Paper Machine Wet Felt Conditioning

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SUMMARY

Pressing is an important function in the process of paper making. Wet felts used in the press section of a paper machine do the dewatering job in a very economical manner. It is estimated that removal of water by drying costs ten times more compared with the cost of removal of water by pressing. The amount of water removal in pressing depends upon the quality and condition of wet felts used in the machine. Felts are costly replaceable items in a paper machine and the necessity to keep felts running for maximum period without affecting producion cannot be over-emphasized.

Even with a good quality felt, production can be considerably disrupted if the felts are not kept clean and conditioned to perform its multifarious functions. This paper deals with the functions of wet felts in dewatering, the factors affecting the filling up of the felt, various felt cleaning and conditioning systems in vogue and the precautions to be observed in adopting the cleaning and conditioning techniques.

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FUNCTION OF WET FELTS

The function of the wet felt as expressed by Wahlstrom and Wrist is to provide a structure, to which water from paper can flow in the ingoing part of the nip and, that will retain most of this water in the expanding part of the nip. In addition, felts must be able to uniformly distribute pressure over the paper and provide a soft nip with a controlled pressure pulse to give sufficient time for fluid flow. Felts, therefore, are a necessary intermediary between water repectacles of holes, wires or grooves and the paper. Only an elastic capillary structure as a felt is able to perform this function satisfactorily. The best felt should give a perfectly uniform pressure distribution, lowest possible flow resistance in the fluid flow region and a smallest possible rewetting in the outgoing part of the nip. As these properties are somewhat contradictory, the quality of the felt will become a compromise to get optimum conditions for each particular application.

The uniformity of pressure application is only dependent on characteristics of the felt and can be eliminated by utilizing modern felt technology. Mid nip dryness will be determined by the specific pressure applied in the nip, compressional characteristics of the mat and flow resistance in the system. Under given conditions, mid nip dryness can only be optimized by reducing flow resistance as far as possible. The first step is to reduce flow resistance in the felt as this adds to hydraulic forces resisting compression in the paper. This is being done by minimizing flow distance through the felt by employing transversal flow presses in which water receptacles are provided under the felt continuously through the nip. Secondly, by reducing flow through the felt which is done by running with dry felts. Thirdly, we can reduce flow resistance by changing the characteristics of the felt, and by operating at high temperatures. The key to good pressing is, therefore, reduction or elimination of resistance to flow outside the paper, i.e. in the felt.

As a general rule, presses should be run in such a way as to eliminate completely the effect of flow resistance by reducing felt moisture so that there is no flow in the felt. Felts with the lowest possible permeability should be used to reduce rewetting and to maintain flow resistance at a negligible level without effort in keeping the felt open. This involves optimizing felt cleaning systems, both through mechanical and continuous chemical cleaning.

With the evolution of high synthetic content needled wet felts, felts are seldom removed from the machine, because they are worn out. They are generally removed because they are filled or compacted to the point where they no longer handle water uniformly and lack the drainage capabilities to maintain a high level of pressing efficiency. The press felt in conjunction with a properly designed conditioning system plays an important role in the removal of water in the press nip. However good may be a felt, effective gains can only be made with a good upto date conditioning system, which cleans and flushes the felt uniformly, resist compaction of the felt yarn and provides optimum drainage in the press nip over long periods of time.

FACTORS AFFECTING FILLING UP OF FELT

In a broad sense all the raw materials and additives used in the paper making process are potential contaminants of a felt. The materials most commonly responsible for filling a felt can be divided into five main categories.

ALKALI SOLUBLES—Certain materials clogging the felt can be removed from a felt by dissolving in a strong alkaline solution. These are normally organic materials, such as lignin from wood pulp or furnish or from additives such as starch and rosin size.

PAPER FINES—Small particles of fibre that get trapped in the felt. Paper fines cannot be dissolved in any chemical that is safe to use on felts. They are best removed by the mechanical action of a high pressure water shower and suction box.

