Modern paper machine clothing a help to energy conservation

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SUMMARY

While the Paper makers have been striving hard to cope with the raw material shortages, rising cost of pulp and paper making chemicals, souring cost of plant and machinery, the higher wages and overheads, the energy crisis, the energy prices have forced them to concentrate on the energy aspect more than any other single factor. As a matter of fact, today the paper maker is already under considerable tension due to prevailing extremely competitive market and obliged to improve the quality of his product, cut down on the basis weight of his regular product and still maintain the rigid specifications inspite of the poorer furnish substituting more expensive long fibered stock with short fibered hardwoods, agricultural residues and other inferior fiberous material. The ingenuity of the paper maker has no doubt enabled him to maintain the quality and quantity of product but the cost of production has still been adversly effeted.

In paper making the most interesting part of the whole process is that in the first instance stock is diluted to very low consistencies to form a sheet of paper and thereafter all efforts are made to remove the added water as quickly and economically as possible. Adding the water and removing of water both consume enormous amount of energy. The ideal solution to conserve energy would be to restrict addition of water initially and form a sheet at high consistency or use a dry forming process Both processes have had certain amount of success though still not perfected for the common grades of papers under consideration.

For the usual paper making practice, it will be interesting to note that on a paper machine cost of water removal and energy consumption increases at each succesive stage as the wet sheet of web progresses from wet end to dry end. Drainage on the wire is comparatively inexpensive, pressing out water at presses cost considerably more and evaporating water at dryers involves a major expenditure in the process of paper making as it initiates large consumption of energy in the form of steam coal and power. In normal practice evaporating water in dryers is 20 to 25 times more costly than removing water at the presses through mechanical means.

As a paper making thumb rule:

(a) Mechanical water removal is always cheaper than thermal water removal at dryers and (b) a 1% increase in sheet dryness leaving presses will either offer 4 to 5% saving in steam at dryers or alternatively enable identical increase in machine speed or paper production without change in energy consumption.

To emphasise the economic importance of even small gains in sheet dryness through improved pressing operations it will be perhaps more informative to illustrate through some examples.

Graph I gives some idea of the water which will have to be removed at the dryers per hour for a 100 T/day paper Machine taking extreme case of web leaving presses at 30% dry and 42% dry and paper reeled at 95% dryneess. The figures are absolutely stunning when considering the extreme cases where the difference of water removed is 3770 Kgs per hour which when computed in terms in of steam will work out to 5655 Kgs or almost a tonne of coal per hour. Taking more realistic figures, let us say web dryness improvement from 38% to 41%, it will be observed that there will be

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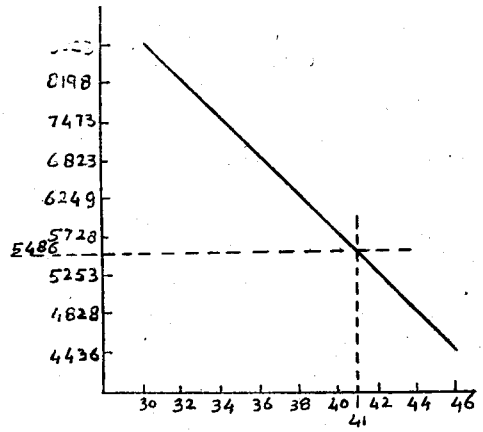
762.378 Kgs less water per hour to be evaporated at the dryers with consequent saving of 1143.5 Kgs steam per hour amounting to nearly 9056.5 tonnes of steam or 1580 tonnes of coal per annum. Just imagine the impact of saving on the profitability of your unit.



WATER REMOVED FOR 100 TPD PRODUCTION AT DIFFERENT SHEET DRYNESS PER HOUR.

GRAPH No. 1

With the present day energy prices, it is obvious that efforts to improve the sheet dryness leaving the press part will pay handsome dividends in the form of energy conservation and consequently the profitability of any unit.

The most important factors which contribute to higher sheet dryness leaving presses are sheet dryness entering press, press nip loading, dwell time in the nip distance water has to travel to reach the felt, felt construction and finally felt conditioning improving pressing efficiency thereby improving sheet dryness leaving presses and conserving energy.

