Effective use of clothing—Paper maker's contribution

MUKESH KUMAR, RAGHAVAN, N. R. V., DUTTA TAPAS*

The escalating costs of clothing have placed tremendous pressure on paper makers to obtain additional tonnage from existing clothing.

Paper Machine clothing on all three sections, i.e., wire or forming, press and dryer part has a much greater impact on machine productivity and efficiency than most people realize. The need for optimizing the performance has never been greater than it is today. Clothing of three sections are discussed separately in the paper.

FORMING OR WIRE PART

Wire/fabric cost has become an important factor in contributing towards the increased cost of production. Besides some abnormal factors, various possible mechanical and chemical factors that influence the wire life are:—

i) Corrosion (in case of metallic wires)
ii) Machine drag
iii) Slippage
iv) Abrasiveness of fillers
v) Poor condition/alignment of rolls
vi) Improper cleaning of wire/fabric etc.

Corrosion : The factors that affect corrosion of wire in papermaking are :—

i) Acidity, i.e. pH of stock
ii) Temperature of stock
iii) Air saturation

Corrosion which normally occurs on paper machine wires may be due to direct chemical action between acid and metal or galvanic action or dezinckification or combination of these. The most corrosive material in any pulp stock is the residual bleach. If it is an oxidizing bleach like hydrogen peroxide or reducing bleach like sodium hydrosulphite still it has a very strong corrosion effect on the wire.

To minimize the effect of corrosion, the pH of the stock should be as high as possible and temperature of stock and air impigement should be minimum. The problem of corrosion can also be solved by using proper corrosion inhibiter.

Machine Drag : The drag of machine is the combination of all those factors which have breaking effect on wire/fabric. Total machine drag is sum of drags caused by flat boxes, foils, forming board and other components coming in touch with wire/fabric. Major contribution to total machine drag is from flat boxes. Therefore, consideration of flat boxes is of utmost importance while studying the effect of machine drag on wire/fabric wear. Excessive machine drag is not only responsible for higher power consumption but also causes wear of wire/fabric. Flat boxes surface material (controlling factor for friction coefficient) vacuum applied and open area of boxes alongwith the pattern are of great importance. The drag load is clearly related to the water removal by flat boxes and any effort to reduce drag is hampered by the concurrent reduction in water removal. By continuous research and trial additional suction on boxes can be avoided. Besides improved performance and life of wire/fabric, power consumption can also be reduced.

To reduce drag load on flat boxes, following recommendations are made :

1. Remove as much water as possible by table rolls ahead of flat boxes and reduce the quantity of water removed by flat boxes (if space permits).
2. If capacity permits, allow the couch to remove more water by running the sheet wetter to it.

*The West Coast Paper Mills Limited,
Dandeli-581 362, Karnataka

3. Apply lower vacuum in flat boxes and have relatively more open area.

4. Choose flat boxes top cover material so as to have minimum friction between wire and cover of boxes.

Slippage : Too little tension as well as wrong type of roll covers are responsible for slippage between driving rolls and wire/fabric, which in turns leads to excessive wear of the wire/fabric and increased power consumption.

Soft rubber cover rolls having 10-15° P & J hardness are best bet to overcome the slippage problem. The tension on wire/fabric should be maintained at that which has been determined as suitable for machine. In most cases this is 5-7 kg/cm.

Correct power distribution between couch and forward drive roll is also important. The recommended power ratio between and forward drive roll are 50 : 50 to 40 : 60. This is necessary to keep the wire under tension. The recommended power input to the breast roll (for machines which apply power to breast roll also) is 10%. Power distribution is most critical on high speed machines and on machines running with high mesh synthetic fabric. Uneven power distribution may result in ridge formation in metallic wire.

Abrasiveness of fillers : Abrasive filler/furnish may be responsible for wire/fabric wear and potential life is basically governed by abrasion coming from rotating element on the inner side of forming medium. The abrasive properties of fillers should be thoroughly examined before use. Abrasiveness of fillers is not necessarily decided by particle size, particle shape is more important.

Fillers having an abrasive index between 20 Mg weight loss and 60 Mg. weight loss are found to obtain good life provided the other factors such as material of rotating element are controlled.

Fillers of 250 mesh and 350 mesh particle size were tested and 250 mesh type filler having abrasive index 50.5 Mg. weight loss was found more economic for Papriformer of WCPM.

Poor alignment/condition of wire/fabric return rolls :

Many faults like ripples edge wear/cracking creases are associated with poor alignment/condition of return rolls which lead to poor runnability and wear.

