Cost Effectiveness Of Machine Clothing By Proper Selection & Optimisation-A Mill Experience

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ABSTRACT

Paper machine clothing includes forming fabrics, press felts, dryer fabrics & process belts. The basic function of the Forming fabric is to give better sheet formation, free from any wire marking and to remove the water from paper web. Press fabrics help to optimize the water transfer from the sheet and dryer fabrics support for effective drying of the sheet. Proper selection of fabric improves the runnabilty of paper machine resulting in higher productivity & also quality of paper. Modern fabric designs help in improvement in machine speed as well as operating efficiency. Clothing optimization by better conditioning & operation can provide significant savings in energy and improves productivity resulting higher production. We could increase the Speed of PM-2 by 115mpm & reduce the steam & power consumptions by selecting the right M/C clothing,. dewatering elements and proper conditioning of Fabrics. We take pride in mentioning that Emami runs fastest paper machine in the country at 1120mpm manufacturing 45gsm news print on 100% De-inking pulp.

Introduction:

New machine configuration, higher machine speed, growing use of short fibers and recycle fibers in furnish and shorter forming length of the machine increases the complexities of the fabric design.

Forming Fabrics:

The forming fabric is a woven, endless fabric through which it makes the sheet formation & then drains water. It gives the smooth support base for the fiber slurry flowing from the head box and also transfers the web from the head box to the press section. Water is drained through the fabric with the help of various dewatering elements. Single fabric fourdrinier section is common in older machines. In modern paper machines there are two separate forming fabrics working together either as gap former or as a hybrid former. Board machines usually consist of several fabrics for making different plies. Modern forming fabric designs can reduce energy consumption and can use higher consistency stock to give higher output with shorter wire length. Many revolutions in design and material have taken place in the recent past in the forming fabric from Phosphor bronze to 100% synthetic fabric from single layer to multilayers, from 4 shaft to 24 shaft and usage of finer yarns and higher fiber supporting index.

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Press Felts

The main function of press felt is to provide resilient, permeable support for the sheet in the press nip to maximize water removal. In the press nip water is removed from the sheet to the felt and carried water from the felt is removed by vacuum. Optimizing press section dewatering is very important to reduce the steam cost in the dryer. Modern press fabric designs include laminated multi-axial seamed, fabrics with special surface treatment and anti rewet designs. Laminated fabrics are made with combination of two or three base weaves. The advantages of using such type of felts are as follows.

1. Improved sheet moisture profile
2. Uniform nip pressure
3. Better compaction resistance
4. Better life

These properties maintain good water removal throughout their life with proper fabric conditioning.

Dryer Fabrics

The main function of the dryer fabric is to ensure even and efficient drying and to support the web in a paper machine as it passes through the dryer section. It ensures good thermal contact between the paper web and the dryer surface and maintain sufficient web tension at the machine and cross direction. It is well established that heat transfer from cylinder to sheet can be improved by raising the fabric tension, thus reducing steam consumption and increase the productivity. Modern dryer fabric designs provide energy benefits by improving sheet to dryer contact, improving air movement in dryer pockets and providing resistance to fabric filling.

Literature Review

Selection Criteria Of Former Fabrics

Forming fabrics are mainly selected on the basis of runnabilty & paper quality criteria.

Based on the above criteria, the final selection of former fabric is done. Type of raw material used and type of former is also considered while selecting former fabric.

Quality Of Paper

In case of writing & printing paper relatively long fibers are used

1) RUNNABILITY CRITERIA

I)	Dewatering	-	Drainage capacity & dewatering uniformity.
II)	Retention	-	First pass & Total retention
III)	Stability	-	Elasticity, Diagonal stability, Stiffness & Tension profile.
IV)	Power Load	-	Power requirement to run the former.
V)	Cleanliness	-	How well a fabric stays clean on the machine.
VI)	Wear	-	Wear potential & thickness maintained during the period of fabric run.

compared to news print. Therefore, the quality of fabric is different In case of furnish with more short fiber and fines (particularly for news print from recycled fibers), fabric with high yarn support points is selected. This is mainly to have reasonably good FPR & FPAR values and improved formation. Apart from this there are more criteria to be considered like open area, void volume, CFM etc. along with fabric support index for final selection of the fabric mesh suitable for particular furnish & machine configuration.

