Open Mesh Dryer Screens and Pocket Ventilation

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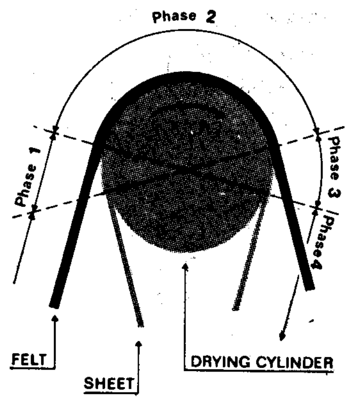
This Paper will deal with drying of paper and the new type of dryer clothing used in this connection. It will also discuss the different aids for pocket ventilation which are in use on modern machines.

We are all aware of the importance of producing a paper sheet that is even in moisture distribution in the cross as well as in the machine direction. It is not an easy job to reach this state and sometimes it is necessary to compromise with other paper properties, for example paper thickness and paper weight in order to get acceptable level on the moisture content in the sheet. In reality there are certain limits to how far we can make the substance weight even, and above all how far we can go in order to level out the moisture profile. It is therefore always necessary to calculate with certain remaining irregularities of the caliper and these have to be corrected at the calender stack.

In the following we will simplify the equation by assuming that the paper sheet leaving the press section and coming into the dryer section has a uniform profile as far as moisture content is concerned.

Drying

First of all we will look into what happens when a paper sheet is dried over a rotating drying cylinder. The common way is to separate the drying on the cylinder into four different phases. (Figure 1).



The four drying phases.

Fig. 1.

During phase 1 the paper sheet hits the drying cylinder and the heating of the sheet begins. In this phase there is not much evaporation from the paper sheet.

The heating of the paper sheet is accelerated during phase 2, whereby the dryer clothing increases the pressure of the paper sheet against the cylinder. Consequently, conductivity between the cylinder and the paper sheet is improved. Water contained in the paper sheet will first evaporate against the hot cylinder surface, after which there is a vapour transport towards the felted side of the paper sheet. The water inside the paper sheet will by capillary action go in the opposite direction towards the hot cylinder surface. Depending on the temperature of the felt, the vapour will either condense inside the felt or pass through to the surrounding atmosphere.

The felt leaves the paper sheet during phase 3, and there is an evaporation from both sides of the felt. An evaporation will also take place from the free surface of the paper sheet. This latter evaporation will be emphasized also during the beginning of phase 4, where the necessary evaporation heat will be generated by the paper sheet itself. The paper sheet is now cooled off rather rapidly, whereby evaporation decreases. This sequence is repeated over the next cylinder, with the difference, however, that the paper sheet is heated from the other side compared with the previous cylinder.

Evaporation velocity can be calculated from the ability of the surrounding air to transport the evaporized water, and is proportional to the partial pressure difference of the vapour inside the paper and the vapour of the air. A low value of the partial presure of the vapour in the surrounding air will consequently mean that we will receive a high evaporation velocity. The evaporation velocity is also a function of the air velocity close to the paper surface, and a proportional relationship exists. This means that drying conditions are improved when dry, hot air at relatively high speed touches the paper surface.

The fact that the moisture content in the dryer pockets on cylinder machines do affect the moisture profile of the sheet has been known for a long time. The first attempts to control the moisture profile were made

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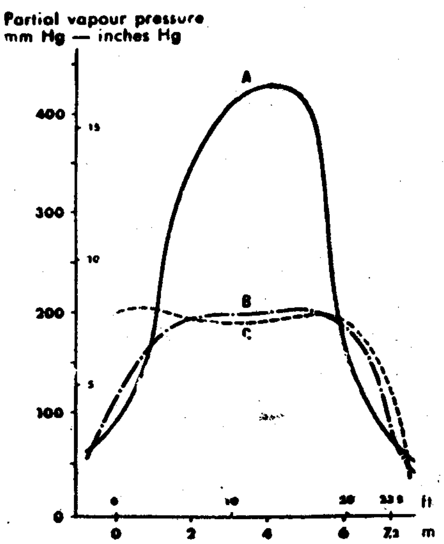
by Grewin when he introduced the air blowing system that today bears his name.

