

Art Paper Properties and Printing Characteristics

A comparative study of indigenous and foreign papers.

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ABSTRACT:- Quality attainment in pigment coating is a complex phenomenon. It depends upon a number of factors, all closely interlinked. These are - the base sheet, the nature and quality of the pigments and adhesives used, the rheological properties of the coat solution, methods of application of coat solution to the base sheet and drying conditions. The printing quality of the coated paper is assessed by measuring the properties like Smoothness, Pick Resistance, Opacity, Print density, and Gloss etc.

In this paper, the laboratory evaluation results of some of the indigenous and foreign art papers are presented. The results of the study indicate that the quality of indigenous art papers is to be improved to compete in international market. The factors affecting the quality and some of the approaches to improve the quality of indigenous art papers are also discussed in this paper.

INTRODUCTION

The developments in the printing industry has laid much stress on the quality of paper to be printed. Smoothness and uniformity of the paper play a major role when the papers are printed by relief printing and/ or gravure printing. The hills and valleys present on the uncoated paper surface gives a rough and uneven surface which causes nonuniform spotty printing with fine half tone impressions. In coated papers the hills and valleys on the surface of the paper are levelled up by a fine film of the coating materials giving in real smooth semi absorbent surface with less two-sidedness. This produces an accurate reproduction of image during printing. Hence pigment coating is used to improve the appearance and printability of paper.

Functional coatings are designed for purposes other than print enhancement where pigmentation is

either not required or of secondary importance.

In coating operations, a surplus of colour is applied to the base paper and this surplus of colour is levelled off in the metering zone. Depending upon the nature of metering done, a variety of coater configurations were developed. The main ingredients of any coating colour or slip are pigment and binder. To facilitate easy operation of coating and to enhance the quality of coated paper/board certain additives are also normally incorporated into the formulations. The sheet after coating is dried and then calendered to get smooth glossy surface. The quality of coated surface is important as it serves as a medium for transmitting information in graphic form. The important properties of coated paper are

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high surface gloss; low ink mottle, high opacity, high brightness, high bulk, high film strength, ink receptivity and high stiffness.

It was estimated that in India the production capacity of coated paper/ board is more than 100,000 T/Year by 1996-97 while the demand is expected to be around 80,000 T/Year.(1) Since the globalisation of Indian economy has created stiff competition, it is imperative to improve the quality of indigenous products. To know the exact quality status of indigenous Art paper, a comparative study of the properties of indigenous and foreign Art papers was carried out. The results of the study are presented in this paper.

PRINCIPAL GRADES OF COATED PAPERS:

Pigmented coated papers are classified as 1) coated on one side C15 and 2) coated on two sides C25, C15 grade is also known as Chromo grade and is mainly used for labels and wrapping. C25 grade is known as Art or Publication grade as it is mainly used for Magazine/ periodicals, Publication catalogues and commercial printings etc.

RECENT TRENDS IN PUBLICATION GRADE PRINTING:

In recent years Magazines and Catalogues contribute as the growing segment of printing industry. In magazines the number of advertisements and pages printed in color are increasing rapidly. This increases the demand for color printing. This inturn increases the demand for art paper as high quality color printing is mostly done on these papers by rotogravure and web off set printing. Hence the study is confined to Art grade papers only.

EXPERIMENTAL:

Market samples of Art paper of different Indigenous mills and foreign mills in four different grammage range i.e. 90, 130, 230 and 300 Gsm were procured. These were tested for the following properties.

- Optical properties (Brightness)
- Opacity
- Smoothness
- Gloss

- Pick resistance
- IGT print density
- Stiffness

1. BRIGHTNESS;

For paper, absolute brightness is defined as the reflectance of blue light at a wave length of 457 nm in terms of perfectly reflecting, perfectly diffusing surface.

coated papers are graded primarily basing on brightness. It is an asthetic property and improves print contrast. In this study brightness measurements were done using Carl Zeiss Elrepho brightness tester.

2. OPACITY:

Printing opacity is the ratio of reflectance of a single sheet of paper backed by a black body to the reflectance of a thick pad of papers.

Opacity helps in assessing the print quality. Poor opacity of the coated paper results in show through (visibility of the printing on the back side of the sheet). It is an important property particularly in light weight papers.

