

Dryer sheet stability for older paper machines

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It is now possible to reach state-of-the-art speeds with an older dryer section design. Attention to the air movements and the design of the dryer drainage system is needed to achieve the best results.

Control of sheet stability in the dryer section is the major limitation on higher speeds for many older paper machines. Many innovative ways to stabilize the sheet through the dryer section are being used on new paper machines. Many of these methods make use of unconventional dryer geometries and configurations. Older machines cannot use these techniques without extensive and costly rebuilds.

The papermaker can gain sheet stability on an older machine without going to the expense of a complete reconfiguration, however. One upgraded European machine, for instance, now runs at a speed of 4200 ft/min on lightweight coated grades using these less expensive techniques.

Press transfer

Transferring the sheet from the press section to the dryer section normally represents the first unsupported draw. Many times, the highest number of breaks occur at this location. The speed difference, or draw required, depends on the force necessary to remove the sheet from the granite roll and to stabilize the sheet over the unsupported length. A long unsupported distance requires a high draw, and the draw requirements increase with speed.

A high draw stretches the sheet. The sheet loses its elasticity as it is stretched, with the unrestrained edges stretching more and resulting in "floppy" edges. Breaks will occur and will eventually prevent the machine from achieving a higher speed.

One solution is to minimize the unsupported draw distance. The return run of the "unorun" fabric is brought in close to the granite roll. In the "unorun" concept, the sheet is transferred from the granite roll to the underside of the unorun fabric. Air jets are used to create a suction on the underside of the fabric, holding the sheet tight and flat to the fabric, as shown in Fig. 1.

The design and operation of the blow boxes is critical.

They must provide enough power to hold the sheet tight and flat over a wide range of operating speeds. This technology has been well proven on many high-speed installations.

Recently, emphasis has been placed on good control of the air boundary layer that the return fabric carries into the transfer area. The fabric can carry large volumes of air into the unsupported draw. Excessive air pumping can cause an unstable sheet draw and sheet drop-off under the blow boxes.

Proper positioning of the felt runs can eliminate the boundary layer carried by the top of the unorun fabric. The unorun fabric should be positioned so that it is less than 1 in. from the lead-out press felt roll. The opposing rotation of the press felt roll serves to remove the boundary layer from the top of the fabric and prevent it from pumping air into the unsupported draw area.

The boundary layer carried on the underside of the return fabric can also be disruptive. Fixed air deflectors are commonly used to control it. A recent development is a blow box which incorporates an air knife to remove this boundary layer, as illustrated in Fig. 2.

Hood operation is often overlooked as a source of problems. Over-pressurization of the hood wet-end has been known to cause sheet drop-off under the press run box and in the unorun section. Sufficient wet-end hood exhaust and proper control of the hood air flows are needed to prevent over-pressurization.

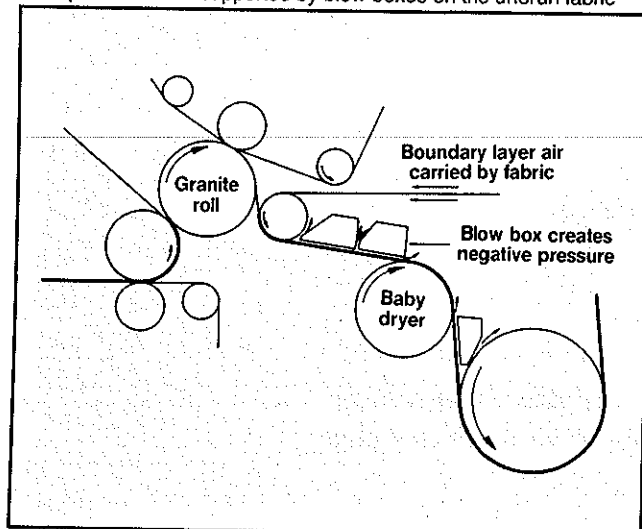
Unorun groups

The unorun concept represented the first major advancement in sheet runnability in the dryer section. While it allowed faster machine speeds, sheet stability eventually became a problem. The dynamics of the opening and closing nips, as shown in Fig. 3, caused the sheet to drop off the bottom dryers and also caused wrinkling. Tighter draws were needed to stabilize the sheet, and runnability became sensitive to fabric permeability, which led to breaks and quality problems.

