

Effect of Moisture Content on Printability of Corrugated Board

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ABSTRACT

Around the globe, corrugated board is known for its versatility in this modern era of packaging. In order to meet high quality and customer expectations, the corrugated board manufacturers are focusing more and more on quality. Moisture content is the most crucial parameter which ultimately affects the quality not only during production, but also after production. Unbalanced moisture is the major challenge for the whole corrugating industry. So in order to know the vitality of moisture content for the corrugated industry, this research was carried out. There for the present study aims to analyse the effect of moisture control on printability of corrugated board.

Keywords: Paper Board, Corrugated Board, Printability, Moisture Content, Adhesives.

INTRODUCTION

Corrugated board is the inevitability of modern packaging industry. In this modern era, corrugated board is the need of hour. No one can ignore this crucial aspect. Without corrugated board the modern packaging sector would fall apart. By far corrugated fibreboard is the common paper and paperboard packaging material fulfilling the criteria for medium for displaying printed information as well as protecting product especially during distribution of goods. Corrugated board is a material having sandwich like structure comprising a corrugated medium (flutes) and one or two liners i.e. flat papers. The flute shape of the medium is formed by application of heat, moisture and pressure during corrugation process. The corrugated board can be manufactured in several ways depending upon the number of liners. If one liner is used glued to a corrugating medium, it is 'single faced'. It can be classified depending upon the structure of corrugated board.

Types of Corrugated Board: - Depending upon the number of liner board and fluting medium i.e. on the basis of their composition structure, it is classified as follow:-

1. **Single-Faced Corrugated Board:** - It consists of single liner glued to a corrugating medium or fluting.
2. **Double Faced Corrugated Board:** - When two liners are glued to a corrugating medium or fluting.
3. **Double Wall Corrugated Board:** - It consists of two facing, two corrugated mediums and an inner liner between the two mediums.

4. **Triple Wall Corrugated Board:** - It comprising of seven paper layers including three corrugated mediums i.e. combination of three media and four facings.

The efficiency of any corrugated board is also decided by the number of flutes and its structure. The particular flutes standards are tabulated in table 1.

Flute	Flutes/meter	Flutes/foot	Thickness	Take-up Factor
A	100-120	30-36	4.67mm	1.54
B	145-165	44-50	2.46mm	1.32
C	120-140	36-42	3.63mm	1.42
E	280-310	86-94	1.19mm	1.27
F	407-433	124-132	0.80mm	1.29

Table 1: Types of flute and Flute Standards

Corrugated Board Manufacturing

Corrugated is an extremely flexible medium that facilitates from a wide range of printing options to fully support the end user requirements. Corrugated Board is made from papers i.e. cellulose fibers which are either virgin or recycled. This makes corrugated a renewable natural resource. The production of corrugated board is a complex process. It is carried out in several stages. First of all the production of single face corrugated board is made. For this the crucial task is preparation of fluting medium. This section is the heart of corrugated machine. Here the fluting medium is made pliable by application of heat and moisture and it retains the flute structure. The flute shape is pressed into the medium by using two profiled rolls as shown in figure 1.

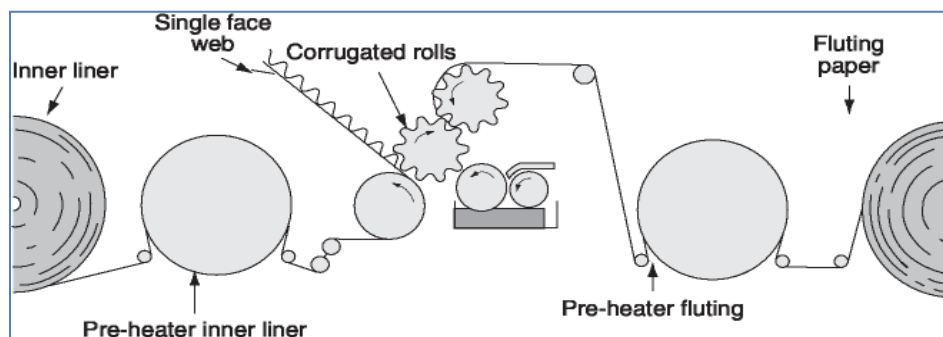


Figure 1: Production of Single-face Corrugated Board

Starch adhesive is applied on the tips of the flutes after preparation of this flute medium. And combined with the liner bring it. This liner is also conditioned at the same temperature and moisture content of the fluting medium. After this the board is dried in drying section. In order to produce double wall corrugate board the machine would incorporate some additional sections. There two single face corrugated web are pre-conditioned before combining with the fluting medium. Then combined board is dried between heating plate before slitting.