In this study opacity measurements were done using Carl Zeiss Elrepho brightness tester using the formula.

$$\text{Opacity \%} = \frac{\text{Reflectance of single sheet of paper}}{\text{Reflectance of thick pad of papers.}} \times 100$$

3. SMOOTHNESS:

Smoothness is an important property that affect the printability. The very purpose of pigment coating is to produce surface smoothness which ensures better contact between the printing plate and paper. If the paper is not smooth, in half tone printing, there is a possibility of missing half tone dots which leads to uneven and poor quality printing.

Smoothness is measured by the rate of air flow across the surface of the paper. The instruments are based on the principle that the void volume between the paper and a plane surface is proportional to the roughness of paper. Several instruments

are available like Bekk (T 479) and Bendtsen (UM 535)⁽²⁾. In this study Bendtsen method is used to measure the smoothness.

4. GLOSS:

Gloss indicates the degree to which the coated surface simulates a perfect mirror in its capacity to reflect incident light.

High gloss printing is the trend of the day to make them eye catching. Gloss is measured by comparing the reflectance of light from a pile of paper with the reflectance exhibited by perfect mirror (specular reflection). In this study, gloss values are measured by Technidyne gloss meter model T 480A using 75° angle.

5. PICK RESISTANCE:

Pick resistance or Pick strength, as the term implies is a measure of the resistance of the coating to being picked or pulled from the raw stock during printing process. In the printing processes, especially in offset printing considerable tension is applied when the paper and ink are separated and to withstand this tension the paper must have a considerable surface strength and also be able to expand or stretch in thickness failing which the paper will split. This is an important property of the coated papers particularly since the development of rapid multi colour printing and speeding of the presses.

The pick resistance of coated papers is measured by, (a) Dennison wax pick test and (b) IGT picking velocity test

a) DENNISON WAX PICK TEST:

It is a simple and quick method and gives a good indication of the strength, provided the coat recipe do not contain any thermoplastic materials. With the increased use of synthetic binders this test has been replaced by IGT picking velocity test which measures the printing velocity at the point of picking.

b) IGT PICKING VELOCITY TEST:

This is the more accurate method of testing the pick resistance. In this study the picking velocities are determined with IGT Reptest Model AIC 2-5 printability tester.

6. PRINT DENSITY;

Print density is good relative indicator of the amount of ink transferred to the paper. It is highly useful as a measure of colour strength.⁽³⁾

Printing was carried out with IGT Reptest Model AIC 2-5 printability tester employing the following conditions:

Printing speed : Constant 0.2 m/s
 Printing Force : 125 N/cm
 Ink applied : 4.8 micron on the printing forme.
 Ink : IGT standard printing ink.

The prints were allowed for drying over a night. The optical density of the printed area was measured using Brumac Densitometer Model RD-45 of Hollywood film Co., U.S.A.

The test results are presented in tables 1 to 4.

TABLE-1
PROPERTIES OF 90 GSM ART PAPER

S.No. Particulars	Indigenous					Foreign
	A	B	C	D	E	
1. G.S.M.	93	93	89	90	85	89
2. Thickness (Mic)	72	78	74	75	73	74
3. Bulk (CC/Gm)	0.77	0.84	0.83	0.82	0.81	0.83
4. Bendtsen Smoothness(ml/min)	25-35	25-35	45-50	33-39	35-35	35-40
5. Wax Pick No.	6A/6A	6A/6A	6A/7A	6A/6A	6A/6A	8A/8A
6. Gloss %	52-60	42-57	40-47	57-61	51	68-72
7. IGT Pick Velocity(Cms/sec)	57	35	66	38	45	52
8. Brumac Print Density	1.76	1.66	1.61	1.67	1.59	2.02
9. Strike through	1.71	1.11	3.01	1.55	1.32	2.54
10. Stiffness mN MD/CD	12/7	16/11	14/8	12/7	14/9	21/12
11. Brightness %	75.0	69.5	82.0	73.0	69.5	85.0
12. Whiteness %	73.0	62.5	79.0	69.0	60.0	82.5
13. Yellowness %	0.67	4.2	1.6	2.3	5.7	1.6
14. Opacity %	97.9	98.2	96.5	98.1	98.6	95.5

