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Development of Specialty Paper is An Art: Barrier Paper from Indigenous Raw Materials — Part VII

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A study was under taken to explore the possibility of manufacturing barrier base paper from indigenous raw materials. Use of indigenous raw materials develop important properties like, klemn absorbency, wet strength, and castor oil penetration, which are essentially required for barrier base paper. Another important property is the high opacity, which is required to prevent, see through problems in sun-mica. Using TiO_2 filler can solve this defect in sun mica. The laboratory made barrier paper fulfils all the requirements.

Keywords: Specialty paper, Barrier base paper, Raw material

Introduction

Barrier paper is highly specialized specialty paper used for making decorative laminates. This paper highly is loaded with TiO_2 in order to impart high opacity. This paper must be able to hide the colour of resin-saturated absorbent Kraft layers. For the manufacture of sun-mica sheet (decorative laminates), 4-5 layers of unbleached kraft absorbent paper are first applied on each other to make a base of sun-mica sheet. Prior to lamination the base sheet is saturated with a resin such as melamine formaldehyde or urea formaldehyde in amount 32 per cent based on the weight of the finished sheet. Then penultimate layers of barrier paper are applied on the base of sun-mica sheet. During the saturation step the air in the sheet is replaced by resin and the refractive index of TiO_2 is approx. the same as that of cellulose.

As a result the sheet becomes transparent and poses see-through problems and the reflectance in the blue end of the visible spectrum decreases to 50 per cent, which indicates that TiO_2 is absorbing this light without reflecting it. The other method for increasing the retention of titanium dioxide filler in the sheet is the use of crystalline colloidal material. In the paper, hydrous crystalline aluminum hydroxide known as α-alumna tri-hydrates (gibbsite or hydrargillite) a common crystalline colloid material was studied for increasing the opacity of flocculated TiO_2 filled sheet. Aluminum trihydroxide (ATH) is a fine act as a gel, having a stable positive charge on surface and spherical particles configuration with a diam 10mμ - 30 mμ, which remains between positive to a pH level as high as 9. The dispersed aqueous slurry of hydrous aluminum hydroxide forms fine gel that entraps titanium dioxide particles in the wet web and prevents removal of fines and fillers. Besides this, aluminum trihydroxide contributes to brightness, ink receptivity, flame retardancy of paper, high whiteness, better smoothness and anchoring fillers in the wet web.

The most significant properties for barrier base paper are as follows:

- The most important property of barrier paper is the opacity. When barrier base paper is subjected to impregnate with melamine formaldehyde sun — mica a decorative laminate

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poses see-through problems. In order to eradicate see-through problem a combination of TiO_2 filler and aluminum hydroxide, which is extender to TiO_2 should be used in stock preparation.

- Water klemn property is related to absorption of melamine formaldehyde by barrier base paper during saturation step. Castor oil penetration property (COP) of barrier paper is related to tendency to retain melamine formaldehyde by fibre structure. Both the properties are contradictory to each other. An optimum value for COP and water klemn can be obtained by varying degree of refining, blending of short fibred pulp with long fibred pulp and, filler dosing.
- Porosity is the function of COP and water klemn and a specified value of porosity should be in the range of 600-800 mL/min.
- The range of ash content as TiO_2 should be about 16±2per cent.
- The other important properties related to sun mica manufacturing process are tearing factor, bulk, and pH.

Keeping this in view efforts have been to explore the possibility of manufacturing barrier base paper indigenously. Presently, eucalyptus, bamboo and sawmill waste of pine along with imported soft wood and hard wood pulp are used for manufacturing of barrier base paper.

Experimental Methodology

Pulp Collection and Stock Preparation — Mill pulp of eucalyptus, bamboo and sawmill waste of pine of brightness 83 °GE and viscosity 8.5 cps was collected from an integrated mill located in the foot hills of shivalik in western UP. Experiments were conducted in two steps:

Step 1— 60 per cent imported hard wood and 40 per cent imported softwood pulps were beaten in WEVERK made valley beater to get freeness levels of 30, 40 and 60 °SR.

Step 2 — 50 per cent imported softwood, 30 per cent imported hardwood, and 20 per cent mill pulp were beaten in valley beater to get 20, 27, and 32 °SR freeness levels.

