Development of Speciality Paperboards from Secondary Fibres

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ABSTRACT:-- Laboratory investigations have been carried out on the potential utilization of secondary fibres to produce different types of speciality paperboards such as Jacquard board, paperboard for casting metal stereoplates (stereoflong) and solid toughened board for packaging purposes. Based on the lab scale data and pilot plant study, process parameters are optimised for production of these speciality boards. Samples of board prepared in laboratory as well as in pilot plant are tested as per TAPPI Standard methods and the results are presented in this paper. For comparative study, imported samples of the product are also collected and tested. The products made in the laboratory as well as in pilot plant exhibit characteristic properties of these types of paperboards.

***KEY WORDS:--** Secondary fibre, disintegrate, potential utilization, parameters, solid toughened board, packaging media, waste paper.*

INTRODUCTION

In recent years, shortage of fibrous raw material for the pulp and paper industry has become a worldwide problem. India, is no exception to this. The major source of cellulosic raw material of the Indian Pulp and Paper industry is the bamboo. In view of the limited supply of bamboo, its high cost of plantation and low annual yield, the existing bamboo forests in the country is not enough to meet the challenge of raw material shortage. The shortfall of pulpable wood and bamboo would be 48 lakhs and 5 lakhs tonnes respectively towards the end of the century[1]. To overcome this critical situation of raw material shortage, much importance has been given for utilization of various types of non-wood plant fibres as a potential source of alternative materials, including utilization of secondary fibres.

It is reported that secondary fibre is the second largest source of fibre for the paper and board industry in the United States of America[2]. The use of secondary fibre is greater in Europe and Japan than it is in the United States. India is lagging behind in secondary fibre utilization. Waste paper accounts for 15% of paper and board produced in the country compared to an estimated 45% in 1997 in the developed countries.

The waste paper consumption in India is about 10 lakh tonnes out of which about 4-5 lakh tonnes is available indigenously and the balance quantity is being imported premoninantly from USA (upto 60-65%) and the Middle East (25-30%). Some small quantities are also being imported from Singapore[3].

The utilization of waste paper in the Indian Pulp and Paper industry is about 5-10% in the stock

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preparation to produce conventional boards like mill board, grey board, duplex board, file cover, file board, greeting card, invitation card, etc. But with the advancement and modernisation of small sector paper industries, the use of waste paper and paperboards has picked up to a great extent. In some cases, waste paper is considered as the principal raw material for paper board making. It may be expected that the utilization of waste paper and paperboard as source of secondary fibre will increase at twice the rate in the coming years.

The advantages of using the secondary fibres are wellknown to the paper makers, some of them are as follows:

i. low cost substitute where cheaper grade pulp is not available.

ii. lower energy requirements for processing of waste paper.

iii. reduction in waste disposal cost.

iv. environmentally friendly.

Worldwide emphasis has been given for utilization of secondary fibres for development of different types of speciality products. Attempts have been made to utilize secondary fibres for producing paperboards with characteristic properties for use in textile, printing and packaging industries. In the field of packaging, eventhough, corrugated fibre boards and some solid fibre boards are conventionally used, but for export packaging and deep freezing products, special type of high impact resistant, waterproof, moth and termite resistant boards with high compression strength are required.

The current market for export packaging is around Rs. 2000 crore, which has a potential to touch Rs. 6320 crore by the turn of the century. Our country loses foreign exchange worth over Rs. 450 crores every year due to rejections, spoilage and breakage arising from poor packaging. Engineering products are the worst sufferers for poor packaging accounting for a loss of Rs. 194 crores. Garment packaging comes next with a loss of Rs. 108 crore followed by marine products, which account for Rs. 72 crores.

It is felt that if a toughened solid fibre board is developed from a raw material like waste paper, which is eco-friendly and bio-degradable, at a considerable economic cost, this type of board may find use in packaging industry especially for export packaging. However, this type of boards can also be used for roofing purposes[4,5].

Other speciality paper boards such as Jacquard and also paper boards for casting metal stereoplates have been developed from suitable pulp furnish made from waste papers in combination with pulp prepared from other cellulosic materials[6,7,8].

Jacquard board is a special type of paperboard, used extensively in the textile industry. Jacquard board plays an important role in the field of weaving. As the indigenous production is not sufficient, a substantial quantity is imported every year to meet the domestic demand of the country.

There are two types of Jacquard board such as - (i) plain and foil laminated Jacquard board and (ii) Jacquard fibre board.

The main characteristics of these boards are that they should possess high tensile and bursting strength, good water repellancy, smooth and easy punchability, good stiffness and dimensional stability.

So also, for making matal stereo plates for use in rotary press for printing newspapers, advertisements, magazines, books etc. a special type of board is extensively used. Generally, this board is a heavy, absorbent, smooth surfaced board with high strength, high compressibility and of specified shrinkage properties.