TABLE-2**PROPERTIES OF 130 GSM ART PAPER**

S.No. Particulars	Indigenous		Foreign	
	A	B	A	B
1. G.S.M.	126	129	131	134
2. Thickness (Mic)	111	111	98	99
3. Bulk (CC/Gm)	0.88	0.85	0.75	0.74
4. Bendtsen Smoothness (ml/min)	35/40	35/30	40/40	25/30
5. Wax pick No.	6A-6A	6A-7A	9A-10A	8A-8A
6. Gloss %	58/56	66/66	69/67	78/77
7. IGT Pick Velocity (Cms/Sec)	50	45	88	77
8. Brumac Print Density	1.84	1.81	1.85	1.96
9. Strike through	1.0	1.1	1.8	1.83
10. Stiffness mN MD/CD	52/30	38/28	36/23	42/30
11. Brightness %	79.0	72.5	83.5	87.0
12. Whiteness %	76.5	65.0	87.0	95.0
13. Yellowness %	1.5	3.8	-1.3	-4.0

TABLE-3**PROPERTIES OF 230 GSM ART PAPER**

S.No. Particulars	Indigenous		Foreign	
	A	B	C	
1. G.S.M.	221	227	228	231
2. Thickness (Mic)	205	200	210	229
3. Bulk (CC/Gm)	0.93	0.88	0.92	0.99
4. Bendtsen Smoothness (ml/min)	30-45	30-40	30-45	35-45
5. Wax pick No.	6A/6A	6A/6A	6A/6A	7A/7A
6. Gloss %	44-48	52-53	55-62	67-68
7. IGT Pick Velocity (Cms/Sec)	42	39	26	127
8. Brumac Print Density	1.67	1.71	1.68	2.07
9. Strike through	2.80	2.08	2.21	1.83
10. Stiffness mN MD/CD	270/130	280/140	270/140	410/180
11. Brightness %	80.5	79.0	75.5	86.0
12. Whiteness %	76.5	76.0	76.0	91.0
13. Yellowness %	2.2	1.9	-0.1	-2.5

TABLE-4**PROPERTIES OF 300 GSM ART PAPER**

S.No. Particulars	Indigenous	Foreign
	A	B
1. G.S.M.	302	295
2. Thickness (Mic)	290	293
3. Bulk (CC/Gm)	0.96	0.99
4. Bendtsen Smoothness(ml/min)	90-130	65-90
5. Wax Pick No.	6A/6A	7A/7A
6. Gloss %	48-55	73-74
7. IGT pick velocity (Cms/sec)	32	136
8. Brumac print density	1.69	2.04
9. Strike through	1.58	1.24
10. Stiffness mN MD/CD	430/390	740/360
11. Brightness %	73.5	85.5
12. Whiteness %	67.0	87.0
13. Yellowness %	4.1	-0.8

RESULTS & DISCUSSION:**A. QUALITY ASPECT : (Indigenous vs Foreign papers)****1. BRIGHTNESS:**

The brightness of indigenous Art papers varied from 69.5 to 82% whereas the foreign Art papers have a minimum of 83.5% and a maximum of 87.0%. This clearly indicates that an improvement in brightness is essential to compete with the imported art papers.

2. SMOOTHNESS:

Except for 300 Gsm boards, the Bendtsen smoothness values of indigenous papers are nearly comparable to foreign papers. Indigenous 300 Gsm board has 90-130 ml/min range whereas it is 65-90 ml/min for foreign boards. This can be improved upon.

3. GLOSS:

The average gloss values of both sides for indigenous papers varied from 44-66 % while foreign papers have gloss values between 68-78%. Hence an improvement in gloss is vital to be on par with imported art papers.

4. WAX PICK NUMBER:

The test results indicate that an improvement in wax pick number is also required as indigenous papers' wax pick number is 6 to 7 compared to 7 to 10 for foreign papers.

5. IGT PICKING VELOCITY:

Though the picking velocities of indigenous 90 Gsm art papers (35 to 66 cm/s) are comparable to foreign papers (52 cm/s), it is clearly seen from the values that the picking velocities of foreign papers are high in other grammage range, where an improvement is essential to be on line with foreign papers.

6. BRUMAC PRINT DENSITY:

Brumac print density values varied from 1.59 to 1.84 for indigenous papers whereas they are from 1.85 to 2.07 for foreign papers. An improvement in

this aspect also is warranted.

