Chemical conditioning of wet-section felts why is it necessary ?

DALAL, R. N., ALATE, A. G. AND RAJAN, V. S.*

The wet section is said to represent the heart of the paper machine because it is here that the wet web of paper having very poor strength is transformed, at a high machine speed, into a stronger and a relatively dryer web without any damage to the paper. The uniform water removal from the paper is crucial in this zone which calls for a good conditioned wet-section felt. Further. the water removal at the wet zone not only reflects on the overall performance of the machine but also has a direct bearing on the economics of drying energy required.

The wet section mainly comprises of the press and pick-up (or lick-up) felts. Over the years, the high wool content conventional felt is being replaced by higher synthetic content felt. Today, therefore, the newer designed high synthetic felts are seldom removd from the paper machine because they are worn out, Generally they have to be removed because they get filled or compacted to such an extent that they no longer can handle water uniformly and have lost the drainage capabilities necessary to maintain high levels of pressing efficiency. The felt gets clogged due to paper fines, fillers (like Titanium dioxide, silica, clay etc.) and other chemical auxiliaries that are added in the pulp mixture. Titanium dioxide (Ti02) as a filler is finding increasing application in the paper industry for the production of various grades of paper. This is because it has high optical scattering power giving high opacity and whiteness. unmatched by other fillers. Once the felts get clogged which may or may not be uniform across the felt widh lots of problem arise in the paper making, viz., crushing, blowing, shadow marking, unglazed spot etc. Besides the felt becomes boardy, thus losing the resilient property that is so essential of a press felt.

From the above one will tend to conclude that even though the synthetic content felts last longer, if their efficiency is not kept at a sufficient level to give optimum dewatering, their longer life will be wasted. Therefore in order to keep a felt in a good working condition intermittent cleaning of the felt is necessary. Felt cleaning can be carried out by both mechanical and chemical means, depending on the extent of clogging. Mechanical means include oscillating high pressure showers, flood showers, and high vacuum suction boxes. Chemical cleaning, as the name suggests, cleans all the impurities from the felt by chemically reacting with them. Of course, the two forms of cleaning can not be substituted for one another.

In the present work a study has been conducted to determine the effiiciency of chemical cleaning on some wet section felts. Choked-up felts from Straw Products J. K. (Rayagada) and Ballarpur Paper Mills (Ballarshah) have been used for the study, in the former case Titanium dioxide loaded paper was produced.

EXPERIMENTAL

The received felts from Straw Product and Ballarpur paper Mills, were cut into a small rectangular strip, 10cm x 80cm to make it suitable to load in the laboratory washer. The felts are of 50% synthetic content. The chemical cleaning was conducted in two steps:

step (1) Acid cleaning

step (2) Alkali cleaning

Both washes are in aqueous medium, using a material to liquor volume of 1:5.

ACID CLEANING

Two commercially available acids, hydrochloric and Sulphamic acids, were separately used to determine their cleaning power. The acid

*R & D Centre, Shri Dinesh Mills Ltd., Vadodara-390 005 (India)

cleaning was carried out for 20-30 min. at about 50°C. The recipes used are given below.

(a) Using Sulphamic acid

Commercial Sulphamic acid (above 95%)	=	90 gms
Non-ionic detergent(98%) (Snid PGN/Lissapol NXI)	=	6 gms
Water	=	2 Litres

(Effective concentration of Sulphamic acid in the mixture is 4.5%)

(b) Using Hydrochloric acid

Commercial grade Conc Hcl (30-33%)	=	60 ml.
Non-irnsc detergent(=98%) (Shid PGN/Lissrpol NXI)	=	6 gms.
Warte	=	2 Litres.

(Effective concentration of Hcl in the mixture is2%)

Following this, the felt was thoroughly cleaned with tap water and subjected to the alkaline wash.

Alkaline cleaning

Mild alkali such as Soda ash was used for the cleaning purpose. (Sufficient caution has to be exercised in the case of 50% synthetic felt as the wool content in the felt would get damaged in strong alkaline condition).

The recipe used is ;

Soda ash	=	60 gms.
Anionic detergent (Lissapol-D paste)	=	6 gms.
Water	=	2 litres

(Effective concentration of Soda ash in the mixture is 3%).

Some small amount of dispersing agent (about 0.1%) was added to boost the cleaning. The felt was cleaned in this solution for 20-30 min. at about 50°C. At the end of this, the felt was thoroughly cleaned with tap water to remove all traces of alkalinity and this is important.

RESULTS

All the received felts appeared highly filled up, boardy and stiff. Not much of wear was noticed as webs were intact. Analysis of the felt (as received from the customer) for filled-up matter (F.U.M.) and other physical properties was carried out in the laboratory prior to chemical cleaning.