We know that dryer felts with low air permeability enclose the air between felt, sheet and cylinder and that moisture content in the air increases towards the centre of the machine, which means that the edges of the sheet are dry when the centre is wet.

The first more serious attempt to map down the air characteristics in a dryer pocket was made in 1964–65 and was a joint investigation between the paper mill, Nordiskafilt and Sv. Flaktfarbriken. Figure 2 shows the



Patrial Pressure of water vapour in a dryer pocket in a newsprint machine.

A cotton dryer felt

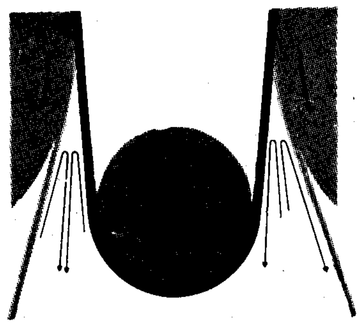
B cotton dryer felt with air blowing

C high-permeability dryer screen

Fig. 2.

results of this investigation. In a certain dryer pocket (over cylinder No. 40 in a 7-m-wide newsprint-machine running 650 m/min) the air humidity across the machine was measured at different positions. Different dryer clothings were used and when running a dryer felt we can see the wet air peak in the centre of the machine. This peak disappears when the dryer felt is exchanged and high permeable dryer screen is used in the position. Consequently a permeable screen will even out the air humidity in the pocket allowing the sheet to dry more evenly in the cross machine direction.

Later a lot of investigations have been made where the self-ventilating effect of high permeable dryer screens are measured. Figure 3 shows the



Flow patterns in a dryer pocket with an impermeable felt.

Fig. 3.

flow pattern in a pocket where a dense dryer felt is used and in Figure 4 curves of the amounts of air ventilated through a dryer screen is drawn for different machine speeds. Air volume is set relative to machine speeds, with the screen's permeability as a parameter. We see how air volumes increase linearly with machine speed. The curves also show that when using very open mesh fabrics, the ingoing air flow into the pocket is bigger than the outgoing flow. We will therefore have an axial flow out through both ends of the pocket. With somewhat closer fabrics, in this case below 6000 m^3/m^2,h, it is quite the contrary and

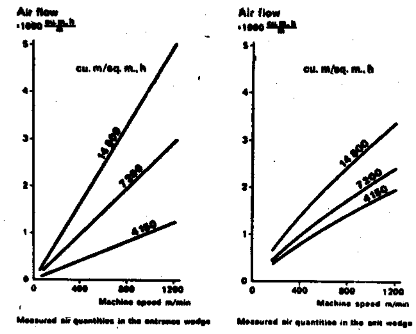


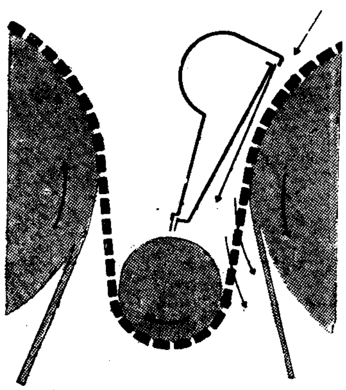
Fig. 4.

we will have an air flow into the pockets from both ends.

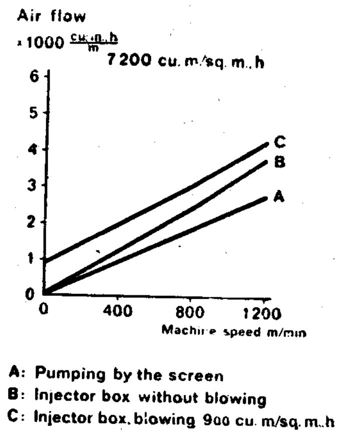
Only the self-ventilating effect of dryer screens, however, do not necessarily lead to a very good paper moisture profile. PV-ducts (pocket ventilation) will make it possible to improve this profile. How PV-systems influence incoming air volumes and how efficiency is effected has also been investigated (Figure 5).