Type of Former Type of former along with furnish decide the conditions in which fabric run on different position. Important parameters are 1) No. of drainage elements 2) Type of drainage element 3) vacuum system 4) speed of the machine.

i) Fabric for fourdrinier and hybrid former

Commonly used fabrics are two and half layer & three layers. In case of news print & other grades, use of furnish which is not draining easily, low drag load is important requirement. Good cross direction stability is other requirement. A fast draining fabric with good retention characteristics, running stability is equally important. The distance between top & bottom fabrics must stay the same throughout the whole width. Fabric should stay clean.

ii) Gap Former

Gap former machines used to produce writing & printing or news print are high speed machines, which need strong support, fast and controlled drainage. Modern trend is to use Triple layer fabrics with 20 or 24 shaft design & fiber support index 140 to 200 depending on the furnish.

iii) Multi-fabrics formers

There are several Head Boxes which produce their own quality. Fabrics are required according to the demands given by each layer. Hence in such type of machines several forming structure can be found.

2)PAPER QUALITY CRITERIA

I)	Formation	-	Quality of formation
II)	Making	-	Topographic making of the yarn knuckles & drainage making.
III)	Fiber Bonding	-	Tensile & burst Index etc.
IV)	Particle Distribution	-	Filler & fines distribution in Z-direction
V)	Two sidedness	-	Difference of top & bottom side absorption & roughness of the paper.
VI)	Profile	-	Basis weight cross direction profile & 2 σ value

Final selection of the fabrics depends upon balance between runnabilty & paper quality.

Cleaning Of Forming Fabrics

Cleaning the forming fabrics during the paper machine run is usually done with continuously operating high pressure shower. However the substances present in the paper manufacturing process tend to adhere to the fabric causing the fabric pores to block partly or totally due to soiling. The soiling weakens the dewatering & causes local difference in de watering, as well as reduces the life of fabric, there by poor runnabilty of machine & paper quality. With usage of 100% de-inking pulp, stickies contamination increases the soiling. Quick swings in the process are usually harmful for example changes in pH cause agglomeration of colloid solid particles or raise in temperature increases the tendency of thermoplastic particles to attach the fiber. Use of anti soil chemicals will keep the wire clean. Some cationic chemicals form very thin, mono molecular layer on fabric surface, preventing stickies from attaching to the fabric. These chemicals will make some part of the soiling particles to go with the paper. In this way we can increase the life of fabric, reduce the down time & increase the productivity.

Selection Criteria Of Press Felts

Selection criteria of press felt depends upon its suitability for particular press position and running condition and type of each press section . Following are the main technical criteria.

Basis weight & Thickness- The basis weight & thickness of felt influences water handling capabilities, compressibility & dimensional stability.

Compressibility- The mechanical compressive properties of press felt affects nip width & peak pressure achieved within the press nip. High compressibility and low void volume press felt is mainly used on the last presses of high speed paper machines where fast startup is required. Compressibility decreases as felt life increases and becomes filled with contaminates. Sufficient void volume is critical when water load at the press nip is very high or hydraulic related problems such as crushing, shadow marking or vibration are present. For Pick up position felt with smooth texture and relatively higher CFM is the requirement.

Stiffness- The stiffness of press felt affects its installation. Very stiff felt is difficult to install in non cantilevered press position. The new machines press positions are cantilevered hence stiff felts are easier to install.

Air permeability and flow resistance

Air permeability measurement has been used for long period of time as a quality control tool in the press fabric mills. However there is seldom any correlation found between air permeability & machine performance. Therefore a better tool to evaluate the flow resistance of press felt in operating conditions, water permeability is to be measured under load. Scanpro Felt Perm has been developed to measure felts water permeability during the machine run. This service tool gives good information of how the felt changes over time. This will help to provide guidelines for scheduling felt cleaning or removal.

Surface uniformity

Felt with finer fibers in the batt surface produces a better sheet dewatering than with coarse fibers. However, too fine top batt reduces the felt life due to plugging and wear. Increased dewatering is partly attributed to better uniformity. It is mainly due to better capacity for retaining water in the pores of the felts.

Press Fabric Conditioning

Increased Use of recycled fiber, Stickies removal becomes a real problem in recycled paper mills. It has been observed from our practical experience that proper showering, vacuum application, use of warm water and on line chemical cleaning lead to better conditioning of the felts, there by increasing the productivity.