Edge wear is a common phenomenon in case of synthetic fabrics. The reason for edge wear is believed to be a combination of edge curl in wire, tension difference and fibre coating at the ends of rolls. This can be overcome by reducing tension at edges and proper grinding of return rolls.

Edge cracking is phenomenon of metal wires. Strands crack and come apart in response to rapid flexing at the wire edges. To minimize or eliminate this condition edges can be relieved by various means including running at lower tension or using rolls with decreased end diameter. Edge cracking can also be reduced by using wire with plastic filled edges.

Improper cleaning of wire/fabric : Proper cleaning of wire/fabric is a must to keep wire performing efficiently.

a) **Cleaning metalic wire** : Continuous cleaning with fresh water knock off shower of 12 kg/cm² pressure is recommended. During machine shut wet end flushing with acid or alkali is helpful for more effective cleaning. Acid (maximum concentration 10%) and caustic (maximum concentration 7%) wash followed by thorough rinsing is recommended as very strong cleaners may attack the metal

b) **Cleaning forming fabric** : For fresh water cleaning high pressure showers of 40-60 Kg/cm² are recommended. Chemical cleaning is recommended for periodic machine shut. Various chemical cleaners which are in use are—

1) Alkali based, 2) Acid based, 3) Organic solvents.

Recommended concentration for caustic cleaning is 10% at room temperature and for acids is 10-12%. Proper care must be taken with sulphuric acid as when it is mixed with water lot of heat is evolved which may damage the fabric. Organic solvents (paraffin, benezene and alcohol etc.) are recommended for spot cleaning of especially difficult areas and small deposits of pitch.

Method of chemical application to be used is most important from economic point of view. Recommended method which allows the cleaners to have good contact time is to foam the cleaner prior to application and apply it as a spray form.

As discussed above cause of wire/fabric wear are many and "what is really happenning in machine" is difficult to find out. Proper study of machine conditions and diagnosis of discarded wire/fabric can help the paper makers in digging out the real cause responsible for particular wire/fabric wear. As soon as the wire/fabric is discarded prematurely paper makers should Check-up the following factors such as (i) weight loss which gives an idea whether corrosion has been responsible for wire removal (in case of metallic wire), ii) thickness profile across the width of wire which gives an idea whether at any particular point the friction of wire/fabric is because of some defect on table.

Life of paper machine wire/fabric is normally reported as number of days run. This method is somewhat confusing and does not give the clear picture. The wire/fabric life should also be reported in terms of revolution made by wire/fabric at the time of removal (since a wire/fabric would obviously not wear as long on high speed machine as on a similar machine with lower speed) and wire/fabric manufacturer should not be blamed always for shorter days run if wire/fabric has revolved for prescribed revolution.

Studies/Changes at WCPM

WCPM has three machines details of which are given in following table :

Machine	Type	Speed range	GSM range	Wire dimension
PM I	Fourdrinier MF	60 to 300 m/min.	40 to 150 gsm	30.150 × 3.575 M.
PM II	Fourdrinier MG	60 to 275 m/min.	40 to 250 gsm	30.150 × 3.575 M.
PM III	Papriformer (Twin wire machine)	400 to 500 m/min.	40 to 80 gsm	13.38 × 3.57 M.

Remarks:—Wet end of PM I & PM II are similar except PM I has pressurized headbox and PM II open headbox. Metal wires are used at PM I and PM II and synthetic fabrics at Papriformer.

Following changes have been done at PM I and PM II for better performance of wire :

1. Suction boxes top cover material has been changed from indigenous high density high molecular weight polyethylene to imported quality which is also high density polyethylene but having ultra high molecular weight (6000×10^3 to 7000×10^3). It is mixed with molybdenum disulphide and has 0.07 to 0.08 friction coefficient. After installation of these flat boxes tops which have not herring-bone pattern, improvement in wire life has been observed.
2. WCPM installed 12 kg/cm² water shower before first wire return roll to knock off the web before it reaches the first wire return roll. However due to highair turbulence the high pressure shower could not be operated successfully at all times.
3. Copper coated rolls have been replaced by rolls with F.R.P. coating.

After above changes significant improvement in performance and life of wires have been observed.

PM III

Problem of ripples and edge wearing were faced frequently in forming fabric used at Papriformer.