Some of the factors indicated above project the press design criteria but we are more concerned here with the part played by the modern machine clothing and the part it plays in conserving energy.

Modern clothing design and construction aims at conserving energy through improved pressing efficiency. High synthetic press felt design employing the vertical flow principles approach very closely the basic rules for significantly improved pressing efficiency. Whitman gives these roles as:

1. Shorten the water flow distance in the nip.
2. Reduce the hydraulic pressure in the nip.
3. Improve the pressure distribution in the nip.
4. Optimize vertical flow.
5. Minimise sheet wetting.
6. Provide water receptacles.
7. Dewater the receptacles.
8. Keep the receptacles clean.

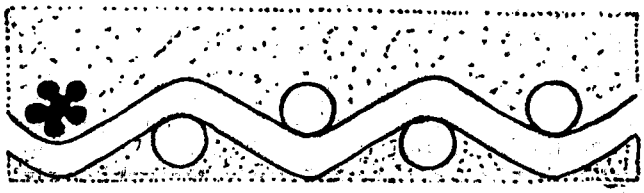
As far as machine clothing for the wet end is concerned, needled felts were the initial departure from the standard conventional felts which of course finally led to the development of more sophisticated and efficient high synthetic content wet felts. The development of modern design 100% synthetic felts were a sequel to better understanding of pressing theories and go a long way—to improve operating efficiencies and reduce production costs by curtailing press breaks and cut down on energy consumption by delivering a drier sheet of paper to paper machine dryers.

The modern high synthetic felt embodies vertical flow principles. The felt construction has the basic design consideration for high permeability, low flow resistance, low compaction, high void volume area with introduction of fine fibres on the paper side of the felt and fine/coarse fibres of different deniers in the body of the felt preventing rewetting, the cumulative effect of which is free water drainage within or through the felt preventing hydraulic transversal flow of water through the nip on account of the non-compacting large void in the felt. Use of plied monofilament in the warp and fine monofilament in weft have contributed greatly in preventing build up of clogging material in the felt. Extended felt life is the result of abrasion resistant non-clogging high synthetic felts.

Though batt-on-Base, weftless and non-woven felts are still quite popular. Yet recent inovation in wet felt designs have been the construction of felts with very high synthetic content of non-compressible Batt-on-mesh design in single, double and triple layers giving higher void volume area and resistance to compaction, a factor which aids in high water carrying capacity of felts for longer period and for greater operating efficiencies. Though every felt manufacturer has its own intricate felt design but the basic construction does not vary radically.

Single layer felt : Normally a Batt-on-mesh felt in single layer design having slight compressibility is desirable for plain presses. The bulge elasticity prevents rewetting of sheet in the outgoing nip. Mono or multi spun yarn or mono-plied mono filaments are used in the construction of single layer felts. The felt is also used on lickup/pickup and

board machines in basis weight range of 700 to 1000 gsm or more (Figure-1).

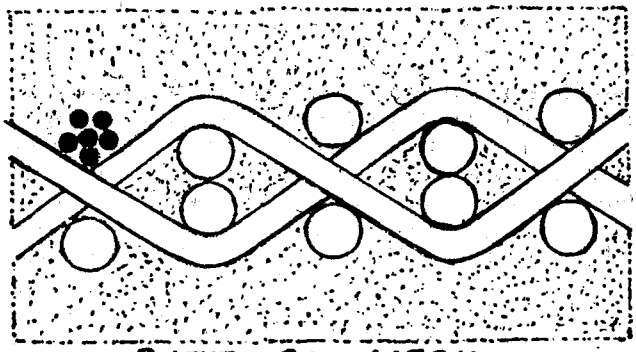


BATT-ON-MESH

SINGLE LAYER

Fig. 1

Double layer felt : Double layer felt is constructed by wett less construction for the top layer and Batt-on-mesh construction for the bottom layer combining the efficieney of the two distinctive features into one felt. The double layer felts are ideal for the suction and the venta nip presses and while imparting smoother finish to the paper help to overcome shadow marking problems (Figure-2).