Table I shows the results of F.U.M. analysis of a typically choked Lick-up and Press felts.

TABLE–I

Filled up Matter Particulars (%)	Lick-up felt		Press felt	
	*TDL Paper	Non TDL Paper	TDL Paper	Non TDL Paper
1. Paper fines & Caustic soluble	13.0	5.3	6.6	6.5
2. Ash (Inorganic matter)	7.0	5.5	10.7	4.0
3. Extractable Matter	1.0	0.5	0.4	0.5
Total F.U.M. %	21.0	11.3	17.7	11.0

*TDL : Titanium dioxide loaded

Note : Total F. U. M. % is calculated on the basis of received felt weight.

TABLE-II

Felt details Lick-up felts (50% synthetic)	Felt Properties as Received			Felt Properties after cleaning			Acid & Alkali used
	Air Permeability ($Ft^3/Ft^2/Min$)	Thickness (MM)	Total F.U.M. (%)	Air Permeability ($Ft^3/Ft^2/Min$)	Thickness (MM)	Weight loss (%)	
1. Straw Product, J. K. Rayagada Machine No. II (TDL Paper Line) Felt No. 1898	2.	1.803	16.6	20.2 **(900)**	1.981 **(10)**	10.2	HCl
2. Straw Product, J. K. Rayagada, M/c. No. II (TDL Paper Line) Felt No. 18981	2.0	1.727	26.6	18.4 **(800)**	1.981 **(15)**	13.5	& Soda ash
3. Straw Products, J. K. Rayagada, M/c. No. II (TDL Paper Line) Felt No. 18980	1.0	1.925	19.2	6.97 **(600)**	1.996 **(4)**	8.4	Sulphamic acid
4. Ballarpur Industries, Ballarshah, M/c. No. 2-5 Felt No. 19618	1.0	1.625	10.8	12.0 **(1100)**	1.791 **(10.2)**	10.5	and Soda ash

TABLE-III

Felt details Press felts (50% synthetic)	Felt Properties as Received			Felt Properties after Cleaning			Acid & Alkali used
	Air Permeability ($Ft^3/Ft^2/Min$)	Thickness (MM)	Total F.U.M. (%)	Air Permeability ($Ft^3/Ft^2/Min$)	Thickness (MM)	Weight loss (%)	
1. Straw Product, J. K. Rayagada, M/c. No. II, (Fabric press) TDL Paper line felt No. 18970	1	1.956	17.7	6.56 **(500)**	2.235 **(15)**	12.6	Sulphamic acid
2. Ballarpur Industries, Ballarshah, M/c. No. 4 (2-3 Press) Felt No. 19621	40.2	1.801	13.6	51.0 **(27.4)**	2.195 **(22.7)**	8.0	& Soda ash

Note : 1. Figures in the paranthesis (—) indicates the percentage improvement after cleaning

2. Overall cleaning efficiency* (i) for HCl & Soda ash = 67%
   (ii) for Sulphamic & Soda ash = 62%

   *(Overall cleaning efficiency has been calculated on the basis of F.U.M. difference before and after clean)

3. All air permeability ($Ft^3/Ft^2/Min.$) values are for $\frac{1}{2}$" water gauge pressure drop.

The analysis clearly reveals that TDL paper feles tend to fill-up to a greater proportion and such felts need constant cleaning. Tables II and III give the summary of test results as were noticed after cleaning the lick-up and press felts respectively.

The efficincy of cleaning, calculated on the basis of F.U.M. difference, for HCl was about 67% and Sulphamic acid 62%. This is also indicated by the percentage loss in weight after cleaning. The air permeability (c.f.m.) shows a remarkable improvement to the extent of about 900%. The felt became fluffy and full, (as shown by the increased thickness = 10%), giving it the resilient property. These changes in properties after cleaning is a good indication that the felt has opened up and can perform much more efficiently.

DISCUSSION

The impurities that accumulate on the felt mainly comprise of pulp fibres, particles of loading material. rosin particles, slime, pitch and eventual impurities arising out of mill water. Accordingly they can be classified as.

(i) Paper fines : Which gets trapped in the felts and can not be dissolved in any chemicals that is safe to use in felts. They are best removed by the mechanical action of a high pressure shower and suction box.

(ii) Alkaline solubles : Which can only by removed by dissolving it in a medium to strong alkaline solution. This include lignin from wood pulp, starch and rosin size.

(iii) Ash : Which is actually a mixture of inerts materials (like TiO2, clay, sand etc.) and acid soluble substances (like alum, Calcium carbonate, hard water metal complexes etc.). These respond well to acid cleaning.

(iv) Extractables : Which are some sort of filler materials (likelatex, pitch, tar, asphalt, inks etc) that are solvent soluble.

