ 5% relative humidity. All printing tests were carried out using IGT printability tester according to procedures as under.

Print density & ink requirement:

Paper strips of 35 mm width and 250 mm length in machine direction were taken. Prints were made on the wire side of paper using different ink layer thicknesses 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 over night and the optical density of 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 for various papers were plotted and ink layer thickness required to get print density of 0.90 was determined for individual paper sample.

Print through and pinholes intensity:

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

For print through values, the density of the print visible on the reverse unprinted side was measured after allowing the printed sheets to dry overnight. For pinholes intensity determination during printing, another strip of smooth blank paper was kept beneath the printing strip to get the ink impression caused by the seepage through pinholes present in the paper. The brightness values of the pinholes impression and blank paper was measured. The difference between the two values was reported as a number directly proportional to the amount of pinholes present in the test specimen.

Speckle:

The prints were made on the wire side of paper using the amount of ink sufficient to get print density equivalent to 0.90. The extent of unprinted area in solid print was compared with IGT speckle scale for newsprint printing. The scale has been numbered from 1 to 7 and the higher values indicate more unprinted spots in solid print thus poor print quality. The printing conditions used were same as those for print density tests.

Set Off:

The prints were made on the top side of the paper strip using the ink quantity required to get print density of 0.90. The printed strip was run through the second nip after time interval of 0.1S, 1S, 5S, 15S & 60S, so that a part of ink gets transferred to a clean strip. The set off print density on the latter strip was measured using Macbeth densitometer. The printing conditions used for set off tests were:

Speed	-Constant, 70 cm/S.
Pressure	-686 N
Disc	-2 cm wide (aluminium)
Blanket	-IGT paper blanket.

Other Tests:

Grammage	-ISO 536
Thickness	-ISO R 534
Brightness	-ISO 2470
Opacity	-ISO 2471
Breaking length	-ISO 1924
Tear factor	-ISI 1974
In plane tear Strength	-Tested using MBR in plane tear tester.
Bendtsen roughness	-Measured using Bendtsen tester
Stiffness	-BIS 11087/1986
Gloss	-Tappi 480 os-72

CONCLUSIONS

- Newsprint manufactured from waste paper by medium/small paper mills studied generally were short of BIS 11688/1986 specifications in parameters such as thickness, smoothness, porosity and tearing strength.
- The web tension in newsprint printing press is quite low as compared to other printing presses. All the above newsprints had sufficient tensile strength to have smooth runnability on the printing press.
- The Elmendorf tearing strength though lower than BIS requirement yet not likely to cause press runnability problem as their in-plane tearing strength was found to be comparable to the newsprints of big Indian newsprint mills and foreign newsprint samples studied.
- The thickness limit specified in BIS standard should not be rigidly desirable as bulkier sheets are preferred for offset printing and dense sheet for letterpress. Even some newsprints manufactured by Indian big newsprint mills and foreign newsprints failed to meet this specification. It may therefore be desirable to review the standard specifications suitably.
- Newsprint from waste paper was quite porous with rougher surface and had about half stiffness value than those of other newsprints.
- The optical characteristics viz brightness and opacity were satisfactory but the papers were highly specky. The gloss was about half the value observed for other samples.
- Laboratory printing tests indicated that these papers had higher ink demand, higher print through and higher speckle tendency as compared to newsprints of big Indian newsprint mills and foreign samples.
- Proper deinking of the waste paper, suitable refining/mixing of the pulp to improve formation & blending of appropriate amount of virgin pulp may improve the over all quality of newsprint produced from recycled waste papers.

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