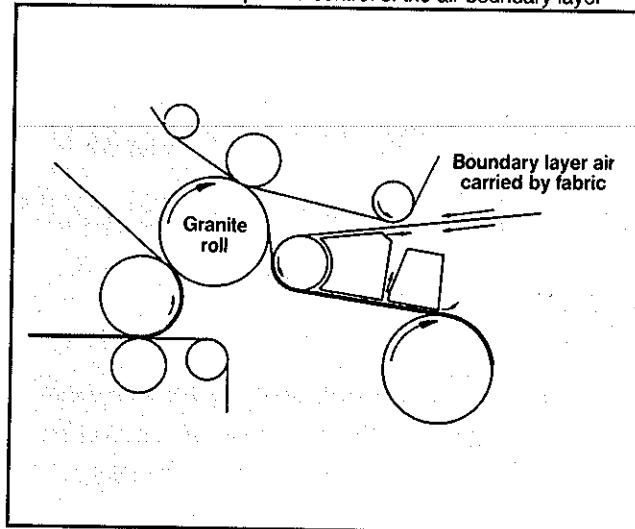
Blow boxes were introduced to hold the sheet tight to the unorun fabric. These boxes have now evolved to the point where they hold the sheet tightly to the fabric through

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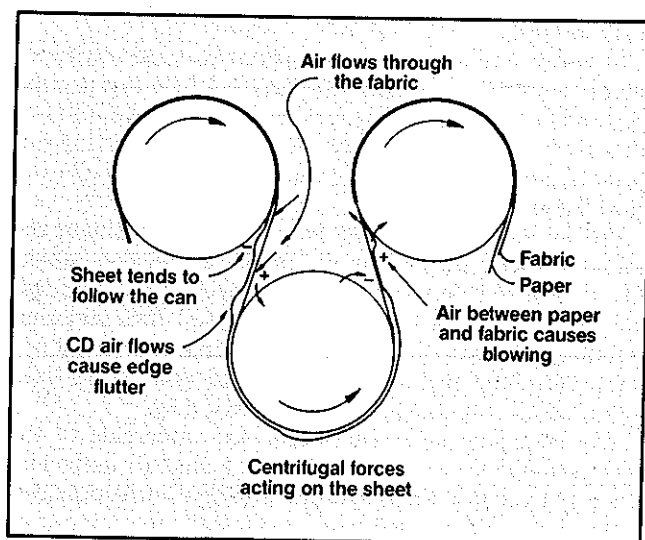
1. A press transfer supported by blow boxes on the unrun fabric



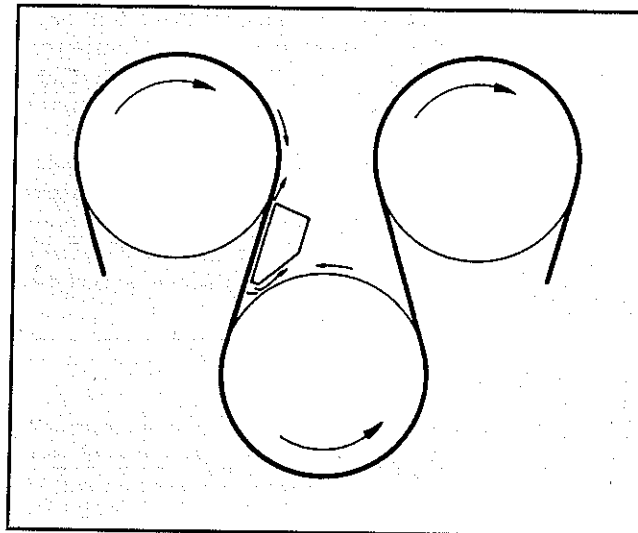
2. Press transfer with improved control of the air boundary layer