The board, better known as stereoflong, is a special type of board and the general properties required for this type of board are: (i) smooth and even surfaces (ii) high compressibility (iii) less water absorbency of the working surface than that of the non-working surface (iv) hydroexpansion of 0.63 mm - 0.70 mm at a moisture uptake of 20-25% and (v) shrinkage of 12.7 mm - 40.6 mm on drying in oven in breadthwise direction (vi) density 0.85 - 0.95 gm/cc when the thickness is 0.6 - 0.8 mm, (vii) withstand a moulding pressure of 70 - 120 kg/cm^2 at a moisture content of 20 - 25%. The board should also have the property to resist atleast 350 - 400^{0}C temperature when molten alloy is poured on the dried and embossed surface of the board and finally the board should have the property to yield six or more

castings from the same sample. The stereo-plate formed from the molten alloy on cooling, should easily get released from the board without piling out of the fibre.

EXPERIMENTAL

Raw Material

The cellulosic raw materials required are waste paper of suitable grade, waste tailor's cuttings or rags and discarded gunny bags, Generally white press cuttings, envelope trimmings, business machine cards, waste kraft paper or paperboards etc are used. The materials must be free from coated paper, synthetic fibres, plastic, wood and rubber pieces and other contaminants.

Commercial grade chemicals and synthetic polymers are used in various stages of manufacture of the above boards.

Pulping of Waste Paper

The waste paper and paperboard of selected grade are softened by soaking in water for 2-3 h and then put into the Hydropulper to disintegrate into homogeneous pulp slurry at 5-8% consistency.

Processing of Gunny Bags

The discarded gunny bags are cleaned and fed to a rag chopper, cut to desired sizes. The dusts are separated by passing through a dedusting machine.

The cut pieces (approx. 2 x 2.5 cm) are digested in a rotary digester adopting Soda process, maintaining the following conditions:

Material to liquor ratio	-	1 : 5
Chemical percentage as Na_2O on OD basis	-	8
Cooking temperature (°C)	-	165 ± 5
Time to raise to maximum temp. (h)	-	1
Time at maximum temp. (h)	-	5

After the degestion, pulp is washed thoroughly with fresh water to remove the unreacted chemicals.

Processing of Waste Tailors' Cuttings

For making pulp, the waste tailors' cuttings or rags are first treated with certain chemicals at room temperature for specific time period. The treated cuttings or rags are washed free of chemicals and then introduced into a valley beater and the beating is continued for 3-5 h to obtain a freeness of 550-600 cc CSF at 1.5% consistency.

PREPARATION OF BOARDS
JACQUARD BOARD

Stock Preparation

To impart strength and bonding potential to the weak repulped fibres, suitable chemicals are added for sizing. Alum is added dropwise to the stock to maintain a pH at 5.5 - 6.0.

Refining

The above pulp stock is then passed through the Disc refiner to get a homogeneous furnish.

Board Making

Multilayered boards of specified grammage are made in a single cylinder mould machine by conventional method with each layer having 60-80 gm/m^2 (o.d. weight) to obtain boards of dry weight of 1000-1050 gm/m^2.

Pressing and Drying

The multilayered boards with high moisture content are then pressed in the hydraulic press to squeeze out excess water from the base boards. In the hydraulic press, first of all, gradual pressure of 5-10 kg/cm^2 is applied and kept for 30-40 minute and again pressure is increased gradually to 10-20 kg/cm^2 and kept for 20 minutes and finally the pressure is increased upto 20-50 kg/cm^2 and kept at that pressure for another 30 minutes and then released.

After pressing in the hydraulic press the boards are dried in the sun or in a hot air circulating oven. Care should be taken so that the dried boards remain flat without curling. The dried boards are kept flat under some weight and conditioned in the room for 3-4 days.

Calendering and Coating

The above conditioned boards are calendered

in a standard calendering machine. The thicknesses of the boards after calendering should remain between 0.90-1.00 mm.

The edges of the calendered boards are then trimmed for applying a coating solution to impart certain characteristic properties to the boards.

Coating of the Base Board

A polymer based coating composition is made and applied on both sides of the base board by spraying. A dry coating pick up of 15-20 gm/m^2 is applied.

The coated boards are dried in air or in a hot air circulating oven at 65-70^{0}C and then calendered to obtain uniform surface and gloss. The boards are then finally cut into different sizes, so as to maintain the corners always at an angle of 90^0, otherwise the boards will not fit into the machine during punching.

Testing

The physical properties of the board made in laboratory as well as in pilot plant are given below in Table 1. The physical properties of an imported board is also evaluated and shown in the table.

SOLID TOUGHENED BOARD

Stock Preparation

The pulp made by digesting gunny bags is put in a hollander beater and beaten at a consistency of 3-4% for about 1 h and waste paper pulp from beater chest is then added to it in the required proportion and the beating of the blended pulps is continued further until the freeness of 300-350 cc CSF, is attained.