Stock Preparation and Sheet Making — In each set non-fibrous additives, as in Table 1, were added to impart barrier properties. Laboratory hand sheets of 100 g/m^2 were made on British sheet former. The sheets were air-dried, conditioned and tested as per BIS specifications. The results are reported in Table 2.

Collection of Barrier Paper Samples and Analysis of Barrier Paper — Samples of barrier base paper used by decorative laminates manufacturers were collected with specifications prescribed by them. The samples were analyzed for furnish components, loading material, surface properties, strength properties and other properties by microscopic examinations, gravimetric analysis and, BIS specifications. The results are reported in Table 3.

Comparison of Results — The results of laboratory made hand-sheets were compared with the specification prescribed by the decorative laminates manufacturers, imported barrier base paper and Indian mill made barrier base paper. The results are reported in Table 3.

Results and Discussion

Table 1 shows the quantity of non-fibrous additives added into the pulp furnish for the preparation of barrier base paper. The ash content in the paper should be about 16±2 per cent as TiO_2 in order to get opacity around 99 per cent. 30 per cent TiO_2 and 2 per cent micronised soapstone were added

Table1— List of non-fibrous additives added in stock preparation during laboratory trials of barrier paper

Sl No.	Particulars	Per cent dosing	Purpose of addition
1	Filler loading		
(i)	TiO_2	30	To get 99 per cent opacity and 16 ± 2 per cent ash as TiO_2 in paper.
(ii)	Micronised soapstone of brightness 90°PV	2	
2	$Al_2(SO_4)_3$ 14-18 H_2O (non-ferric)	pH 6.5-7.0	To entrap TiO_2 particles without agglomeration
3	Melamine formaldehyde resin	1.0	To increase cross-linking

Table 2 — Results of laboratory made barrier base paper

Sl No.	Particulars	Furnish composition					
		60 per cent imported hard wood and 40 per cent imported soft wood pulp			50 per cent soft wood, 30 per cent imported hard wood and 20 per cent mill pulp		
		30 °SR	40 °SR	60 °SR	19 °SR	27 °SR	32 °SR
1	Substance, g/m^2	93	100	100	93	96	94
2	Thickness, μm	195	190	180	175	165	140
3	Bulk, cm^3/g	2.1	1.9	1.8	1.9	1.7	1.5
4	Ash, per cent	13.3	14.8	18.5	11.0	14.5	16.8
5	Burst factor	19	30	34	24	30	32
6	Tear factor	133	136	88	150	154	158
7	DOUBLE FOLD, No	12	53	90	20	33	48
8	Water absorption (4 min), mm	15	13	10	42	27	23
9	Oil absorbency, s						
	TS	18	23	90	7	14	36.5
	WS	20	27	100	9	24	42
	Avg	19	25	95	8	19	36.5
10	Bendtsen porosity, mL/min	500	350	150	1500	550	250
11	Brightness, °GE	89	89	89	88	88	88
12	Opacity, per cent	99	98.5	98	99	98.5	98.5
13	Wet strength, g/cm	187	213	253	173	200	290

to achieve 16.8 per cent ash in paper. Non-ferric alum was added to get pH about 6.5 with continuous stirring. Small quantity of alum serves to entrap small TiO_2 particles into the pulp furnish. One per cent MF resin dose was found to develop cross-linking in terms of wet strength, which is 240g/cm.

Table 2 shows the results of laboratory made barrier paper. A pulp furnish having 60 per cent imported hardwood and 40 per cent imported softwood when beaten to 30,40, and 60°SR, respectively, water absorption decreases from 15 to 10 mm. On the other hand, average oil absorbency increases from 19 to 95 s. Both the properties do not meet the specifications prescribed by decorative laminates manufacturers.

In another set of experiments 50 per cent imported soft wood, 30 per cent imported hard wood and 20 per cent mill pulp having pine, bamboo, and eucalyptus in the ratio 1:2.1:11 were beaten to 20,27 and 32 °SR, respectively. At a freeness level of 32 °SR, 23 mm water absorption and 36.5 s COP was obtained which lies in close proximity with specification.