Titanium dioxide (TiO2), used as a pigment and filler, needs a special mention. The material is totally inert to many of the acids & alkalis and is also non toxic. This makes it an ideal filler material for paper. Added to this is its unique optical properties, imparting high whitenes & opacity. There are two grades of TiO2, rutile and anatase, and both are commonly used in the paper making. While rutile and anatase are the same chemically, the former has a much more compact crystal structure which accounts for its higher specific gravity and refractive index.

It has been found that a major portion of the filled-up material lodges itself in the base structure of a needled (batt-on-base) felt. According to one such finding, only 6 % of the filler material was retained in the batt while remaining 94 % was distributed in the base fabric, the largest part was found in the cross-machine direction yarns. By a proper and well positioned showers and suction boxes, about 15 % of the filled up material (comprising mainly of paper fines) that are held loose on the felt surface can be got rid off. Further removal, however can be effected only by a chemical clean using acid and alkali, The concentrations of the acid & alkali are so chosen that they are adequate to react chemically, with the filled up matter without causing any fibre or felt damage.

Besides removing the acid and alkali soluble matter, this cleaning method is also indirectly very effective in washing away the inert. material like TiO2. The reason for this being the acid and alkaline cleaning liquor which has the PH of 1.5 and 9 respectively is well outside the isoelectric point of both anatase and rutile grades of TiO2.

Table below give the iso-electric point of several fillers.

TABLE - IV

FILLERS	ISO-ELECTRIC POINT
Anatase (Ti02)	3.8-4.0
Rutile (Ti02)	6.2-6.8
Silica (Si02)	2.0
Alumina (Al_2O_3)	9.0
Stannic Oxide (Sn02)	5.8

As it is known that coagulation is maximum at the isoelectric point (Which is the PH value of the system at which zeta potential is zero), the cleaning system employed should operate outside this PH range, This also explains why a felt tends to get clogged faster while using Ti02 fillers, since the pulp mixture used is normally in the PH range of 4-6 which coincides with the isoelectric point of Ti02. Therefore the safest way to wash away these inert materials is to clean in acid medium followed by an alkali medium, which would inhibit coagulation of Ti02 and will thereby facilitate its washing out from the felt.

The cleaning obtained by using Hcl (= 67 % is relatively higher than that of Sulphamic acid

(= 62 %). However,it is much safer to use Sulphamic acid (inspite of this relatively high cost) on the paper machine line because of its less corrosive nature and easy handling. Where HCl is going to be used for cleaning, it is advisable to use some small amount of corrosion inhibitor and extra caution has to be exercised while handling concentrated HCL. Use of detergents in the wash liquor is a must as it helps easy removal of the filled up material and prevents the redisposition of the impurities on to the cleaned felt. The results in Tables II and III clearly indicate the improvement in air permeability. removal of contaminants and the desires restoration of resiliency of the felt after cleaning.

For an intermittent cleaning during production, this cleaning method can be adopted as often as required. Approximately 250 litres of acid & alkaline wash liquor has to be kept ready prepared for cleaning 50 kg felt. While washing on the machine, it is preferable to run the felt in slack condition to get the optimum cleaning, In the case of 100% synthetic content felt, caustic soda (50 % strength) can be used in place of soda ash for the alkaline cleaning, as the former has a more cleaning power.

The actual cost of cleaning chemical work out to be negligibly small when one compares in with the benefits obtained from the improved felt performance, To save on downtime of the machine, a preplanned cleaning schedule can be worked out.

CONCLUSION

(i) Felt cleaning by machanical and chemical means is an important necessity with high synthetic content felts so as to take full advantage of their longer life.

(ii) Intermittent cleaning is recommened on the paper machine in a planned manner, so as to save on downtime of machine. Besides this is more beneficial than a protracted shut down cleaning.

(iii) It is quite understandable that a conditioned felt will increase the sheet dryness as it leaves the press section. Besides, one obtains few breaks, better quality product and reduced downtime for clothing changes which in a way are additional money saving benefits to be realised from a cleaner felt.

RFERENCES

1. Dinesh Felt News (India). Nos. 2, 3, 4, (1975) No. 2 (1977). No. 1, 2, (1980)
2. Albany Felt and Fabrics Facts (Canada). Aug. 1978; Jan/Feb. 1975; Feb. 1981.
3. A E S Chemical - Bulletin C-5. Albany Engineered Systems, USA.
4. J. G. Penniman, Paper Trade Journal, February (1981).
5. W.R. Willet, "Titanium dioxide and other Pigments" chapter 8-2 in "Handbook of Plup and Paper Technology", Ed. K.W. Britt, Pub. Van Nostrand Farnhold company, New York (1970).
6. "Paper Machine Felts and Fabrics, Published by Albany International Corporation New York (1976).