In one particular design of fabric used at bottom position ripples were observed in fabric after couch roll. During study it was observed that rippling effect was minimum at higher tension and when the tension reduced rippling increased slightly. This showed that with greater MD tensile loading the fabric stretched further due to yarn's inherent modules of elasticity. This stretch in effect opened up the fabric thereby reducing drainage resistance. It indicated that use of more open area might reduce the ripple problem. The fabric of more open area (open area was increased from 19.3% to 21%) was used and the ripple problem was greatly reduced. But this change had caused poor retention of fibers and filler and WCPM is trying hard to solve this problem.

The edge wear was also faced frequently at WCPM Papriformer.

A fabric discarded due to edge wear was sent to laboratory for study. The results are shown in graph I and II, As fig. II indicates that the wear across the body of fabric had been fairly constant with much heavier at edges. Fig. I shows the weft strength profile and this is very similar to cross machine thickness profile with much heavier at edges. Then it was concluded from above test that in the body of fabric there was still considerable amount of life but at the edges fabric was worn out. Frequent grinding of return rolls could solve the problem partly. This problem is still to be eliminated fully.

PRESS PART CLOTHING

Moisture removal efficiency of the press felts play an improtant role in the economy of paper production as pressing cost is very low compared to drying.

Before considering the factors which ifluence the performance of press felts, it is better to review the qualities of an ideal press felt. It should have :

1) Maximum dewatering ability from the web without crushing and with uniform distribution over the paper in the nip.

2) Capacity to impart a suitable surface finish to the sheet and should remain open for a sufficient period without getting clogged.

3) Sufficient rigidity to withstand mechanical stresses and its dimensional stability should be good.

4) Ability to Equalize pressure distribution over void and land area of the roll to eliminate or reduce shadow marking caused by grooved or suction press roll.

5) Capacity to transfer the sheet from one position to another and act as power transmission belt, driving all undriven rolls in press section.

MAINTENANCE OF PRESS FELTS

Felts account for approximately 1.2% of paper and paperboard production costs. Even if it is possible to increase its life by 10% it will merely save 1-2 felts per year plus 2-5 hrs. downtime. Therefore, important requirement of a press felt is that it should enable the machine to run non-stop, with original dewatering capacity from the moment it is installed to the moment it is cut-off. 1% extra dryness after presses amounts to nearly 4% less thermal energy or similar gain in output by speeding up the machine, if drying is the limiting factor.

PLUGGING OF FELTS

Various factors which cause plugging of felts are—fillers, wood pitch, alum and rosin, pulp fines and debris from the felt itself. Paper makers should check out ash and pitch content, permeability, percent weight loss and basis weight profiles of the felts and decide the exact cause of plugging.

SUCTION BOX DEWATERING

For suction box dewatering of press felts the following factors are of prime importance :

i) Type of felts
ii) Vacuum in suction box
iii) Suction area
iv) Water content
v) Machine speed

Increased dewatering is obtained if the vacuum is increased at fixed suction area or if suction area is increased at fixed vacuum. If air flow is fixed and the suction area is increased the vacuum will go down and dewatering of felt is reduced. As a general rule any vacuum below 150 mm Hg. is likely to cause wet streaks. The lowest advisable vacuum is 250 mm Hg.

Recommended air flows at operating vacuum through felts with different permeabilities at different speeds are available in literature. These can be used as a guide to arrive at the balance of slot width, pressure drop and air flow required to do the specified work of dewatering. Generally the specific air flow rates that are available in literature are measured in terms of standard air volume but these must be converted to rarefied air volume when sizing vacuum pumps.

A slot width of 10 mm is sufficient for dewatering at acceptable air requirement and at the same time there is usually no risk for plugging of slot. Felt wear is also less if felt is not sucked down into the slot. When a greater open area is required it would be preferable to divide it into several slots of 10 mm width.

Studies/changes at WCPM

WCPM, in past 25 years, have changed from 100% woollen to 10% synthetic press felts due to their well known advantages.

Initially, after the change over, no improvement was noticed in the performance of felts, rather the runnability became poor. To detect the reason 'Scanpro tests' (moisture test) were carried out. Air flow levels were also checked and it was concluded that the air flow levels maintained in press felt boxes were inadequate for the type of felts being used. In most cases full width suction boxes were not taking out any water from the felts. After changing the vacuum pump capacities, performance of felts became very good and machine runnability greatly improved.