LOADING MATERIAL—Any loading material such as China clay, Soapstone powder, Sodiumcarbonate etc. used in furnish and present in the paper web are likely to leave behind some residue in the felt, during pressing. These loading materials which are adhering to the felt fibres will fill up the felt and reduce the porosity of the felt.

EXTRACTABLES—These fillers are resinous or polymeric materials, that are solvent solubles such as pitch, tar, asphalt, latex, ink etc.

WET STRENGTH RESINS—They are used to impart wet strength to a sheet of paper that will be exposed to high moisture conditions such as tissue, towel, etc. There are synthetic polymers of two general categories, acid set and neutral cure. The acid set are melamine and urea formaldehydes. The neutral cure resins are of different polymer forms, primarily polyamide.

FELT COMPACTION—Another reason by which a wet felt has to be discarded is felt compaction. The fillers act as adhesives and tend to stick the felt fibres together. This action together with the compressive action of the fibres in the press nip, results compaction of the felt. The rate of compaction is determined by felt construction, permeability, nip loading, machine speed, and type of furnish. At some stage, even though no adhesive of fibres are present most felts will ultimately compact to the point where drainage is retarded and pressing becomes inefficient.

FELT CLEANING SYSTEMS

The maximum life of felt is taken by keeping felt is good shape by providing felt conditioning. Conditioning can be done mechanically, chemically or by a combination of both. With the emphasis on greater use of reclaimed fibres, utilization of lower grade pulp, increased use of fillers, and the pressure to close up mill white water system to meet ecological demands, there is need for both types of conditioning systems. The basic construction and distribution of synthetic content in the felt largely determines the type of conditioning provided for the felt.

Modern needled felts containing a higher proportion of synthetic fibres has made it both necessary and possible to use more effective cleaning and conditioning equipment because of the following factors:

(a) The greater stiffness of needled felts reduces their self-cleaning capacity since there is less stretching and construction respectively before and after the driven rolls.

(b) Needled felts particularly batt-on-mesh felts with incompressible yarns, are cleaned purely by plain wringer presses.

(c) The strength of needled felts with high synthetic content permits a concentrated high pressure water jet to be used effectively.

(d) The open structure of needled felts provide effective dewatering in suction boxes.

By high synthetic content felt it is meant felts containing 50–75% synthetic fibres.

MECHANICAL FELT CLEANING

The most widely used mechanical contraptions to condition the felt are the wringer press, the vickery felt conditioner and the full width conditioning box. With the increase in machine speed and with the increased use of synthetic in felts, full width conditioner has come to be recognised as the only dependable mechanical conditioner. The full width conditioner keeps a felt clean by use of shower pipes used in the felt circuit. A typical felt circuit with full width felt conditioner is given in the attached sheet.

Types of showers used in felt conditioning are:

(a) Detergent showers
(b) High pressure shower
(c) Flooding and/or washing shower
(d) Lubricating shower

DETERGENT SHOWERS—The detergent showen should be located on the inside of the felt as early in the return run as possible to provide the longest dwell time for the detergent to act. Normally a full width stationary shower is used for detergents. They should be equipped with fan nozzles and should be able to deliver from 0.08 to 0.15 gallons per minute per inch of felt width. Pressure should be between 40 to 100 psi.

HIGH PRESSURE SHOWER—High pressure showers generally operate between 400 and 1000 psi. The shower should oscillate and would have a fail safe control to protect the felt if oscillation fails. Needle jet nozzles capable of delivering 0.19 gallons per minute per inch of felt width should be used. For best results showers should be located inside the felt near an outside supporting roll and before the suction box.

Mills installing high pressure showers should notify their felt suppliers since felt changes may be required. High pressure showers may damage low synthetic content clothing. Consequently it is necessary to use high synthetic clothing, if their full cleaning potential is to be obtained. Primary results from laboratory and field studies indicate that high pressure showers offer great promises for felt cleaning. When properly used they may extend the life of high synthetic press clothing significantly. When used with specially designed press clothing still greater benefits may be obtained.

