IPPTA

SILVER JUBILEE 25 YEARS 1989

Silver Jubilee International Seminar & Workshop
Appropriate Technologies For Pulp & Paper Manufacture
In Developing Countries.

New Delhi - 1989

THE ADVANTAGES OF TWO PLY FORMATION FOR THE PRODUCTION OF LINER

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Important properties for linerboard and test liners include caliper, bursting strength or mullen index, tensile strength and stiffness.

When linerboard was made from predominantly softwood fibres with a maximum of 20% hardwood or recycled waste, mills had little difficulty reaching the international test requirements for the above characteristics. There are still areas in the world with abundant wood supplies where liner is produced from 80-100% softwood kraft pulp, however we in Europe have to use the raw materials available and so liner must be produced from an ever increasing percentage of inferior quality pulps and waste paper. At the same time technological advances in paper machines and wet end clothing in recent years have enabled mills to produce liner from these lower quality furnishes, while maintaining the test properties demanded by the international market.

Linerboard was traditionally made on single wire fourdrinier tables until recently. In order to use a lower quality pulp of high yield and kappa number, a two layer forming system was devised in which another headbox was mounted above the fourdrinier near or at the dry line to deliver a high quality stock on the top side of the already formed web covering the imperfections of the lower quality base layer. This added stock drained through the bottom layer forming the thin high quality covering, crating a high strength bond between the layers.

Strange as it may seem this secondary headbox system, as it became known, produced a liner sheet with a lower burst index for the same furnish than the original mono jet liner because the water from the top layer is washing through the already formed base sheet disturbed the formation reorienting the fibres, so that more fibres were lined up towards the vertical or "Z" direction.

The introduction of two separate ply forming systems for linerboard in the early seventies, brought about a revolution in the industry due to the improvement in the physical properties of the sheet. In general with this system a short conventional fourdrinier wire table was mounted above the main fordriner running in the opposite direction and the sheet formed on this mini fourdriner was brought down along with the mini wire to be combined with the bottom layer by nipping the two wires together below an open wire driving roll. This configuration was to a large extent made fesible by the development of the plastic forming fabric.

At that time nearly all linerboard produced in Europe was made on fourdrinier machines with secondary headboxes and the two play formed liner showed much improved test characteristics, for burst index up to 25% increase and for ring crush up to 15% increase.

In addition the improved formation of the top layer gave a finer surface for printing which had begun to become important as the demand for high quality printed containers increased. In addition mills who addapted the two ply forming principle to existing machines found they were able to increase production due to a better formed stronger web, which lead to better runability through the press section and the smoother web was easier to dry in the dry ing section.

We should now examine the reasons for these improvements. Clearly a web formed at low headbox consistency on a top wire will have better formation than a sheet formed upon an existing web where drainage is difficult to control and the top layer will magnify imperfections on the surface of the underlying web. The consistency in the conventional secondary headbox must be maintained high due to the limited drainage capacity available after the box, even though the retention in this case will approach 100% for the top layer.

Low consistency forming on the other hand, as is the case on a mini top wire, enables the web to be formed better and much more uniformly and with the standard fourdrinier drainage elements, the micro turbulance in the forming zone, the drag rush ratio between the jet and the wire speed and the time in which the web formation is frozen, can all be adjusted to alter the MD/CD ratio and other characteristics of the final sheet to give optimal values for bursting and tensile strength as well as stiffness.

Multi ply sheets, because they are thinner than a single web of the same basis weight, will have many more fibers orientated in the horizontal plane of the web, with less fibers in the vertical or "Z" direction. It is the fibers running in the machine direction and cross machine direction which contribute most to the tensile, burst and stiffness properties of the sheet. In a homogeneous thick sheet, there is a greater tendency for the fibers to align themselves in the "Z" direction and this is also true for composite webs formed with a secondary headbox, where the washing action of the covering layer draining throu gh the base sheet aligns some fibres in the "Z" direction.