7. STIFFNESS:

Imported Art boards (230 & 300 Gsm) have higher stiffness (180-740 mN) compared to indigenous boards. (130-430) and is also to be improved.

B. APPROACHES FOR IMPROVING THE QUALITY:

1. BRIGHTNESS:

Brightness of coated paper is mainly dependent upon the brightness of base paper and the pigments used in coating.

The particle size and distribution of pigment has much effect on coated paper properties like brightness opacity, gloss, smoothness and ink receptivity, etc.,⁽⁴⁾

Clay is the major pigment used in pigment coating. The quality of clay available in our country has less brightness (80-82%) and fineness (the percentage particle size less than 2 micron) compared to the clays available in foreign countries (minimum brightness is 86%). An improvement in quality of clay supplies helps to overcome this hurdle. A concerted effort by coating plants and clay manufacturers helps in this aspect.

By and large indigenous base paper has a brightness of around 75% with considerable yellowness due to the bleaching technologies adopting in our country. This contributes to lower coated paper brightness. However, due to the introduction of Chlorine-di-oxide and Peroxide in pulp bleaching some of the mills are already able to get good brightness base papers.

Use of fluorescent optical whitening agents in coat recipe formulations improve the apparent brightness of coated paper.

Usage of pigments of high optical properties like Satin white, TiO_2 , is low due to their high cost in our country. Hence, this can be compensated by the use of less expensive pigments like aluminium Tri Hydrate, Calcined clay, Calcium Carbonate (GCC/PCC) etc. in coating formulation. This helps to improve the brightness of coated paper.

2. GLOSS & SMOOTHNESS;

Gloss of pigment coated papers is mainly dependent upon the binder, pigment and the calendering conditions employed in the process.

Pigment particle size and distribution has more impact for higher gloss attainment.

Both smoothness and gloss are directly related to the uniformity of the coverage base stock. Fine particle size, high bulking pigments like Satin White, delaminated clays and amorphous silica/silicates provide more volume per unit weight. So addition of small percentage of these pigments in coat recipe helps for better coverage of base stock. this helps for higher smoothness and gloss values of coated papers even at low calendered pressures.

The higher interaction between the binder and pigment provides a bulky coating and enhances smoothness.

Dispersion of pigment is utmost important for good gloss and smoothness. Use of proper dispersing agents helps to prevent agglomeration and flocculation of pigments or otherwise due to raise in particle size yields low gloss and smoothness.

Coarser pigment particles gives lower gloss.

As protein binders gives lower gloss values due to greater shrinkage on drying limiting the usage of these helps to improve gloss.. Moreover latex binders improve plastic flow and particle orientation of the coating during calendering and enhances gloss.

Use of pigments like spherical PCC provides high gloss due to their lower binder demand.

3. PICK RESISTANCE:

This property depends upon the binder and base stock surface strength.

Surface strength of base paper is prime requisite for good pick resistance. Since most picking occurs because of the difference in strain between the base paper and the coating layer at the time of printing, increased beating of the raw stock and addition of functional additives at wet end helps to improve the surface strength of paper.

Foreign countries have long fibered soft wood

pulps in their furnishes. At present short fibered hard wood pulps constitute the major proportion of the Indian raw material mix. and this is one of the reasons for low picking velocities of our papers. Our experience shows that the addition of proper functional additives at wet end improve the surface strength of paper.

Use of higher coating solids tend to minimise binder migration and improve pick resistance.

Use of alkali sensitive Styrene Butadiene lattices helps to improve the pick resistance. The high bonding power of these systems is due to the increased particle size and the deformability of the swollen particle. This allows more of the binder to be in contact with pigment during film formation⁽⁵⁾ which leads to greater degree of interaction between binder and pigment and also between binder and substrate.

4. PRINT DENSITY:

A balanced selection of pigment and binder is required to get good print density. Addition of Calcium Carbonate into coat recipe improves the print density.

CONCLUSIONS:

Quality attainment in pigment coating depends

on a number of factors like the base sheet, the binder, the pigment, the drying and calendering conditions of coating etc. and all closely inter linked. To match indigenous art papers on par with foreign art papers, concerted efforts are to be made by coating plants, coating chemicals manufacturers and paper mills.

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