Efficient PV-ducts have proved capable of increasing the ventilation effect up to three times at speeds around 300–400 m/min Their influence is relatively smaller at high speeds. From this we can conclude that the impingement ventilation is justified only for machine speeds up to 400 m/min. After this it has very little influence on the ventilation eflect, and sometimes it may have a negative effect as the increased air turbulence will cause unnecessary sheet fluttering.

Another positive effect of the PV-ducts is, however, that air of high temperature and low humidity is introduced into the machine in the position where it is needed, i. e. in the dryer pockets. This is, of course, valid also for speeds exceeding 300–400 m/min. Total air consumption can be reduced if the main



Injector box



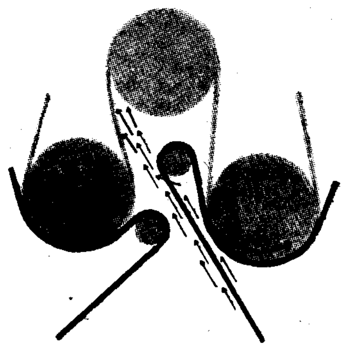
Injector box operation

Fig. 5.

part of the dryer air is introduced into the dryer part through PV-ducts.

On high speed wide machines making newsprint it is today possible to guarantee an evenness of the moisture profile of $\pm 0.75\%$ at an absolute level of 8.5%. To reach these figures it is necessary to use permeable dryer screens in connection with a good pocket ventilation system.

If too permeable screens are used when running high speed machines, (over 600 m/min), on rather light weight papers, (newsprint) sheet flutter might cause problems. In most cases these problems start in the intersection between dryer groups where two dryer screens meet. Figure 6 shows how these problems normally can be overcome by replacing felt rolls or by using air doctors. Sheet flutter is not a problem when running heavier paper grades like kraftliner, corrugated medium and board.



Disturbing air current

A, B and C show different ways of eliminating the disturbance.

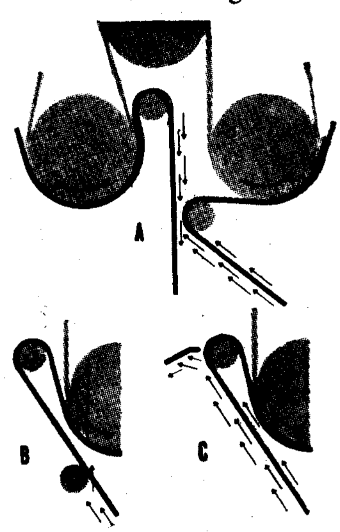


Fig. 6.

The following conclusions were drawn on drying during the 1968 Symposium on Pressing and Drying in Canada.

1. Open hoods and Grewin systems very often cause irregular air turbulence and uneven moisture and temperature conditions inside the pockets.
2. Overdrying of the edges in non-ventilated hoods is caused by the dry air that comes in from the sides of the paper machine and into and under the hood. This can be controlled only by a sufficient air stream from the centre and outwards from the pockets.
3. High permeable dryer screens used without any additional ventilation will pump large amounts of air into the pockets and will consequently cause good mixing of the air inside the pockets.
4. A conventional dryer section will to some extent equalize the moisture profile. However, it often happens at the expense of overdrying the sheet.
5. Additional pocket ventilation has two effects. The first positive effect is that it increases drying capacity up to 30 or 40%, and secondly that it increases the possibilities of keeping an even profile. To obtain full effect, forced ventilation has to be utilized throughout the dryer part.
6. An even moisture profile of the paper sheet from the press section and into the dryer section is highly desirable. Crown-con-

trolled rolls, especially in the last press, will help to improve the profile.

Dryer Screens

Nordiskafilt was the first company in the world to start producing dryer screens with high permeability. This happened back in 1963 and we have up till now from our factories in Sweden and Finland delivered more than 4,500 screens. Nordiskafilt's dryer screens are sold under the names of SCREENTEX or THE-RMOTEX.

Permeability

The permeability of dryer screens is determined by the air volume that flows at atmospheric pressure through a certain area of the fabric during a specified time and under a certain vacuum. The metric conversion of this will be cu.m/sq.m,h at 10 mm water gauge. Screens with a permeability higher than 4000 cu.m/sq.m,h are considered to be very permeable.