3. Instabilities in sheet travel in a single-felted dryer group



4. In the newest design, the blow box provides full support between dryers.

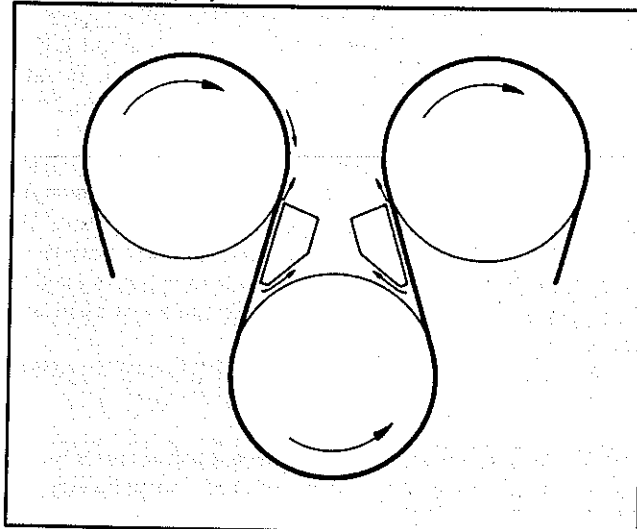


the entire unrun section. **Figure 4** shows the latest style of blow box, which covers the full distance between dryers. The air boundary layer is peeled off the fabric by an air jet before the fabric and sheet leave the dryer. This prevents the sheet from following the dryer can. Early designs did not attempt to pull the sheet off the top dryer and immediately onto the fabric, and a bubble in the sheet appeared as machine speeds increased.

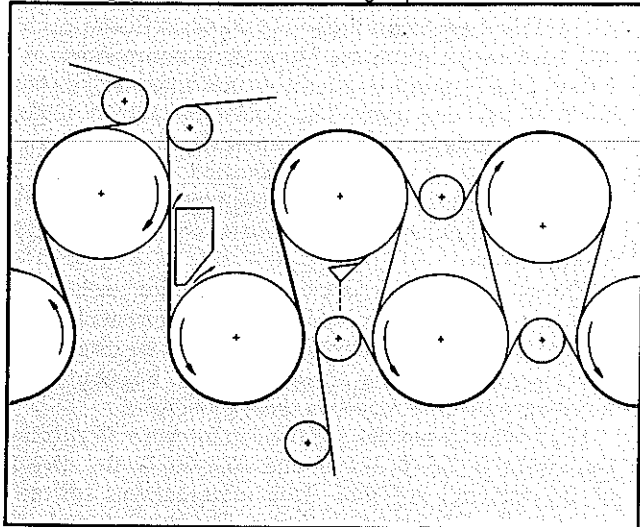
A second air jet peels off the boundary layer carried by the bottom dryer, creating a negative pressure zone through the full distance between dryer cans. The sheet is held tight and flat to the unrun fabric, resulting in stable operation.

One problem has become evident on older machines running at high speed. The bottom unrun dryers are often driven at the same rotational speed as the top unrun dryers. Since the fabric is sandwiched between the sheet and the dryer on the bottom cans, the effective diameter of the bottom dryers is greater. Consequently, the sheet must stretch as it goes around the bottom dryer. At high

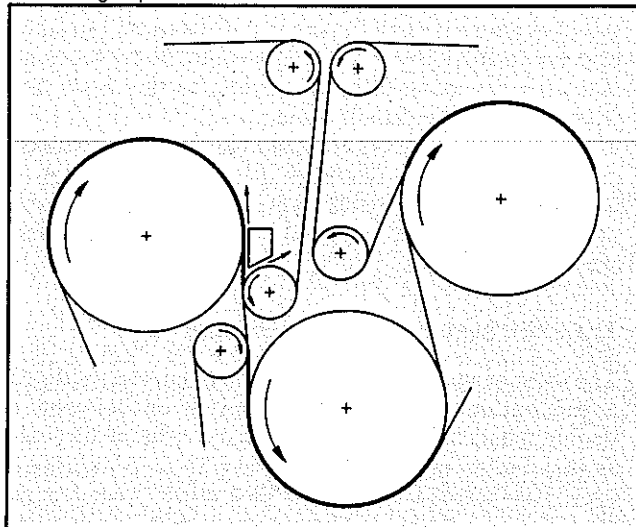
5. High-speed configuration with a blow box in the position between the bottom and top dryers