Because of the hygroscopic nature of paper, there occurs absorption due to humidity, temperature and adhesive level. It affects dimension stability of corrugated board. So being quality concerned, it is mandatory to control the moisture level at various stages during production cycle of corrugated board.

Objectives of Study

The key objectives of this research are to elucidate on the following aspects of moisture content while manufacturing and printing of corrugated board: -

- i. Analysing variation of moisture content at various stages of corrugated board manufacturing
- ii. Analysing printability of corrugated board due to moisture
- iii. Effect of moisture on dimensional stability of corrugated board.

RESEARCH METHODOLOGY

The research work was carried out at Janus Packaging Pvt. Ltd., carton packaging industry in India situated at Himachal Pradesh (Baddi). The whole research was based on the corrugated board manufacturing processes. In research methodology, different jobs were analyzed from initial step to final production. The specifications of the job tracked for the research work is summarized as below: -

Job Specifications

Raw Materials	Function of Raw Materials
Duplex (G/B) – 300GSM	Board for printing
BOPP film	Printing on a non-absorbent surface
Kraft paper	Liners and flute making
CMYK	Printing
Starch based gum	Sheet pasting
Fevicol Gum	Side pasting
Die	Laser/ Manual for Punching
pH Strips	Measuring pH of paper
Double sided tape	For sample checking
Pantone Color	Printing
Brown paper	For creasing on manual punching
Type of flute	E - flute
Liner GSM	100

Table 2: Job Specifications of the Corrugated Board

Various Instruments Used for measuring the Quality Standards while data

Collection: - The instrument with their function are summarized in table 3 as below:-

Type of Instrument	Function and Working
pH Meter	It is used to measure pH value. It gives the value from 0 – 14.
Cobb Tester	It is used for measuring the water absorption percentage. This expressed result is known as Cobb Value. Greater is the cob value, it will absorb more moisture.
Digital GSM meter	GSM of paper and paperboard is the weight per unit surface area of paper or paperboard. It expresses the GSM of paper/paperboard.
Thickness/ Caliper Meter	This is used for measuring the perpendicular distance between two parallel surfaces. It gives the value of thickness of paper/paperboard. Its expressing unit is micron.
Bursting Strength Tester	This test determines the maximum pressure required to rupture the sample by constantly increasing the pressure applied through a rubber diaphragm. It is used to measure the strength of paperboard or carton. It is the resistance to rapture. Its expressing unit is kg/cm ² .
Ford Cup Tester	It is used to measure the viscosity of adhesive or gum which we use while corrugation. Adhesive is required during flute making, sheet and side pasting. The adhesive viscosity depends on the nature of adhesive used for various purposes.
Scuff Resistance Test	Also known as Rub resistance test. This test is carried out to check the bonding of ink with paperboard (at 300 rounds). Scuff Resistance Tester rubs two printed surfaces against each other (face-to-face) at the same speed (60 rpm) under a constant rubbing pressure.
Hot air Oven	Hot air oven is used for moisture dryness. Its temperature range is up to 300 ⁰ C. It is also used for all type of coating i.e. varnishing, adhesive, gum, U.V coating, drip off etc at a temperature of 60 ⁰ C-105 ⁰ C.
Moisture Meter	The moisture content is the percentage of the part of water in board in normal condition to the moisture content of board. It is an instrument used for measuring the moisture content of paper and paperboard.

Table 3: Instruments used for measuring Quality Standards of the Corrugated Board

DATA COLLECTION & ANALYSIS

The research data i.e. observation of moisture content during the production of corrugated board was collected on day to day basis. The data so collected was compiled and analyzed in order to accomplish the research effectively. The following aspects were taken into consideration during analysis:-

1. Analysing variation of moisture content at various stages of corrugated board manufacturing
2. Analysing printability of corrugated board due to moisture
3. Effect of moisture on dimensional stability of corrugated board.