Few test results and changes made thereafter are discussed below :

SCANPRO TEST DETAIL—PAPER MACHINE I

Product	: Azurelaid, 70 gsm	
Speed	: 240 m/min.	
Press Details	**Ist press**	**2nd press**
Type	: Suction	Plain
Nip pressure	: 40.0 kg/cm	42.5 kg/cm
Suction (if any)	: 500 mm Hg. vacuum	—
Felt Details :		
Weight	: 1100 gsm	1200 gsm
Synthetic	: 100%	100%
Quality	: Hydroflow	Batt-on-mesh Kencomb 'A'
Felt conditioning		
Slot width × Slot length	: 12.0 × 3600 mm	12.0 × 3600 mm
No. of slots	: One	One
Vacuum running	: 260 mm Hg.	200 mm Hg.
Capacity of vacuum pump	: 26.3 M³/min.	$\frac{58.0 \text{ M}^3/\text{min.}}{2}$
Air flow (measured) Cfm/Sq. in. of open area	: 9.8	9.8
Air flow (theoritical) Cfm/Sq. in. of open area	: 13.09	14.4
Moisture to felt ratios (Showers in operation)		
After press and before conditioning equipment	: 1.03	0.86
After conditioning equipment	: 1.15	0.92
Moisture to felt ratios (Showers turned off)		
After press	: 1.08	0.86
After conditioning equipment	: 1.08	0.86

Conclusions and changes made after the test :

From above table it was clear that no water was being removed from the felts by suction boxes. Moreover the shower water being added to the felt prior to the suction box was also not being removed. Air flow level of 9.8 cfm/sq. in of open area was also very low for the type of felt running on machine.

Keeping in view the fact that the vacuum-pump should have a capacity nearly double the air flow required through the slot, WCPM installed new vacuum pump for Ist press felt box of capacity 58.0 m³/min. Similarly for 2nd press felt also capacity was increased from 29.0 m³/min. to 58.0 m³/min.

Although air flow levels were not checked again after the changes but a marked difference is observed in machine runnability and in the sheet dryness after the press.

SCANPRO TEST DETAIL—PAPER MACHINE 3

Product	:	White ptg. 60 gsm	
Speed	:	460 m/min.	
Press Details		**1st press**	**2nd press**
Type	:	Suction pick-up	Plain press with inner fabric
Nip pressure	:	70.0 kg/cm	63.0 kg/cm.
Vacuum (if suction)	:	Pickup zone 100 mm Hg. Dewatering zone 300 mm Hg.	—
Felt Details			
Weight	:	1400 gsm	1050
Synthetic	:	100%	50%
Quality	:	Batt-on-mesh	Weftless
Felt conditioning			
Slot width × Slot length	:	10.0×3600 mm	10.0×3600 mm
No. of slots	:	Two	Two
Vacuum	:	180 mm Hg.	300 mm Hg.
Wringer press			
Nip press	:	48 kg/cm	—
Vaccum	:	180 mm Hg.	
Capacity of vacuum pump connected to F. W. Box	:	60.0 m³/min.	50.8 m³/min.
Air flow in cfm/sq. in. of open area (theoritical)	:	20.18	16.9
Air flow in cfm/sq. in. of open area	:	11.0	3.5
Moisture to felt ratios			
After press	:	0.94	1.32
After conditioning equipments	:	0.84	1.36

Conclusions and changes made after the test

The suction box of first press felt was removing approximately 140 gsm of moisture. There fore its performance was quite satisfactoy. The moisture to felt ratio after press was not very high, which suggested that the press could be loaded further, However due to some other problems nip pressure could not be incressed than 70 Kg/cm.

At second press position it was obvious that the suction box was removing no water from the felt, Therfore following changes were made at This position—

1) Felt quality was changed from 50% synthetic weftless to 100% synthetic Batt-on-mesh. With the use of these combi felts elimination of inner fabrics was also possible, as they have built-in-fabric. This change in quality led to several other advantages also like—

a) Less wear of rubber press roll due to elimination of inner fabric.

b) Clothing life improved by 100 to 150% in comparison to 50% syntnetic weftless felts, thus reducing cost of clothing per tonne of paper.

c) Low inventory cost

Elimination of inner fabric adversely aftected moisture percentage in sheet at the inlet to dryness in the beginning. This problem was solved with improved felt designs. Sheet dryness at the inlet to dryers is at present in the range of 40-43%.

2) The vacuum pump running for felt box at this position was very old. Its capacity had considerably redueed, which was apparent from the air flow levels. Owing to the type of new felt, WCPM installed a new vacuum pump of capacity 119 m^3/min.

At this machine also, although air flow through slots and moisture profiles were not checked after the changes under similar conditions but the machine runnability has improved a lot and since than there is no problem to run any modern Batt-on-mesh felt in double or triple weave.