Selection Of Dryer Fabrics

Selection of fabric for each dryer position depends upon balance of fabric properties to achieve maximum life at optimum production rates and maintain runnabilty without adverse influence on the quality of paper. Fabric geometry can influence the drying rate and runnabilty of machine. Every fabric during the paper machine run carries a certain amount of air. The amount of air varies depending on the fabric structure. A large amount of air carried with the fabric in the dryer pocket area can influence the runnabilty of the machine. The most important fabric related factors are tension & surface of the fabric against the paper web. The surface structure of the fabric depend on two parameters 1) the no. of contact points/cm^2 and 2) the relative area of contact points. Fabric with high permeability gives higher drying rate but poor runnabilty due to paper fluttering & breaks. Fabric durability, dimension stability & structure stability are important factors because dryer fabric works as a drying element by supporting the web through the dryer section. Fabric wear is usually due to abrasive nature of filler particles in the furnish or bad condition of cylinder & roll surfaces. The weakest point is the seam. Hence seam uniformity has most important criteria in abrasion prone conditions.

Dryer Fabric Cleaning

Contamination due to use of 100% de-inking pulp will affect dryer fabric performance, there by paper machine performance. A combination of high pressure steam shower and chemicals will keep dryer fabrics permeability & surface clean enough to improve the life of fabric and productivity.

Mill Experience

Case Studies

Case Study No-1(Paper Machine-2)

Switch over of forming fabric from single layer to 2.5 layers & improvement in dewatering efficiency and cleaning of fabric.

PAPER M/C-2

TYPE OF M/C-> Fourdrinier
Quality-Writing printing & News print
M/c installed in 1996 (old M/c from Portugal)
Head Box-Hydraulic
M/c configuration-Bi-nip press, size press, dryer group, kuster calendar
Operating speed with single layer fabric-360mpm
Operating speed with 2.5 layer fabric-475mpm
Basis weight range-45, 48 g/m^2

Experience with single layer fabric-

Poor retention 50 to 55%, weak seam, more fabric elongation, prominent wire mark (8-shaft) and average life of fabric 60 days (1996 to1997)

Experience with 16-shaft 2.5 layer fabric with FSI - 125(Dec 1997 to onwards)

The retention has increased to 60 to 65%., Smoothness improved & Porosity reduced, no wire mark observed in paper, formation improved, retention aid chemical dosing reduced by 50%, slippage and elongation problem minimized and wire drag load reduced.

But it was experienced that drainage has reduced after 3months of running, hence quality along with formation was getting deteriorated and streaks observed in paper at the sped of 415/min.

Hence to address the problem wire table was modified by installation of Tri-vacuum, duo-flow and changed to ceramic top for foils and forming board from UHMWPE.

High pressure shower pressure was increased to 25kg/cm^2 from 12kg/cm^2.

All the above modifications helped in increasing the machine speed by 60mpm i.e. 475mpm.

Better formation, first pass retention further increased 65% & overall machine efficiency improved.

More noticeable improvement found on changing the wire design was to avoid paper creasing complaint at the user end.

Reduction in down time to 18hrs from 36hrs by switching over the wire from single layer to two and half layer (No of wire change reduced).

Production increased by 63.0T (Rate of production 3.5T/hr x 18hrs).

Case Study No-2 (Paper Machine- 2)

Improved Press fabric conditioning by giving more attention to proper showering, vacuum application, direct fabric heating & on line chemical cleaning

PAPER M/C No.-2

Quality of paper-News print
Furnish-ONP & Magazine
Press part- Bi-nip press (Suction pick up followed by center press roll & groove roll)
Nip load- 50 to 52 kg at pick up
78 to 80 kg at 2nd press

Previous experience on press fabric

M/C speed 475 mpm
Dryness after press - 39 to 40%
Steam consumption-2.0 Tons/T of paper
Power consumption - 470 KWH/T of paper.
Press zone vacuum -400 to 450 mm Hg
Uhle box vacuum-380 to 450 mm Hg at pick up & 400 to 450 mmHg at 2nd press
Uhle box slot width-8mm & 10mm at both the sections
High pressure shower- 10 to 15 kg/sq.cm at pick up (continuously) & 5 to 10 kg/sq.cm at 2nd press
(1 hour in a shift)

Pick up Press felt used-Double layer 3/4 plied twisted monofil at MD yarn & 4 plied twisted monofil at CMD yarn.
Batt distribution-Cross lapped cascade.
Material-100% synthetic polyamide, Air permeability-60 cfm, Caliper-3.2 mm, Basis weight -1350gm/sq.m
2nd press felt used-Double layer 4 plied twisted monofil at both MD & CMD yarn.
Batt distribution-Cross lapped cascade.
Basis weight -1450 gm/sq.m, Caliper-2.8 mm, Air permeability- 52 cfm
Due to 100% deinking furnish, press fabric got clogged very fast & has to be cleaned once or twice in a week.

