Ply - Bonding in a Multiply Paper - Board

SHARMA, R. C.*

SUMMARY

An extensive study on ply-bonding in multiply paper-board has been made by the author and practical observations on this phenomenon are given here, so that it may be useful for paper-board manufacturing in case a paper-board maker finds ply-bonding weak in his board. Cereful scrutiny of the various factors involved in the process of the board manufacturing in light of suggestions made, can enable him to arrive at a proper solution.

KEY WORDS

Adjacent layers,, Fibre to fibre bonding, Fibre characteristics, Mechanical intermingling of fibres, Electro-chemical hydrogen bonding, Freeness, Vat and cylinder mould machine, Lamination, Extraction of water, Delamination, Blowing, Drying, Calendering, Slice Board, Dirty mesh, Pickup felt and press felts.

INTRODUCTION

Most of the paper boards are used for manufacturing of cartons and boxes for industrial packaging, and in this process they are subjected to repeated physical stress and strain during the printing, punching, folding operations, and also during the end use of the cartons or the boxes. The ply-bonding between the adjacent layers in a paper-board must, therefore, be strong enough to withstand this repeated stress and strain phenomenon.

Hence, in the process of paper-board manufacturing, a paper-board maker should know very well all those factors which affect the ply-bonding in a board.

The ply-bond strength in a paper-board depends on the fibre to fibre bonding characteristics of the stock, or stocks, out of which the board is made.

*Superintendent, The Sirpur Paper Mills Ltd., Sirpur Kaghaznagar—A.P.

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However, conditions on the machine also influence the ply-bond. All these factors, which influence the ply-bonding in a board, are summerised below:

FIBRE CHARACTERISTICS

Strength of fibre to fibre bond is dependent on two phenomena:

a) the mechanical intermingling of fibres,

b) the electro-chemical hydrogen bonding.

(a) The mechanical intermingling of fibres depends on:

(i) the morphology and physical characteristics of a fibre itself to develop fibrillation after beating,

(ii) pulping and beating conditions, and

(iii) conditions of sheet forming operation, i.e., the degree and uniformity of the dispersion of the fibres in the aqueous suspension and the mechanism of dewatering the sheet on the forming equipment.

(b) The hydrogen bonding mainly depends on the hemicallulosic content of a pulp and the degree of hydration during its beating. Wet-end additives, such as, modified gums, galsctomanans and carboxy methyl cellulose (CMC) etc. also help to develop this bonding.

CONDITIONS AT THE TIME OF LAMINATING THE PLIES.

(a) One important point to remember here is

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that the stock characteristics of the two adjacent layers should not differ much and wetness (or freeness) of the two stocks should be maintained nearly equal to each other; so that when the sheet is shrinking during the drying operations, all the layers in the board experience equal and uniform shrinkage, and there is no undue physical strain between the layers of the board.

(b) The plies should not become very compact before lamination, that is, they should be only loosely formed and there should be enough water in the plies to permit the intercrossing and intermingling of fibres of the two adjacent layers when they are pressed together in the sheet forming section of the machine. Otherwise, the basic need of intercrossing and intermingling of fibres of the two adjacent plies would be overlooked resulting in poor ply-bonding.

With this basic idea in view, in case of a vat and cylinder mould machine, the operator should see that the head differences between the outside and inside levels is not too much, as this will tend to increase the drainage of water from the sheet making it more compact before it comes into contact with the coming layer over it. In case of fourdrinier sheet forming machine, the operator should see that the sheet is not dewatered beyond the critical value before the point of lamination.

(c) The pressure of the couch rolls on the preceding moulds should be kept only enough for couching operation and not more, in order that the sheet passing through that nip is not too much consolidated to resist the penetration of fibres from the next coming sheet.

(d) In case of a cylinder mould machine, if plybonding is found to be weak between two particular layers, then decreasing the offset of the couch on the mould on which this particular lamination is weak, will improve that ply-bonding.