DRYER CLOTHING

The major factors which should be considered before selecting a dryer clothing are :

1) **Heat Degradation** : An important consideration while selecting a material for dryer clothing is degradation from moist and dry heat. Synthetic fibers show a distinct improvement over cotton and woollen fibers. Comparative figures of various materials are available in texts.

2) **Permeability** : Air permeability, an important property of dryer clothing is given in Table A, for different types of dryer felts and screens. With monofilament and multifilament dryer clothing, it is possible to achieve much higher permeability than with wool and cotton. Monofilament plastic fibres also provided the widest range of permeabilities, from 30 to 1000 cfm/ft2 at 0.5" of water pressure.

3) **Runnability** : To save the cost of clothing per tonne of paper produced, runnability of the clothing should be quite satisfactory. In general, the running life is considerably longer for synthetic fabrics than for wool and cotton dryer felts.

MODIFICATIONS AT WCPM

In order to improve the life of dryer felts and to bring down the cost of clothing WCPM has experimented with different felts and screens ranging from 100% wool/cotton to 100% synthetic. Many problems were faced when changing over to 100% synthetic dryer screens. By incorporating certain modifications on the m/c. the problems were overcome. The modifications were as follows :

1) **Guiding system** : WCPM had manual guides for controlling the play of felts. The dryer screens are more susceptible to play as compared to felts and it was not possible to control the cross direction movement with manual guides. Pneumatic autoguides were installed in place of manual guides. These guides are functioning quite satisfactorily and have resulted in reducing screen damage due to cross direction movement.

2) **Removal of Felt Dryers** : The felt dryers were removed from all those dryer groups where dryer screens were installed. This way the steam consumption for drying the felts was saved. Besides this WCPM was able to install a new dryer group in M/c. No. 1 by using the felt dryers, as well as by purchasing a few more. which resulted in increased capacity of M/c. No. 1.

3) **Introduction of Pocket Ventillation** : At the time of change over to dryer screens, pocket ventillation had not yet been introduced. It was found that due to hydrolysis, pitting corrosion occured on the felt rolls. After a careful study, it was decided to install Pocket ventillation with blow boxes for every dryer group. Moreover the felt rolls were given a coating of fiber reinforced plastic (FRP) to avoid corrosion.

ADVANTAGES ACHIEVED

1) By introducing dryer screens, along with the modifications in the m/c, the performance of of dryer screens was found to be quite satisfactory. The life of various felts used on M/c. 1 dryer groups in the last decade was studied and it showed that dryar screens performance has been magnificient compared to dryer felts.

The average life and production of dryer clothing at M/c. No. 1 in the last 8 years is given below :

Dryer Clothing	Average life in days	Average production in tonnes
100% cotton	264	14,980
12.5% Synthetic	498	31,407
100% Synthetic	844	54,252

From the above table it is seen that dryer screens gave an average life of 3 times that of 100% cotton and similarly the production was also more than 3 times.

Going into cost aspect, a dryer sureen is costing approximately double than that of cotton felt, whereas a life of 3 times is realized, besides less downtime saving in steam and better paper quality. In this way lower dryer fabric cost/tonne of paper has been achieved.

2) Improved moisture profiles and fewer sheet defects. Quality problem such as cockles have been reduced with the improved restraint of the sheet on the drying cylinders and more uniform air moisture profiles in the pocket.

3) A decrease in steam consumption has been achieved by the elimination of felt dryers or running at the same speed with better drying rates using less steam.

4) Increased production through higher m/c. speeds and less downtime for fabric changes.

5) Production time is increased through the elimination of paper wraps, as the sheet will not follow the screen.

6) Ability to clean screens on most positions has been a tremendous advantage. Original permeabilities are maintained allowing uniform continuous operation.

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TABLE—4. AIR PERMEABILITY OF DRYER CLOTHING

Dryer clothing type	Basis weight g/sqm.	Air permeability range m^3/sq.m-/hr. at 10 mm H_2O qauge.
Wool felts	2200 — 4000	20 — 50
Wool-synthetic felts	2000 — 3500	20 — 50
Cotton felts	1800 — 2500	5 — 20
Cotton synthetic asbestos felt	2000 — 2500	200 — 700
Needled felts	1500 — 2200	200 — 400
Batt-on-mesh felts	1200 — 1500	700 — 1000
Monofilament screens	700 — 1200	4000 — 13000
Multifilament screens	1000 — 1500	2000 — 10000
Fabrics of staple yarn	1500 — 2000	500 — 2000
Mono-multifilament fabrics (controlled permeability)	1000 — 1500	2000 — 6000