Table 3 shows the comparative test results of imported barrier paper, mill made paper and specifications prescribed by decorative laminates manufactures. Substance and ash content in imported, laboratory made, and mill made barrier paper follow the specifications, as laid down by BIS strictly. However, ash content in mill made paper is slightly on higher side. Wet strength of imported barrier paper and laboratory-made hand-sheets are on higher side than the prescribed specifications. It exhibits better cross-linking in paper, which is beneficial during saturation step. Oil absorbency of laboratory-made hand-sheet closely resembles the specification, whereas in imported barrier paper; it is slightly lower than the specified value. The mill made paper may pose problem during saturation step due to lower oil absorbency value. However the water klemn value for laboratory made paper is slightly lower than the specified value. This property may be improved by optimizing the pressing during paper manufacturing. Beside these properties other properties were tested keeping the customer's complaints in view. Double fold and tear factor of laboratory made sheet is found much more than the mill made paper. Brightness and

Table3 — Comparative test results of imported barrier paper, mill made paper, specifications prescribed by decorative laminates manufacturers and laboratory made hand-sheets

Sl No	Particulars	Specifications prescribed by sun-mica manufactures	Imported barrier paper	Mill made paper	Laboratory made barrier paper
1	Substance, g/m^2	100±3	103	104	96
2	Thickness, μm	—	155	132	140
3	Bulk, cm^3/g	—	1.5	1.27	1.5
4	Ash per cent,		15.8	21.1	16.8
(i)	TiO_2	16.2	15.0	16.0	15.0
(ii)	Soapstone	—	0.8	5.1	1.8
5	Burst factor	—	10	11	32
6	Tear factor				
	MD	—	62	44	—
	CD		66	49	—
	Avg.		64	46.5	58
7	Double fold, no				
	MD	—	5	5	—
	CD	—	4	3	—
	Avg.	—	4.5	4	48
8	Wet strength, g/cm				
	MD	—	440	174	—
	CD	—	227	130	—
	Avg.	150	333.5	152	240
9	Water klemn, mm (4min)				
	MD	—	35	30	—
	CD	—	28	28	—
	Avg.	25-29	32.5	29	21
10	Oil absorbency, s				
	TS	—	17	9	31
	WS	—	19	10	42
	Avg.	20-35	18	9.5	25.5
11	Bendsten porosity, mL/min	600-800	660	920	650
12	Brightness, per cent ^{0}GE	—	88	87	88
13	Opacity, per cent	—	97.7	99.4	98.5
14	pH of hot water extract	—	6.8	4.1	5.5
15	Morphological analysis	—	85 per cent bamboo + 15 per cent softwood	30 per cent softwood + 30 per cent imported hardwood + 40 per cent other pulp	50 per cent softwood pulp + 30 per cent imported hard wood pulp + 20 per cent mill pulp

opacity of laboratory hand-sheet and mill made paper are almost equal but pH of hot extract of mill made barrier paper is 4.1. It clearly indicates that excess of alum was used to retain TiO_2 filler which is evident from ash content in paper. The mill made paper may pose see-through problem as result of agglomeration of titanium dioxide particles, light scattering efficiency of barrier base paper decreases sharply during saturation step.

Conclusions

1 Pulp furnish comprising 50 per cent softwood pulp, 30 per cent imported hardwood, and 20 per cent mill pulp (sawmill waste of pine bamboo and eucalyptus in the ratio of 1:2.1:11) was found optimum to develop barrier paper.

2 A freeness level of 32 °SR was found suitable to induce optimum barrier properties, like water klemn and COP.

3 Non-fibrous additives like, 30 per cent TiO_2, 3 per cent micronised soapstone of brightness 90 °PV, and one per cent MF resin were found suitable to impart barrier and other properties. It is important to note that pH ranging between 6.5-7.0 was maintained by the addition of non-ferric alum

4 All other properties of laboratory -made hand sheet like, substance, ash content, wet strength, and oil absorbency were in close agreement with the prescribed specifications except water klemn. Water klemn and porosity may be improved during sheet pressing.

5 Besides specified value all other properties of laboratory-made hand-sheet are related to mill made paper. However the process conditions may be changed as per requirements to get desired results during paper manufacturing.

Recommendations

1 The use of retention aids should be avoided otherwise it causes agglomeration of filler particles and poses see-through problem in sun-mica.

2 Pressing and calendaring to be avoided to adjust to get a bulk of 1.5 cm^3/g and a porosity of 600-800mL/min.

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