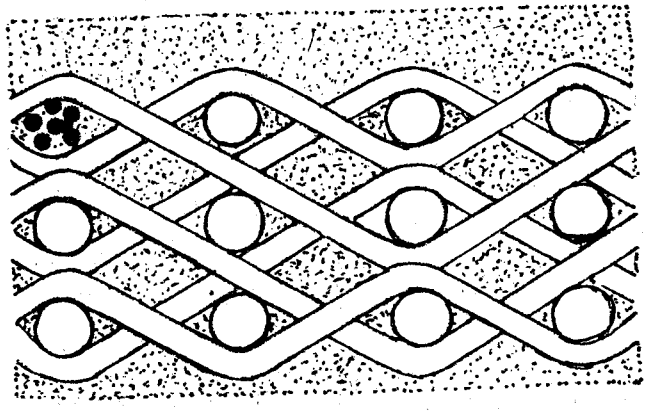


BATT-ON-MESH

DOUBLE LAYER

Fig. 2

Triple layer felt : Triple layer felts are constructed more or less in the same way as double layer felts but with three layers which have higher void volume area for lower hydraulic pressure build up in nip and greater water flow rates through the felt. These felts are more suited to double felted pressess, fabric presses without fabric and highly loaded venta nip presses. While the new felt designs have helped the paper makers to utilize the existing equipments to better advantage achieving improved operating efficiencies through greater water removal, conserving energy yet paper machinery manufacturers have been and still developing better press designs like the Double Felted Presses, Bi-Nip, Tri-Nip Press configurations with latest addition being the Beloits Extended Nip Press and KMW'S Hi-Impact press. Both these press designs require special felts with low abrasion quality having large pore volume, resistance to compaction under high nip loads, capability to minimise sheet re-wetting at the outgoing nip and ability of the felt to readily give up moisture at the felt conditioning tube (Figure-3).



BATT-ON-MESH

TRIPLE LAYER

Fig. 3

The success of both these presses is attributed to the very wide nip width 250 mm. and 100 mm. (High Dwell time in nip) and high linear pressure. Sheet dryness upto 45 to 46% have been attained on 450 Gsm sheets. So far, as is inherrent with all double felted presses, exceptional gains have not been attained on lighter basis weight sheets. However, the saving in steam recorded is as high as 25% and the inovations can be said to be excellent contributions to energy conservation.

Besides the additional water removal through the use of high synthetic content felts much greater life from these felts as compared to conventional felts normally offer operating efficiencies in the long run.

A thorough analysis and comparison of production records of the two qualities of the felts will very convincingly prove that initial reluctance of the paper maker to go in for higher synthetics felts,

just on ground of high initial cost is rather not correct. It will not be out of place to mention that the first step in improving sheet dryness leaving wire/press part is to improve web, dryness entering the Ist press itself. Couch presses with combination felt installed over suction couch have been reported to be giving very good results. But we feel that lump breakers rolls, when properly designed and operated give improved sheet dryness in the range of 1 to 3 percent.

FACTORS GOVERNING PRESS PERFORMANCE

For a given furnish basis weight, machine speed and felt construction, the press efficiency appears to be related to the following factors :

i) The applied pressure used to compress the paper and the felt.

ii) The length of time (Dwell time) the force is applied and allowed to act in the nip.

iii) The amount of water in the felt entering in the nip as well as the amount of water in the sheet as it approaches the nip.

iv) The distance for the water to travel in the nip.

v) and the felt design and construction.

All the innovations in press part configurations, improvement in wet felt designs still leaves about 50-52% moisture to be evaporated in the dryer section. This is a very large energy consuming area considering that for each Kg of water evaporated about 1.4 to 1.6 Kgs of steam is required. For a 100 tonne per day unit and at sheet leaving presses let us say 38% dry, the steam requirement would be around 9375 Kgs of steam per hour. Of course by improving in pressing efficiencies and raising the sheet dryness to 42% level about 16% of steam can be saved directly which means a saving of 1500 Kgs. of steam per hour. However, 7875 Kgs of steam has still to be used in the dryer section for the stipulated production.