It is also a fact that the more plies making up a web the better will be the tensile and burst properties and thin webs have higher Burst Index figures. However, the more plies in a sheet, the lower the international bonding of the plies. With the two-wire arrangement used for liner where the top sides of the webs are combined together, the plybond, when measured with he Scott plybond tester, will never be less than 90% of the intrnal bond of one of the gingle plies which is well within the test requirements. Plybond can however be a problem where more plies are involved. Ply bond is affected among other things by formation and fines retention on the surfaces to be bonded and these can be controlled on the fourdrinier wires to a large extent.

During the seventies, many mills modified existing machines by the addition of some type of top forming device such as the mini wire to take advantage of this new technology. The main advantages gained were:

1. The improved formation of both the top and base layers enabled a lighter weight top layer to be run, while maintaining the same coverage. Two ply formation has another advantage over the secondary headbox system and some other types of on top drainage devices in that the two plies are brought together in the plastic state and there is no intermixing of the stocks as is the case with a top or secondary box where impurities from the already set base layer are upset by the top jet and float upwards into the top layer.

   As most mills were using a high percentage of virgin fibre in the top or covering ply, this reduction in weight of the top ply meant a considerable reduction in vergin pulp costs.

2. With the mini top wire arrangement the available drainage capacity of the bottom wire table was increased, and the bottom web did not have to have as high a dry content at the point of combining as previously with the secondary headbox. This enabled heavier base ply basis weights to be run at lower consistencies than with the traditional system, with consequent improvement in formation.

3. The improved sheet properties such as ring crush and mullen obtained with the two ply configuration enabled many mills to reduce the total percentage of virgin fibre in the sheet and at the same time to use a lower quality waste furnish in the base sheet while maintaining the all important test characteristics.

4. Where previously the size press had to be used to reach the mullen test requirements (size presses give 12-15% increase in mullen in general), it was now possible to exceed the previous results without the size press, thus increasing by 25-30% the drying capacity, so that where previously the drying was a bottle neck machines could now run faster with considerable increases in output.

5. With the better formed and stronger web the runability of the press section much improved with less press breaks, leading also to higher felt life.

6. The improved formation and smoother surface of the top ply increased the evaporation rate in the drying sections. the moisture profile entering the dryers improved as wet streaks caused by the snaking and skating of the secondary headbox stock jet on the already formed base web were eliminated. The smoother top surface brought the web in closer contact with the bottom dryer surface and it was not longer necesary to overdry in order to eliminate web stock increases in evaporation of from 8 to 13% were reported.

7. The improved off the wire moisture profile improved the out of press profile, and enabled the dryness off the last press to e inceased.

8. Improved printablity of white top liner was achieved and can be further improved as also can the coverage, by adding a small percentage of clay filler.

   With the mini top wire configuration, the back water circuts are separated so there is no risk of contamination of the furnish of one ply by the other.

9. Reduction in fourdrinier drive load was reported due to the reduced wire drag as the fourdrinier no longer required high vacuums to dewater the sheet. Total drive load was reduced in some cases to 70% of the previously required.

10. The reduction in wire drag, particularly on machines with polyethylene drainage element covers, meant a considerable improvement in the base wire life.

With the big gain in mullen, and a similar increase in ring crush properties when using the same furnish as previously used with the secondary headbox formed sheet, the two ply forming principle is here to stay. In the future we forsee a growing need to increase again the amount of secondary of recirculated waste fiber used for the production of containers and packaging, while at the same time the quality of available waste paper continues to deteriorate. In addition, the current trend in packaging and marketing will require improved printing characteristics for many grades, particularly with white top board for the flexographic printing process. Conventional linerboard machines with their secondary headboxes will be unable to meet this demand, two ply formation however, can and will continue to meet the ever increasing demand for first class liner and test li ner produced from cheaper and poorer quality raw materials.