These various aspect from research point of view are illustrates as below: -

1. **Analysing variation of moisture content at various stages of corrugated board manufacturing:** - As we know the corrugation is a complex process of combining linerboard and flutes with the application of adhesives. Also Kraft paper is also conditioned before using it into the corrugated board manufacturing machine. So there are numerous stages where moisture plays a vital role during corrugation. The variation found in moisture content at various stages is expressed in table 4.

Sr. No.	In feed Paper Machine	Out-feed (in flute making)	Online Sheet Pasting	After 4 hour	Room Temperature	Relative Humidity
1	6% - 8%	8% - 11%	16% - 18%	10% - 14%	22 ⁰ C	45%
2	6% - 8%	8% - 10%	11% - 14%	10% -12%	22 ⁰ C	45%
3	6% - 8%	12% - 15%	19% - 23%	14% -18%	22 ⁰ C	45%

Table 4: Moisture level at various stages during corrugated board manufacturing

The results of the research are expressed in Table 4. During the research it was found that at relative humidity of 45% and temperature of 22⁰C there was the variation of moisture content during the manufacturing of corrugated board. Initially the moisture content increased while infeeding, outfeeding and online pasting, on the other hand after 4 hour the moisture content was reduced.

2. **Analysing printability of corrugated board due to moisture:** - Printability is an important aspect that should be taken in consideration while corrugation. Moisture content affects the number of factors which are directly associated with the printability. A result for the same is tabulated in table 5 based on the research.

Moisture Content	Effect of moisture
Below 8%	Cracking at crease
10% - 12%	Standard required
12% - 14%	Soften the board, strength decreases.
14% - 18%	Due to high moisture paper extended in areas Also registration is out on creasing area.
19% - 23%	Paper expands due to increase in Moisture Content (Registration out during creasing) and Contracts due to less Moisture Content (Cracking at creasing)

Table 5: Effect of moisture content on Printability

- 3. Effect of moisture on dimensional stability of corrugated board:** - Dimensional stability is the key aspect of every type of paper used in printing as well as in packaging. Relative humidity, temperature and moisture content greatly affect the paper dimensions. Results for the same are expressed in table 6.

Surrounding Conditions	Area : Sample 1	Area : Sample 2	Area : Sample 3	Effect on dimension stability
After Sheet Pasting R.H=45%	40.54*60.90cm ²	40.56*60.90cm ²	40.64*60.90cm ²	Area Expands
After 12 hr, Temp at 22 ^o C, R.H=45%	40.50*60.88cm ²	40.52*60.88cm ²	40.60*60.88cm ²	Area Contracts

Table 6: Effect of moisture content on Dimension Stability

The results of the findings are expressed in table 6. This result indicated that due to more moisture content the area expands and on the other hand the area contracts as moisture content is low.

RESULTS AND CONCLUSION

During the analysis it was observed that the results obtained during the research were in accordance with the print quality standard range. On the bases of the research carried out the following results were concluded:-

- **Moisture content during corrugated board manufacturing:** - As table 4 depicts that there was rise in moisture content of paper from infeed paper machine (6% - 8%) to online sheet pasting (11% - 23%). Reason being there was contact of adhesive during corrugated board manufacturing. But after four hours the moisture content was found decreased.
- **Printability of Corrugated Board:** - From the table 5, it is depicted that the standard range found for moisture content was from 10% to 12%. Below this range cracking during creasing was occurred. On the other hand increased range caused the occurrence of troubles directly affecting printability.

- **Effect of moisture on Dimensional Stability:** - During the research it was observed that paper sheet was expanded due to more moisture content and conversely reduced the size due to less moisture content because of hygroscopic nature of paper.

In the other words it was concluded that moisture content was a key issue while manufacturing and printing of corrugated board. If the moisture content was either below or above from the standard range it affects printability of corrugated board. Hence prime concern was maintaining the moisture content during production as well as printing of corrugated board.

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