Modifications to paper machines and approach flow system to improve performance :

DATHATHREYA C.T.*, DUKANIA M.P.**

ABSTRACT :

This article deals with some of the important aspects of approach flow and paper machine modifications with a view to improve their performance. The areas discussed are Head box, wirepart, effectiveness of shake and Dandy, hydrofoils, vacuum augmented foils, approach flow system, press section, Dryer section and calendering. The information given on modifications are based on literature cited under references. Improvements in quality and or production achieved at SPM after some modifications are mentioned.

INTRODUCTION :

The Scenario in Pulp and Paper Industry is changing similar to other Industries. With ever increasing cost of inputs and increasing demand by the customers for quality products, only those industries which are dynamic, can meet the challenges and survive. From the foregoing it is apparent that the thrust should be to maximize the ratio Q where Q stands for quality and C for cost. To put it in other words, C the cost has to be reduced at the required quality level or a better quality should be achieved at a particular cost level so that realization is increased.

To achieve the above objective, it is necessary to consider the following option depending on the circumstances.

(i) Updating Technology (This includes computerization)—This is a costly step and hence to be considered only when other steps have not yielded desired results.

(ii) Improving Instrumentations, especially in critical areas so that the process can be operated at optimum levels

(iii) Modifications to improve efficiency of equipment and ultimately the paper machine.

This article deals with aspects of Modification to improve the efficiency of Paper Machines (Fourdrinier). Before embarking on any modification, it is necessary to know the current performance.

Important data to be collected are (i) first pass retention (ii) check vacuum systems (iii) check dryer capabilities. Then these data are related to machine furnish and operating conditions based on current performance and experience on other similar grade machines.

The objectives of rebuild or modifications should be clearly spelled out such as improvements needed in quality and required production rates.

HEADBOX : The main function of a head-box is to deliver a uniform stock jet with well dispersed fibres. Many commercial head-boxes do not come up to the requirements of its main function because they deliver flocculated and streaky jets.

Hence improvements needed in this area include pressure forming, high early table turbulences, formation showers or serrated slices.

M/K systems Inc. recommends serrated slices or special formation showers combined with nondewatering formation board to optimize formation on slower speed machines.

+Technical Superintendent, **Chief Enginaer,
The Sirpur Paper Mills Limited, Sirpur-Kaghaznagar (A.P.)

It is normally necessary to set forming boar ds such that 5 to 15% of the stock jet is removed by the 1st blade. (This ensures minimum breast roll pumping in addition to avoidance of sheet sealing tendency and good retention).

FORMATION AND DRAINAGE : The initial part after forming board is critical to achieve formation, equalizing variations coming from head box and to remove water at a controlled rate for optimum paper making conditions on the fourdrinier table.

Phase 1 Entry	Phase 2 formation	Phase 3 Drainage	Phase 4 Transition zone	Phase 5
Slice & formation board	Proper spacing of Drainage elements for good turbulence	Incresing drainage	Vacuum augmented drainage	High differential pressure

Though table rolls are still used on many machines (This is the case especially in India in mills with older machines) the present trend is to use foils and vacuum foils for low grammage paper. Table rolls are recommended especially for Liner board machines.

Richard A. Reese has the following guidlines to offer (1) :

(a) In the forming zone, wider blade spacings increase drainage per blade and decrease turbulence.

(b) Uniform blade spacings at the wet end improve turbulence and optimize formation.

(c) Increased blade spacings reduce stock jump.

(d) Blade width and spacings influence scale of turbulence.

(e) Mixing high and low angle foils can optimize turbulence.

(f) At the dry end, closer blade spacings increase drainage per blade (Please see Fig. 1)

(g) Use vacuum augmented foils at the dry end of the tabte to provide a transition before head boxes.