Figure 7 shows the wide permeability range covered by Nordiskafilit's dryer screens. From this Figure the different names of the products are to be seen, as for example SCREENTEX, THERMOTEX and POROTEX. These dryer clothings cover air permeabilities from 500 up to 8000 cu.m/sq.m,h and are, if correctly chosen, suitable for all paper grades at any machine speed.

Design

Our dryer screens are all in a two-layer design. This pattern will give the screens a high dimensional stability, good running characteristics and at the same time a fine surface.

The main part of the Nordiskafilt screens are made in monofilament and the synthetic meterial is either polyester or polypropylene. We also use spun yarns as for example acrylic and asbestos.

Different materials have been investigated for remaining strength when they are exposed to heat and humidity. From Figure 8 can be seen that polypropylene has outstanding properties in this respect, and that acrylic and asbestos also have very good characteristics whereas polyester of either mono-or multifilament is not as good as the other materials.

Air permeability of dryer felts and screens
m^3/m^2. h at 10 mm w. g.

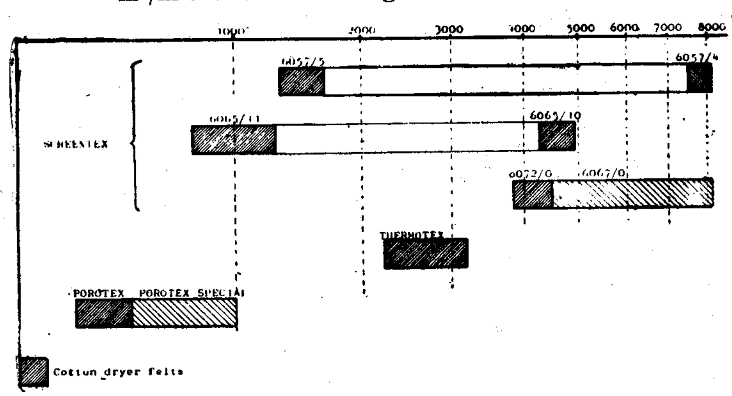


Fig. 7.

SCREENTEX 6057

This is the name of the polyester dryer screen which is made in permeabilities ranging from 1500 to 8000 cu.m/sq.m,h. The weave pattern is to be seen from Figure 9 and this is a length-wise cut through the screen.

The material of the fabrics is of course of great importance. Despite long running times, it is very seldom that mechanical wear limits the life of the fabric, but rather the thermal degradation caused by the combination of moisture and heat.

This screen has been running successfully on many paper grades, i. e. newsprint, kraft, corrugated medium.

SCREENTEX 6065/10

For many years Nordiskafilt has been looking for a material usable for dryer screens that had not the disadvantages of the polyester material to hydrolyse under heat and moisture. This material has now been found and is a specially stabilized polypropylene. The design of this screen is almost the same as the polyester screen design. In Figure 10 the pattern is shown. A certain amount of acrylic spun yarns are interwoven into the screen in the lengthwise direction. The acrylic yarns will give the screen a high length stability. The permeability of this screen is 4500 cu.m/sq.m,h. By adding more yarn in the cross direction it is possible to make closer screens.

The polypropylene material is unique and screens made of it are available only from Nordiskafilt.