At the early stages of beating operation, chemicals imparting stiffness and such other desirable properties to the dried board, are added to the pulp stock. The pulp stock is then beaten to the required freeness and then synthetic polymeric substances are added to the beater and the beating is continued for about 15-20 min for thorough mixing of the chemicals. Sizing chemicals are then added followed by fillers and additives in the beater.

Sizing chemicals are precipitated over the fibres with the help of alum solution at a certain pH. The stock is then, pumped out to a storage chest, fitted with agitator.

Refining

From the stock chest, the pulp is fed to a disc refiner, wherefrom refined pulp is transferred to the refiner chest.

Board Making

The pulp from the refiner chest is then fed to the head box of the single cylinder paperboard making machine.

Multilayered boards are made, maintaining a thickness of about 5 mm. The boards are then pressed in a secondary smooth press. The final boards, coming out from the secondary smooth press, contained about 40% moisture.

The boards are initially dried in the sun and then dried in a controlled temperature.

The dried boards are then treated further with surface treatment agents such as special type of

Table-1

Physical properties of Jacquard Board

Sl. No.	Sample	Basis weight	Thickness	Density	Breaking length (30 mm width strip)	Effect of immersion in water for 20 h	
						Thickness increase	Water absorption
		gm/m^2	mm	gm/cc	metre	%	%
1.	Laboratory sample	1000	0.98	1.052	3185	14.40	18.80
2.	Sample made in pilot plant	1045	0.90	1.047	2960	17.20	23.80
3.	Imported sample	1040	0.92	1.034	2624	20.00	32.00

synthetic resin in order to make the finished boards highly water repellant as well as smooth surfaced. Alternatively, the virgin boards are also waxed by hot melt coating composition consisting of wax, a synthetic resin and a rubber chemical to impart flexibility and high degree of water resistance.

Testing

The laboratory test results show that the boards made from the blends of waste paper and jute fibre pulps, with specific chemical treatment are found suitable for use as a speciality packaging boards. The boards so prepared possess adequate physical strength properties and other characteristics needed for such a product.

Results obtained from testing some of the physical properties of the board prepared on pilot plant are summarised in Table 2.

BOARDS FOR STEREOPLATE MAKING

Stock Preparation

Pulp from waste tailors' cutting or rag is prepared as mentioned. Pulp from white press cuttings is also prepared separately. Both these two pulps are then mixed together at a certain ratio and the beating is continued to get freeness of 300-350 cc CSF. Sizing chemicals are added to the pulp stock and after mixing thoroughly, the pH of the stock is brought down to the range 5.0-5.5 by adding alum solution. Multilayered paper boards are formed in the conventional way in a single cylinder mould machine. The dried boards are calendered and trimmed.

A water based coating composition has been developed and the same is applied on the working surface of the board. The coated boards are then dried and calendered by the conventional method in a calendering machine and finally the boards are trimmed to required sizes.

The physical properties of the board are evaluated, which is presented in Table 3.

RESULTS AND DISCUSSION

The board samples made in the laboratory as well in the pilot plant, are tested for different properties adopting TAPPI & ASTM standard methods

Table-2

Physical properties of solid toughened boards

Properties	Thickness (mm) 2.5	4.0	5.0
* Water absorption (%) (24 h)	11.62	11.65	11.8
* Water percolation test	NIL	NIL	NIL
* Weight of sheet (kg)/ 1 x 1.5 m sheet	3.685	3.870	4.050
* Breaking load (kg):			
i. 30 cm span	120.	125	135
ii. 40 cm span	65	65	70
* Fire resistance	Satisfactory	Satisfactory	Satisfactory
* Delamination	Nil	Nil	Nil

Table-3

Physical properties of paperboard for casting metal stereoplates

Sl. No.	Sample	Basis weight gm/m²	Thickness mm	Density gm/cc	Moisture uptake by the non-working surface %	Hydroexpansion at 20-25% uptake mm	Shrinkage after at 100 + 5°C. mm	Temp. resistance of the coated surface °C	Moulding pressure resistance kg/cm²	Ash content %	No. of casting Nos.
1.	Lab.	720	0.80	0.92	23	0.65	1.28	380	162	16.8	18
2.	Sample made in pilot plant	735	0.82	0.93	24	0.67	1.22	378	160	17.2	20

and the results are shown in Tables 1, 2 and 3. In case of Jacquard Board, it has been found that the laboratory made board sample have shown higher strength properties and water resistance in comparision to the imported board sample. In case of stereoflong and the solid toughened boards, the properties of the samples made in pilot plant are within the limits specified for such boards.

CONCLUSION

It may be concluded that one of the best utilities for secondary fibres, is to develop speciality paperboards, having high market potential, as the products mentioned in this paper. Based on the recent development of indigenous technology, small scale industries may come up, utilizing secondary fibres, as the products mentioned here, have already found indigenous market.

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