Most high pressure showers are capable of operation at pressures nearly 1000 psi. Nowadays most of the mills operate these showers between 250 and 750 psi pressures as high at 1000 psi appear to be necessary in a limited number of cases. For practical purposes any shower operating over 100 psi is normally called a high pressure shower. It is important to realise, there is in fact no single pressure suitable for all felts and in all conditions. The most effective pressure for cleaning depends on several factors.

High pressure showers utilise hydraulic energy to work the fibres within the felt structure. In the process foreign material is removed and felt bulk and resiliency are restored. The pressure necessary to accomplish this in any particular situation, depends on felt design, machine speed and felt location as well as the type of nozzle used. These factors must be blended together for efficient high pressure shower cleaning. To combine them together is not simple. An index to indicate optimum shower pressure is the first requirement.

Shower pressure—If shower pressure is too low, good cleaning will not be obtained. If pressure is too high, felt may get damaged. The simplest index to use is that water should just penetrate the felt. Pressure should be adjusted until this point is reached. The felt should be running as the adjustments are made. Preferably pressure should be low initially and increased gradually until penetration occurs. Usually at low speeds water in the form of a spray or mist will emerge from the opposite side of the felt when pressure is correctly adjusted. At other times

with higher speeds, dense or older more filled felts spraying or mist may not appear.

Nozzles—The effect of good cleaning depends on the nozzles. Both needle and fan nozzles can be ussed effectively. For any given supply pressure, needle nozzle will penetrate and condition the felt more effectively because of the higher unit hydraulic pressure at the felt surface. The problem of felt damage is greater if carelessly used.

Location of showers— Felt cleaning showers should be mounted on a short felt run wherein the felt is well started. Otherwise the felt will be blown away from the nozzles with loss of the important impact cleaning effect. Normally the shower is mounted on the back side of the felt with the intention of pushing the contaminants back out of the paper to the paper surface side where they are removed by a suction box mounted a short distance after the shower. It is important that felt does not pass over a felt roll in contact with the paper side in the space between the high pressure shower and the suction box which could push the contaminants back into the felt. It may be of interest to note that contrary to the accepted theory in the case of heavy batt-on-mesh on combination felts, the cleaning is effected with an oscillating needle shower mounted on the paper side. The reason for this is because of the very thick unpenetrable mesh on the base of these felts. The jets are ineffective on the back side of the felt for forcing the dirt particles, whereas when used on the paper side the high pressure shower is able to dislodge the dirt (Refer paper February 6, 1978).

Felt Types— Cleaning with high pressure showers is not suitable for all felts. The impact of high pressure shower causes distortion and severe mechanical working on the felt. The same action may cause hair shedding and yarn damage that can reduce the felt life markedly. Generally high pressure showers should not be used on conventional felts and needled felts with less than 40% synthetic content. To get the best results the felt should be specifically designed for high pressure washing.

Though needled felts normally will have 40% synthetic fibre, the location of these synthetic fibres within the felt structure and the type of needling employed during manufacture are also important. If the synthetic fibres are properly placed in structure, resistance to wear will be further increased and will result in better felt life.

PRECAUTIONS TO BE OBSERVED FOR HIGH PRESSURE FELT CLEANING

(i) Use needled felts preferably with 40% or more of synthetic.

(ii) Use an oscillating shower with needle nozzles incorporating a fail safe oscillating device which shuts off the shower in case of oscillation failure.

(iii) Locate the shower on the back side of the felt.

(iv) Adjust the shower so that water just penetrates the felt. The pressure will depend on the type of felt, the extent of filling and the machine conditions. Start low, observe the results and increase or decrease the pressure as required.

(v) Determine cleaning frequency by trial and error. To start with, try 10 minutes showering per shift.

(vi) Follow the high pressure shower with a low pressure flooding shower to even out wet streaks.

(vii) Follow this shower with a full width straight slotted suction box on the face side of the felt.

(viii) Locate shower pipe 4" to 5" from the surface of the felt.

(ix) Use hot water upto 160°F if available.

FLOODING SHOWER—Flooding or washing showers have two functions To flush a large volume of water through the felt to remove the dirt and to provide uniform moisture, following a high pressure shower. Without the flooding shower, suction box dewatering tends to be uneven after the high pressure shower, resulting in water streaks causing poor sheet moisture profile.