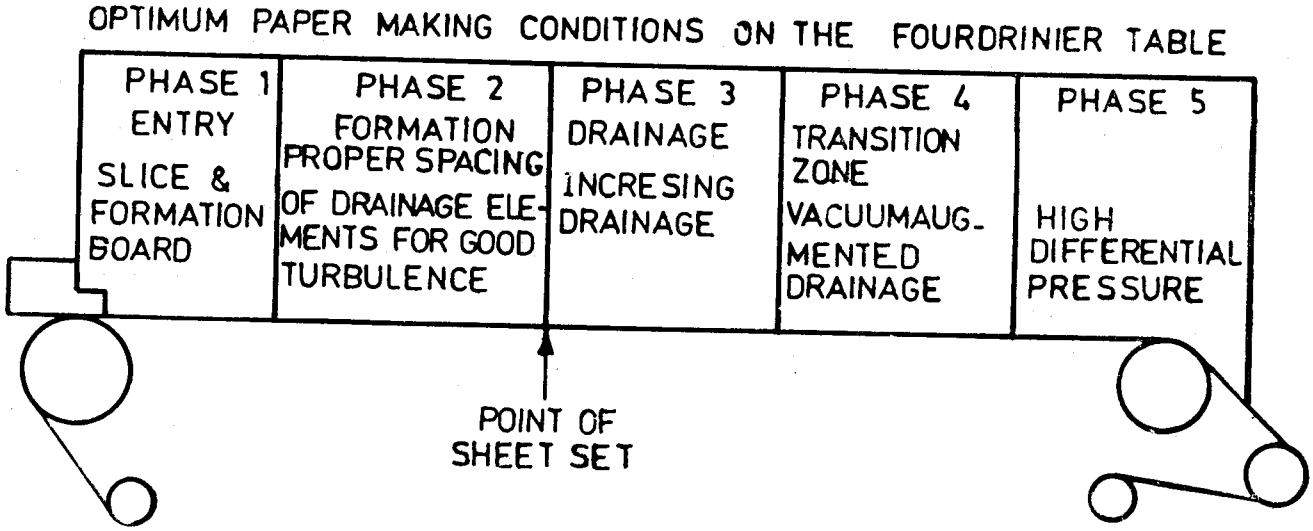

FIG. 1

(h) Grind polyethylene blades when half of their width is flat.

(i) Use ceramic blades for constant turbulence and dewatering conditions.

Also drainage, pulse duration and drag load are affected by blade width. Drainage pulse magnitude increases with blade width on the wet end of the table. A wide blade with lower angle produces the same drainage pulse as a narrow blade with a higher angle It should also be noted that wider blades cost more and have higher drag.

Experience and observations indicate that the guidelines for spacing of foil blades at the wet end table are that it should be around 1 cm for each 12 m/min. speed with maximum spacing of 35 to 38 cm.

However, for multigrade machines operating with wide range of speeds. the foils are installed considering lowest speed and as speeds increase, some of the blades are removed.

Fourdrinier shake helps in improving formation, especially at lower speeds and the effectiveness of shake decreasing with increasing speed.

The following relationship is given in reference(1)

Shake Number $= \frac{(\text{Amplitude})\ (\text{frequency})^2}{\text{Machine speed}}$ where

Amplitude is in mm, Frequency in strokes per minute, and Machine speed in m/min. Sheet formation increases as shake number increases upto 2500 per minute.

In SPM by installing foils in place of table rolls in our Machine No. 4, we are in a position to achieve same quality and production with less refining. Refining used to be a constraint earlier to achieve quality and quantity.

VACUUM AUGMENTED FOILS : Here the drainage compartment is sealed from the atmosphere to enable to apply an external source of vacuum. In view of the application of external source of vacuum, the forces which come into play are (i) foil-generated vacuum (ii) Vacuum from external source. Sheet dryness achieved ranges from 5% to 8% as against ordinary foil values of 2%-3%. Because of this, lower head box consis tences can be maintained.

Typical types of foils are AEs Unfoils, Johnson orthoflow units and Huyck formex.

DANDY ROLL :

Reference (1) gives the following guidelines for Dandy roll applications.

(a) Unsupported area equivalent to roll diameter

(b) One-third of open area upstream

(c) Speed 0.5% to 1% faster than wire

(d) Depress fabric 6.5 to 19 mm–adjust for grammage changes

(e) Sheet consistency 2.5% to 3.5% entering dandy

(f) 150 to 200 rpm at wire speed

(g) Internal shower : 0 33 inch (8.4 mm) Needle nozzles 1.5-2.0 inch (38-to 51 mm) centres, 3 inch (76 mm) oscillation, 140-250 psi water pressure (0 96 to 1 72 MPa)

(h) Internal save all pan

(i) Clean with alkaline solution

Under proper conditions, dandy can improve formation considerably. It is important to select suitable diameter so that it runs in the recommended rpm range.

FLAT BOXES : If 8% to 10% consistency is achieved after vacuum augmented flat boxes, the drag on flat boxes can be reduced. Cermic flats will help to reduce drag and air leak. Vacuum should be increased gradually from wet to dry positions with control for each box for optimum operation.

LUMP BREAKER ROLLS : They can help to reduce moisture of sheet off the couch.

GUIDELINES FOR CHANGES

(i) TABLE LENGTH : If rebuilds are made with a view to increase machine speed, higher dewatering capacity has to be build. The thumb rule for this is that the table should be long enough so that it takes the stock at least one second to travel from the slice to the 1st flat box on most paper grades.