Experience with improving vacuum application, proper showering, warm water showering & on line chemical cleaning

1. Warm water shower used just before the uhle box from top side of the fabric.
2. Uhle box slot width increased from 8mm to 10 mm & box diameter increased from 6 inches to 8 inches.
3. On-line chemical cleaning started.

Press zone vacuum-400 to 450 mm Hg, Holding zone vacuum-150 to 200 mmHg
Uhle box vacuum-350 to 400 mmHg
High pressure oscillating shower continuously running with 15 kg./sq. cm at pick up position & 5 to 8 kg/sq.cm at 2nd press.
Dryness after press increased to 42 to 43%
Power consumption reduced to

430KW/ton of paper & steam consumption reduced to 1.7 ton/ton of paper.

Cost implementation- To increase the dia. Of the uhle box, 4 nos. of new boxes purchased

Cost of 4 boxes-Rs 4.0 lacs.

Cost of online felt cleaning chemical-Rs 18/T of paper

Hence, cost of felt cleaning chemical - Rs 18/T *85 tons=Rs 1530/day =Rs 45,900/-month=5.5Lacs/Annum

Due to reduction in power, steam consumption, better cleaning & better run ability of M/C resulting improvement in productivity & quality of paper.

Cost benefit analysis:-

Cost of steam=Rs 500/Ton

Previous steam consumption-2.0 Tons/T of paper

Previous cost of steam for 85 tons production=Rs 85,000/day

Present steam consumption-1.7 T/ ton of paper

Hence present cost of steam for 85 tons of paper=Rs 72,250/day

Cost saving on steam=Rs 12,750/- day & Rs 3, 82,500/- month = 45.9lacs/Annum

Previous power consumption was 470 KW/ ton of paper

Cost of power=Rs 4.55/- unit

Hence for 85 tons of paper power required=39950KW/day

Cost of power for 85 tons=Rs 1, 81,772.50/day,

Present power consumption = 430 KWH/ ton of paper

Hence for 85 ton of paper power required =36550KW/day

Cost of power for 85tons=Rs 1, 66,302.50/day

Cost saving on power=Rs 15,470/- day and Rs-4, 64,100/- month,=55.7lac/Annum.

Total cost saving on power & steam=Rs-8, 46,600/ month

Total Cost saving in energy = 45.9+55.7lac=101.6lacs

Net saving in energy: - 101.6-5.5= 96.1 lacs/Annum (Excluding capital investment of Rs-4.0 Lacs)

Case Study No-3 (Paper Machine- 3)

Modification in fabric (Triple layer design)

Machine Details:

Type- Bel-Baie Horizontal Gap Former having tri-nip press & Soft nip calender

Product: News Print 45GSM
Furnish: 100% DIP
Machine Speed: 1120mpm
Deckle: 3.6Mt.

Production: 250TPD

Problem: Excess wire drag load while increasing machine speed.

After commissioning the paper machine at 750mpm, the speed of the paper machine was increased gradually and found the torque on both top & bottom wire was increasing gradually, this increased torque limited the machine speed going beyond 1050mpm due to frequent tripping on higher torque.

We have taken up this issue with wire manufacturers for suitable modification in the design to avoid higher torque.

The wire manufacturers suitably modified the design of both top & bottom fabrics with respect to yarn diameter, FSI, CFM which reduced the drag load without affecting the first pass retention and enabled to speed up the machine to present 1120mpm.

Conclusion

1. Modern machine clothing design & optimization can achieve significant improvements in machine speed, operating efficiency & gives non capital and low cost alternative for reducing energy consumption.
2. Modern forming fabric designs can give better formation, lower specific energy, better retention and better drainage.
3. Modern press fabric designs can improve the press loading & sheet dryness after press.
4. Modern dryer fabric designs provide energy benefits by improving sheet to dryer contact, air movement in dryer pocket & providing resistance to fabric filling and longer fabric life.
5. Effective conditioning & cleaning minimizes fabric wear, fabric filling & improve machine efficiency.
6. Proper selection of fabric plays an important role for steady operation of machine.
7. We could increase the PM-2 machine speed from 360 to 475mpm by changing single layer fabric to two and half layer Fabric with better drainage elements and proper conditioning of fabric. It has also improved the quality of paper, FPR and specially eliminated the creasing problem at user end.
8. Proper conditioning of PM-2 press fabrics helped to reduce steam and power consumption by 0.3Ton & 40KWH/T of paper respectively.
9. By suitable modification of forming fabric design with respect to yarn dia, FSI and CFM, we could increase the machine speed to 1120mpm and achieved higher speed above the design speed.

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