(e) In a cylinder mould machine the surface of the mould and the couch rolls should be uniform to ensure a uniform nip pressure in running direction, as well as, cross direction. Low spots in a cylinder mould or uneven couch rolls may result in a nonuniform ply-bonding and, at times, blowing in the board.

EXTRACTION OF WATER FROM THE SHEET

The vaccum extraction of water from the sheet should be used with discretion and, as far as possible, should be avoided till all the layers have been laminated. The final couch pressing, before any vaccum extraction of water from the sheet is made, should be as much as permissible under prevailing conditions. The extraction of water from the sheet by means of suction does not produce any disturbance in the web, where expression of water by carefully controlled

nip pressing does produce the fine disturbance, which facilitates the desirable intercrossing and intermingling of fibres of the adjecent layers for good ply-bonding. That is why, a board made on a machine without vaccum extraction in its wetend exhibits better ply-bonding, compared to that made on a machine with vaccum extraction in the wetend, with identical stock furnish.

However, when blowing defect appears in the board-sheet, judicious application of vaccum extraction at the point of origin of the blow will help to overcome this problem.

DRYING OF PAPER-BOARD

During the drying operation, the paper-board should be heated up in a gradual manner. Very rapid and drastic heating of the board must be avoided, as it would be detrimental to the bondage of the fibres. In a multi dryer cylinders machine, the first few cylinders should not be heated beyond 45° to $50 \,^{\circ}$ C and the temperatures in the subsequent dryers should be gradually increased in such a manner so as to avoid an y undue strain in the board.

FINISHING OPERATION

When a very thick board is subjected to application of water on its outer surface by means of a size press on water doctors on the calender rolls, and or is passed through a number of calender rolls, these operations may exert some physical stress and strain between the adjacent layers giving tendency to weaken the ply-bonding. To avoid this, a breaker stack of two calendering rolls or a M.G. Cylinder at an appropriate location within the dryer section of the machine should be preferred as compared to calendering with water doctors.

However, this adverse effect of calendering with water finish on ply-bond is not noticeable in light substance boards-say below 300 G.S.M. or so. It is only with very thick boards that, at times, the problem of blowing and delamination appears in the calendering operation with two or more water doctors on either side.

OTHER FACTORS

Associated with the subject of ply-bonding in the board, is the problem of delamination due to blowing in the board. Though the main cause for the blowing originates in the wetend of the machine, yet the blowing, some times, may not be detectible at the wetend and may appear in dryer part or calendering or after printing or punching or folding operation for the end use. The blowing in a paper-board is effected by any one of the following causes:

(a) Leakage in the slice board before a couch roll over the cylinder mould. This type of blowing is easily detected by two nearly parallel running lines, sometimes, called the rail roads.

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- (b) If a pickup felt is very thick or is not properly wet, then big air blows will develop between the felt and the board sheet.
- (c) If the pickup felt or any press felt is having dirty streaks/spots, that will not permit free escape of the air accompanying the sheet and, as such, blowing may develop in press section.
- (d) Any one of the intermediate moulds running with dirty mesh wire may cause blowing.
- (e) If the liner stock gets more refined and the liner sheets are formed more compact, compared to those of the filler stocks, there are good chances of blowing for obvious reasons.

The phenomenon of delamination owing to blowing is more frequent with thicker boards. Hence, while running thicker boards, due attention should be given towards the cleanliness of pickup and press felts, as also towards the characteristics of the liner and filler stocks. With a given set of machine conditions, the most critical and important variable factor in the process is the degree of beating and refining of the stock or stocks. Hence, some kind of systematic control on this variable, that is, wetness of the stock, is essential to obtain a good and uniform plybonding in a paper board. In addition, cleanliness of the wire mesh, pickup felt and press felts are to be maintained properly by means of suitable water showers and felt conditioners.

A POINT OF CAUTION

The ply-bond strength in a multiply board for folding cartons or boxes should be about only 1.5 Kgs./cm² and not more. If the ply-bond is too strong, the board would defy the purpose of creasing operation and may crack on folding: because, the purpose of creasing a board on the lines of folds is to loosen the ply-bonding on those lines so that the outer layer does not have to stretch on foldings.