From the above discussions, it is clear that the primary factors to be considered are (i) Furnish (ii) Formation (iii) Production (iv) Fabric. There should be flexibility to change blade angles of the foils.

APPROACH FLOW SYSTEM : In the above

paragraphs we have discussed the wet end system for improvements. However it is necessary to ensure that the approach flow system is designed properly to ensure stability.

Scott pantales (2) has described some of the important areas which need proper design to control Long term and short term variations.

LONG TERM VARIATIONS CONTROL :

(i) Proper design of pipe line which feed stuff into the flow box and the pipe line from flow box to fan pump suction and the flow box itself.

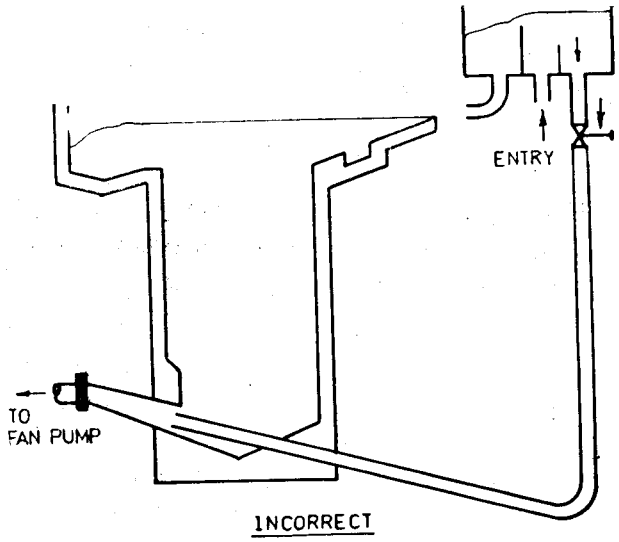

FIG. 2

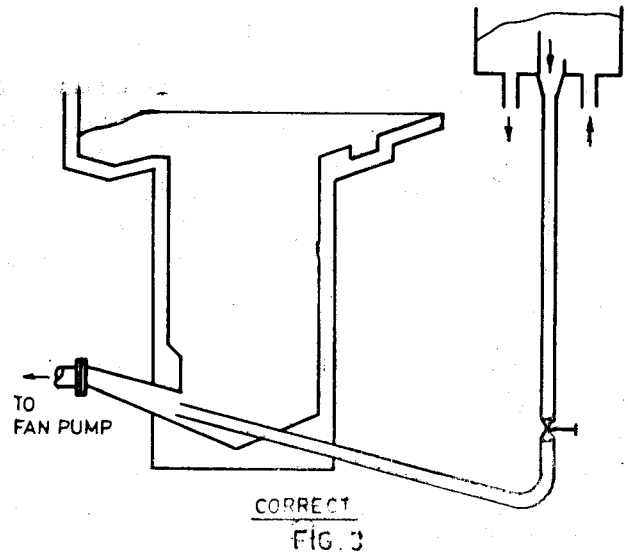

FIG. 3

(2) ,Heavy stock should enter axially into the suction of the Fan pump. Alternatively it may enter at a 45° angle to the direction of flow. (Fig 4).

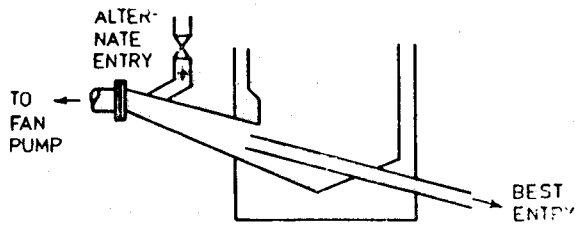

FIG. 4

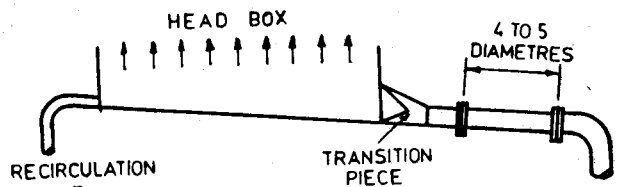

FIG. 5

(3) The section of pipe line before the head box should be straight with the tranition from circular to rectangular shape accomplished gradually Fig 5.

(4) AIR ENTRAINMENT : This is one of the principal causes of instabilities leading to pressure variations, MD grammage variations, Slime and dirt spots, foaming and pin holes. To eliminate this problem it is necessary to

(a) find and eliminate source of air entrainment

(b) Remaining air to be conveyed in a manner that is least detrimental

(c) Expell air at convenient point, Generally the sources of air are **water falls** and **vortices**.