To bring about the improvement it is necessary to optimize drying condition in the dryer part of a paper machine by :

a) Controlling sheet moisture profile uniformly entering dryers.

b) Steam inlet and condensate outlet control of dryers to ensure uniform dryer temperature.

c) Control of air condition surrounding dryers by means of hoods and pocket ventilation system.

d) Installation of suitable dryer clothing with suitable air permeability to accelerate water evaporation.

While control of sheet moisture profile is basically a function of the wire and press part yet rest of the above noted factors can be improved through manipulation and adjustment of the dryer section. Initially and as a first step towards improving the dryer efficiency the dryer drainage system should be checked and suitably modified. Steam control to dryers through thermo compressors is a major advance in the direction of energy conservation.

Dryer Screens : Of the many innovations in machine clothing designs, dryer screens or fabrics of varying air permeabilities are equally important. All synthetic open mesh screens constructed from mono or multi filament polyster nylon, fibre glass or teflon coated yarn and other material have air permebility in the rang of 500-14000 $Mtrs^3/M^2$/ per hour (30 to 860 cfm) to suit the various needs.

Dryer screens provide more uniform contact with dryers resulting in better heat transfer. Because of all synthetic material of construction moisture pick up by screen is practically nil so the condensation in fabric and subsequent re-evaporation is absent. High permebility of screens allowed better evaporation and more cooling of backside of sheet, temperature differential increases heat transfer favouring higher evaporation. All these favourable factors not only enhance evaporation but allow more uniform moisture profile during drying of sheet through dryers.

On the whole benefits derived from dryer screens can be summerised as (a) Increase production (b) Longer clothing life (c) Improved moisture profile (d) Reduced steam consumption (e) improved sheet quality.

Pocket ventilation : Till the advent of high permeability dryer screens, pocket ventilation system did not prove to be very efficient and effective for the simple reason that moving current across the width of the machine picked up moisture and the air could not find sufficient vent thereby resaturating the felt and the sheet. With the introduction of high permability screens, the position was changed and the moisture laden air could pass through highly permiable screen thereby increasing recirculation of air and consequently the evaporation rates improved.

During a past two decades or more improvement in the dryer section have been made as enume-

rated above, which have cumulatively increased the dryer efficiency by about 30% and pocket ventilating devices working in conjuction with dryer screens/ fabrics have contributed considerably to this.

The main advantages visualised are (a) Capacity increase between 10 to 15% (b) more uniform moisture profile, one percent higher moisture at reel contributes to 1% B. D. fiber saving (c) Steam savings upto 10% have been noted as with the system it is not necessary to overdry the edges and(d) shorter dryer fabric/screens can be used as the felt dryers can be by passed.

Machine Hood : Open and completely closed hoods are installed on the dryer part of the paper machines firstly to improve aesthetic aspect of the machine and secondly to prevent condensation from the ceiling as Saturated vapours deposit and condense on the roof trusses etc. rendering the working conditions unpleasant. Besides the above the vapours saturated in the pockets and relealses from the dryer felts have to be removed. Atleast 40% of fresh heated air of the exhaust volume has to be replenished to give a satisfactory working hood. Very little gain in drying capacity is atained with an open hood but completely closed give about 2% drying capacity gain

CONCLUSION

To economise on the process of paper making, efforts to be made to remove water faster particularly at the wet end of the paper machine, where it is more economical to remove, taking advantage of the modern wet end clothing which is now designed not only to allow higher sheet dryness leaving the press nip but also to give reasonably longer clothing life. Proper installation, operation and selection of wet and clothing will enable the paper maker to get higher paper tonnage per Kg. of felt and also conserve energy in the dryer part.

The introduction of high permeable dryer screen/fabrics contribute to cheaper water removalat the dryer end of the Paper Machine. Thermo compressers for control of steam to the dryer, introduction of pocket ventilation system and lower energy consumption which is and should be the aim of every paper maker.

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