LUBRICATING SHOWER—Lubricating showers are with fan nozzles and are used to ensure good seal lubrication at the suction box. They are low volume showers.

TEMPERATURE AND pH IN FELT CLEANING SHOWERS

Hotter the water used in felt showers, better the result. Hot water has a low viscosity and consequently it flows easier and water removal is better. In principle water temperature in excess of about 110° F should not be used since wool in felt will get degraded after long exposure to temperature higher than this. Hot water will not harm high synthetic clothing.

With the pH on the shower water controlled at the pH of the paper being made, there will be less filling up of the felts with less problem in keeping felts clean.

FULL WIDTH FELT CONDITIONER

Paper makers today are in general agreement, that a full width vacuum application in felt suction cleaning provides substantial benefit. Uniform water removal across the felt can condition the clothing to perform

its basic function of accepting water at a press nip or of uniform picking up and holding the sheet.

The full width suction box should be fixed on the paper side of the felt and a shower on the opposite side leading the box atleast by 6 ft. On high speed machines a greater lead distance between the shower and the box will allow more penetration time.

Increased benefits have resulted by modifying the full width application of vacuum by use of slots in a herring bone pattern. This pattern when properly angled to the machine direction flexes the felt weave on both conventional and needled felts. The flexing action dislodges mechanical inclusions (loadings) for easier flushing and cleaning. The design of the slots is such that the vacuum area is uniform for full felt width. Depending upon the width of the cover used, each segment of felt is flexed atleast twice on each pass providing mechanical loosening of included stock and impart a slight wringing action to promote flushing and conditioning.

Regarding vacuum requirements for the full width felt conditioner, a pump capacity of 3 cfm for each square inch of slotted area is recommended. Again this may vary with individual mill condition. When herringbone slotted covers have been used to replace a single slotted cover, the open area can increase from 60 to 100%, with the result the area of felt exposed is correspondingly increased permitting lower vacuum gauge readings to allow full and gentle flushing.

Metal covers should not be used on the boxes as the surface will develop hair line cracks with microscopic saw tooth edges. When this happens, felt wear is sudden and devastating. Two slotted covers appear more efficient because they use less air at a given vacuum to remove comparable amount of water from the fabric.

The normal vacuum level in a felt conditioner vacuum box will be around 4"-8" depending on the felt condition and characteristic.

The paper maker should keep a wary eye on the vacuum gauge fitted to the boxes, to assess the degree of filling up of press felts. The vacuum gradually builds up as the felt is getting filled up thus indicating reduced air flow and hence water removal.

It is preferable to connect the felt conditioner boxes separately to vacuum pumps to independently assess each press felt performance. It should be noted that combination felts require higher air flow (nearly twice) for removing water from the batt than conventional felts.

CHEMICAL FELT CONDITIONING

High synthetic press felts can be conditioned adequately in many cases by a properly designed mechanical system, but this does not eliminate the need for chemical cleaning. This can be done on a continuous, intermittent or on shutdown basis. Chemical cleaning is a supplement to mechanical cleaning. It is often necessary to have chemical cleaning to keep the felt in efficient operating condition.

An analysis of the furnish in conjunction with analysis of used felt samples will indicate what materials are filling the felt. Once these have been identified, chemical cleaners can be selected which will react with them in such a manner that they can be flushed or rinsed from the fabric.

CHEMICAL CLEANERS

Chemical cleaners generally contain a heavy duty detergent as a base to which a variety of builders, emulsifiers and solvents have been added. They are formulated to attack specific filling materials. Inhibitors are also added to minimize corrosion of any machine parts coming into contact with the solution. The three major detergents widely used are, acid, alkaline and solvent.

Acid detergents usually have a non-ionic detergent base with either muriatic, sulphuric, phosphoric or sulfamic acid as a builder. These are very effective in mills that have a high ash content in their furnish.