COMMON WATER FALLS ARE ;

(a) Full lines to the chest that do not have the discharge submerged

(b) Weir overflow baffles or gates where the level drop downstream of the devise is excessive.

(c) Control valve located too high to provide full lines on the down stream side

(d) Fourdrinier drainage devises such as table rolls, foils, save all down spouts and suction box separators.

VORTICES :

Commonly found over the discharge outlets of chests, stuff boxes and wire pits. This is the results of outlet being insufficiently submerged below the liquid surface (Fig. 6)

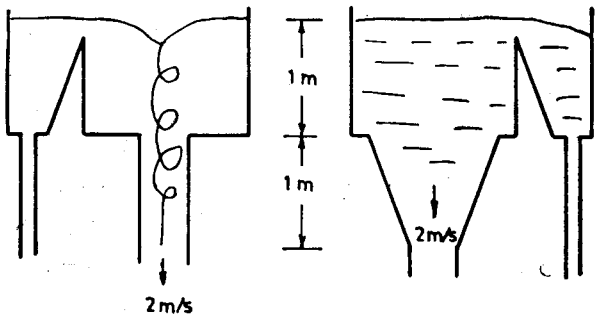

FIG. 6

However, as any air entrainment from fourdrinier elements is virtually impossible to eliminate, it becomes necessary to remove it subsequently. Other sources of air entrainment include violent agitation and low levels in an agitated chest.

Inspite all care being excercised to prevent air entrainment as discussed above,, the stock will contain some residual free air and hence the system must be designed to minimize its effect.

Also it will be necessary to pitch the pipe lines carrying pulp suspensions, especially at low flow velocities, say less than 2.8 m/s. By this the air tends to move further instead of adhering which can be vented out (Fig. 7).

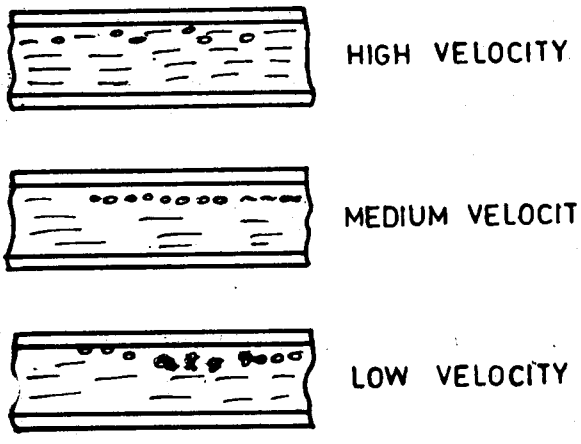

FIG.7

Ultimately Deculators can be used to reduce air to the minimum.

SHORT TERM VARIATIONS : It is necessary to have a suitably designed Fan pump and a suitable constant speed drive to prevent pulsations originating from this source.

It is to be noted that air padded head boxes can, to some extent dampen pulsations which is not possible with hydraulic head boxes but can be effective only at 5 HZ frequency.

Diaphragm type attenuators can dampen pulses in the range of 0.15 to 40 HZ and are suitable for hydraulic head boxes.

CLEANLINESS : It is necessary to have a clean system to prevent slime growth etc. Proper pipeline velocities help dispersion of fibres and also promote cleanliness in pipe lines.

MATERIAL OF CONSTRUCTION OF PIPE LINES :

It is obvious that noncorrosive materials such as SS are used.

FLANGE JOINTS : Improperly made flange joints can be source of trouble especially when pocket are formed by using improperly sized flanges. Hence it is essential that flanges should be concentric with the inside pipe dia.

Metal-to-Metal flanges are preferable between pressure screen and head box to prevent lump or string formation.

PIPE INTERIORS : All pipe interiors surfaces and welds should be polished.

VENTS AND DRAINS : As discussed earlier, an upward inclination is necessary and the high points have to be vented and at low points drains have to be provided.

PIPE REDUCERS AND PIPE EXPANDERS

It is necessary to make them with non-symmetric conic sections to prevent pocket formation. (Fig 8 and 9).