The screen is suitable for all paper

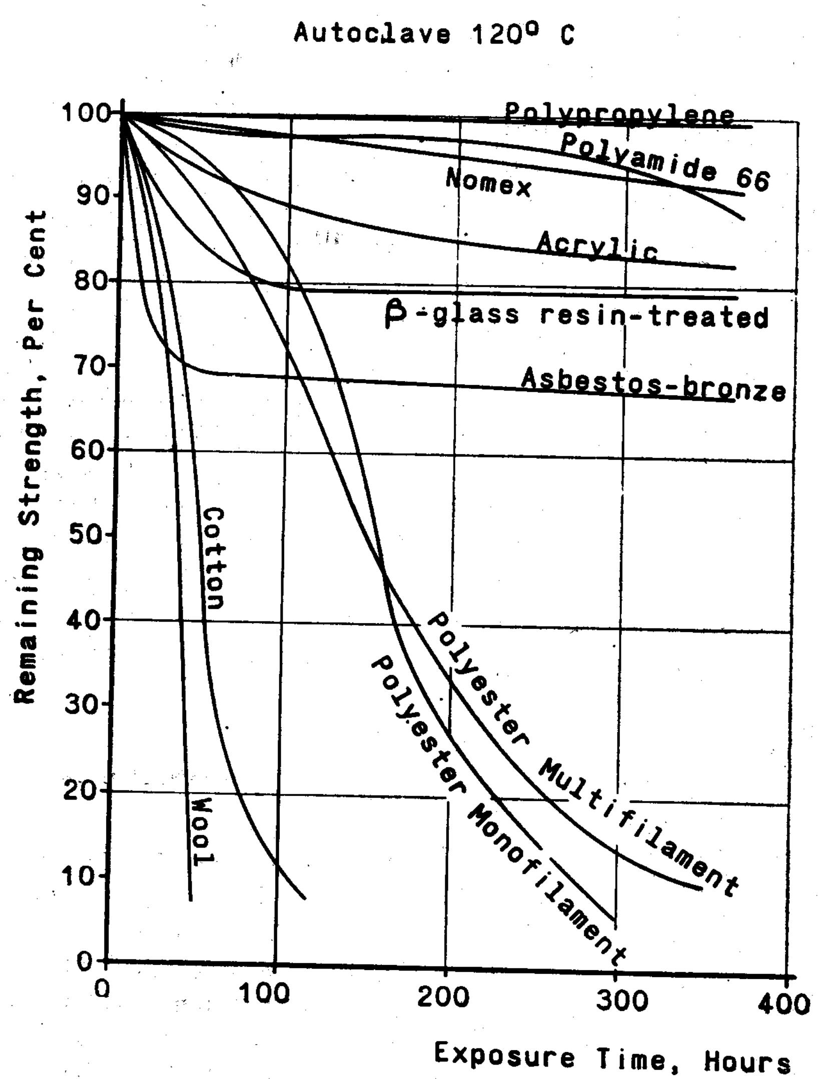


Fig. 8.

grades with the exception of paper dryed on cylinders with temperature higher than 140°C.

THERMOTEX

This screen is made of acrylic yarns in the lengthwise and asbestos yarns in the crosswise direction. These two materials have very good resistance against heat and moisture and they can also stand high cylinder temperatures. This screen fills the gap where temperatures are too high for 6065,

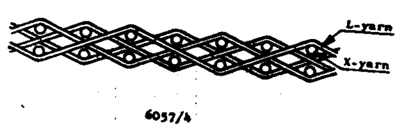


Fig. 9.

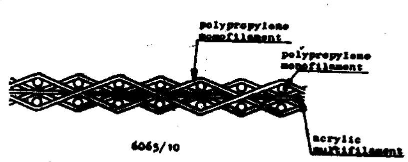


Fig. 10.

that is *e. g.* on some liner machines. Air permeability about 3,000 cu.m/sq.m,h.

POROTEX SPECIAL

This is a type of screen with an exteremely fine surface. The baseweave consists of polyester monofilament and acrylic spun yarns on top of which there is a batt needled into the base. POROTEX SPECIAL is suitable for fine papers where non-marking is very important. Permeability about 1,000 cu.m/sq.m,h.

Seams

All these dryer screens can be joined together with a mechanical seam and this is the normal way to make the screens endless.

Nordiskafilt is now in the position of being able to deliver absolutely markingfree seams on the styles 6065/10 and 6057/4.

These to styles can also be spliced endless thus giving maximum strength and minimum risk for marking for machines where it is possible to install endless screens.

The POROTEX SPECIAL is either woven endless or joined with a mechanical seam.

Conclusions

The rapid development of modern permeable dryer clothing has given better general ventilation of the dryer section and led to more efficient drying and more even dryness profile of the paper sheet. Special synthetic monofilament and multifilament materials with sufficient resistance to heat and humidity are used. The design of seams for different applications is very important.