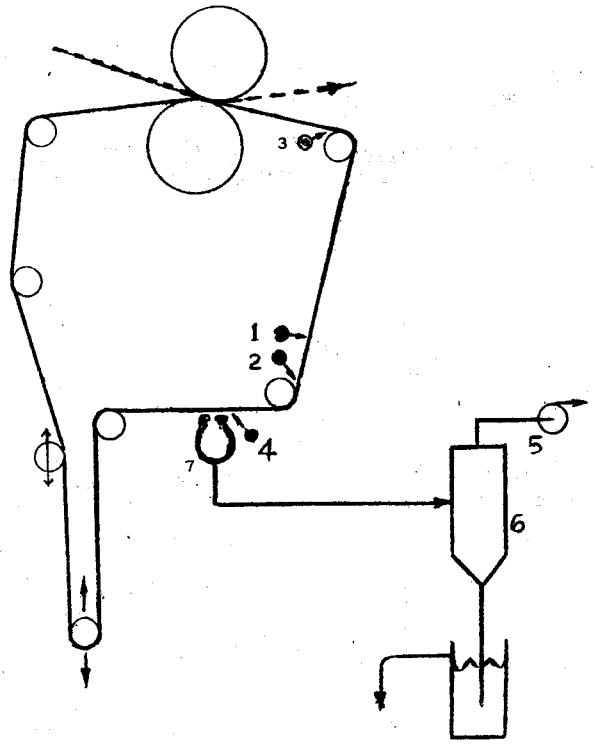
Alkaline detergents usually have a non-ionic detergent base but may be ionic to promote formulation stability. The builder may be a strong alkali, such as caustic soda or potassium hydroxide or a mild alkali like soda ash and potassium carbonate. They are effective in removing rosin, paper fines and alkaline soluble materials.

Solvent detergents have detergents and emulsifying agents mixed with a solvent. They are used primarily for removing heavy concentrations of resinous fillers found in mills which use poor grades of contaminated secondary fibre.

CHEMICAL FELT CLEANING

SHUT DOWN CLEANING—Many mills clean felt during a shut down with the felt flat and machine running at slow speed with the top press roll and or wringer roll in lifted position. Detergent solution is added for 5–15 mts using about 45 gallons per 100 lbs of felt. This is preferably added through a shower pipe just ahead of the press. An alternate location is inside the felt at a point just prior to a felt carrying roll which will help to force the solution into the felt. It is often desirable to run a water shower at low volume to help build lather and allow it to run away slowly during washing.

It is not desirable to clean the felt when there is a long shut for few days. A felt which has run for few days will contain some resin content etc sticking to the surface which preyents any bacteria attack. Whereas a clean felt will have more chance for fungus attack. Hence it is desirable to clean the felt just before restarting the machine.



1. High Pressure shower 2. Flooding shower
3. Detergent shower 4. Lubricating shower or mist shower
5. Vacuum pump 6. Separator
7. Full width suction box

Suction type Felt Conditioning

ON THE FLY CLEANING — Some mills find it expedient to clean the felt intermittently without breaking the sheet. Detergent solution is applied by shower to the face of the felt or inside at a carrying roll nip to force it into the felt. The solution would be put on as soon as possible after leaving the sheet. It is showered and vacuumed on the face surface before recontacting the sheet. Solution for this type of wash is generally 1/3 or 1/4th the strength of the shut down wash and with similar proportion (2% acid plus 0.25% non-ionic detergent). If the pH of the stock is acid (pH 4–5.5) then the acid detergent solution should definitely be chosen for on the fly washing.

CONTINUOUS CONDITIONING — Conditioning of the felts by the continous method basically involves applying minute quantities of a synthetic detergent to the felt on uninterrupted basis. It is not designed to clean a filled felt but to maintain a clean one. The effectiveness of continuous conditioning is based on the theory that while this small amount of detergent is on the felt, the felt has less filling material accomulated on it. Note that this is referred to as "*conditioning*" rather than cleaning, because the concentrations usually 5 to 25 ppm are below the range of true cleaning or washing.

For continuous conditioning to be successful, it is imperative that it be started at the moment the felt is put on the machine or very shortly after and carried out uninterruptedly throughout the life of the felt. Non-ionic detergent solution of .02% concentration is used for this type of cleaning.