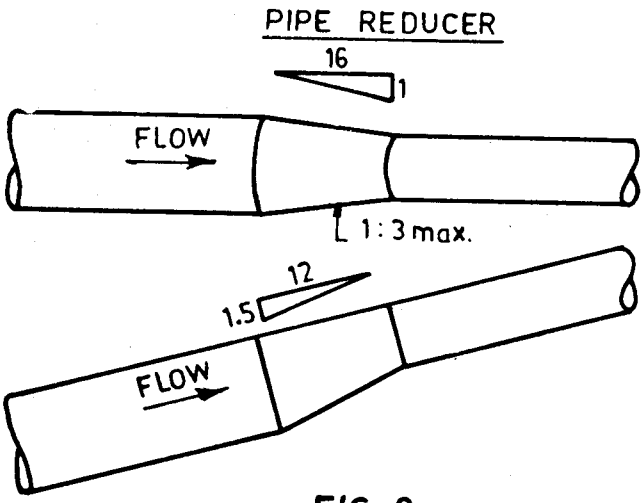

FIG. 8

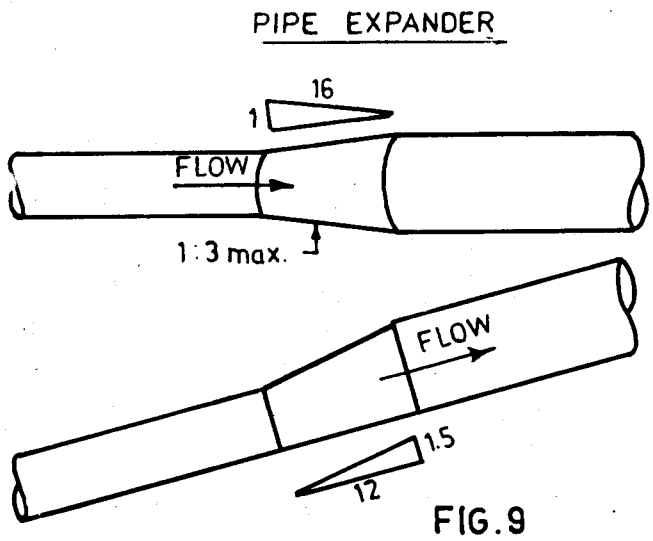

FIG.9

PRESS SECTION : There has been tremendous development in this area namely (i) Double felting (ii) wide nip presses such as Beloit extended nip press, Voith Flexonip Press and Escher-Wyss Intensa-s press (iii) Wide nip roll presses developed by KMW, Tampella, Voith Escherwyss and Er-We-Pa (iv) Hot pressing. The objective of all these are same that the sheet leaving the press should have higher solids content. Any improvement in dryness will have beneficial effect in terms of reduced steam requirement of drying.

Double Felting is a simpler modification. In a flow-determined nip (webs with higher grammage, higher water content and high degree beating), the flow resistance through the sheet is the decisive factor. To ensure that the web does not get crushed and also maximum dryness is achieved, to most obvious method available is to increase press residence time. This can be done by (a) using bigger dia rolls (b) reducing machine speed (c) double felting (3).

One additional benefit of double felting is that the direction of flow of water is duplicated i.e , double the transverse flow area and the flow distance is halved.

Paper quality benefits achieved are that optimum dry content is obtained in fewer presses and hence retention of better bulk. Two sided dewatering also entails move equal finish on both sides.

In SPM after installation of double felts for the Ist press we have consistently achieved the following results.

Machine No. 1 : We used to get oil penetration value for unbleached absorbent kraft widely varying for top and wire side. After conversion to double felting the oil penetration value for Top and wire side are much closer and also the surfaces.

Machine No. 3 : We used to face regular press picking problem and poor runnability even with low ash levels (8-10%)for creamwove and coloured printing varieties. After conversion to double felting, the press picking problem is considerably reduced and we are in a position to load the paper between 14-18% ash level.

Machine No.6 : We manufacture Duplex and Triplex board varieties from 220 to 550 g/m^2. Before Installation of double felt press, we used to face sheet crushing problem and reduced production as we had to run the machine at lower speeds. With double felting we have eliminated sheet crushing problem and we have speeded up the machine to regularly achieve higher production without in any way sacrificing quality.

DRYER SECTION : For those mills which do not have a casecade system, better to go for it. This will help in reducing steam consumption.

Considering the relative cost of water removal of (i) Fourdrinier wire part (ii) Press section (iii) Dryer Section, it is observed that it is approximately in the ratio 1 : 40 : 800 (4). Hence any improvement to reduce water entering the dryer section would reduce the

cost considerably. However, there is a limit to this. In view of this it is necessary to ensure that the dryer section is performing at its optimum level.

To use steam optimally, cascade system with well designed condensate removal, air removal system should be installed and have to be controlled.

In addition, PV system and its operation with controlled exhaust air humidities will improve the performance of Dryer section.

CALENDERING : It is also necessary to maintain and operate calender at top performance. In addition to have suitable crowning, their performance can be improved by installing and operating cold air jet system.

Installation of more developed versions of calender namely,

(i) Kusters Swimming roll
(ii) Nipco rolls or Kusters Hydrovario rolls

will help in more uniform calendering and getting uniform rolls of paper.

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