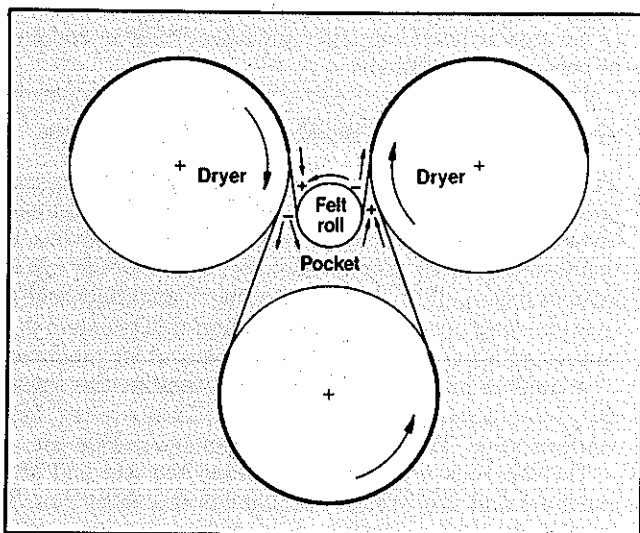
6. "Pistol grip" transfer between drive groups



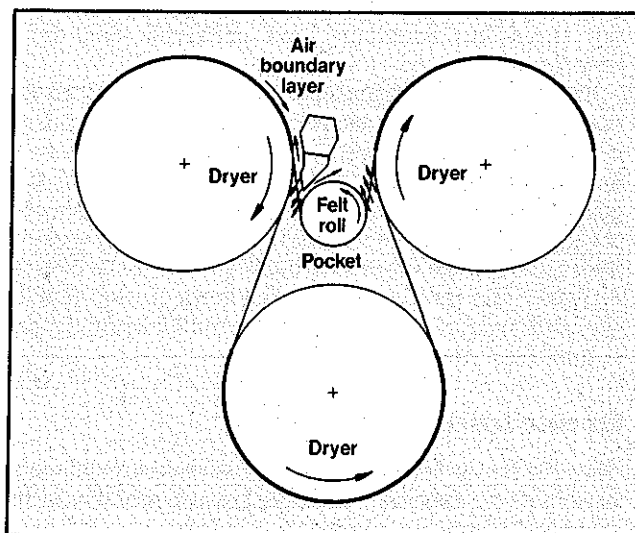
7. Drive group transfer



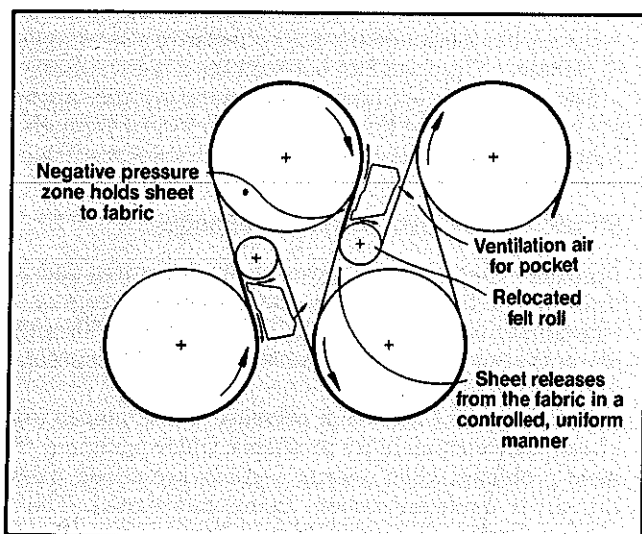
8. Pressures induced by moving rolls and fabric



9. Pocket ventilator design to control the boundary layer



10. Sheet stabilization in double-felted groups



speed, the stretched sheet will become unstable as it runs upward between the bottom and top dryers. A second blow box is needed in these cases to stabilize the sheet, as Fig. 5 shows.

In this position, a blow box is not generally needed until speeds exceed 3500 ft/min. However, the speed at which stability in this position becomes a problem depends on the paper grade and the machine geometry. Lightweight coated grades are the most sensitive to sheet instability in this "uprun" position.

Unorun fabric permeability

The advent of press run and unorun blow box technology has made machines less sensitive to fabric permeability and design, but permeability can still be a problem. A flat weave, monofilament fabric is recommended. A design permeability of 75-120 ft³/min is generally adequate.

The unorun fabric needs to be kept clean. A 100-ft³/min fabric can plug quickly, depending on the furnish and

other machine operating variables. The blow boxes will accept some reduction in permeability but will gradually lose their effectiveness below 50 ft³/min. Many high-speed machines are using cleaning devices on the dryer fabric to keep the unrun fabric clean.

The fabric should be designed for minimum caliper to reduce the effective diameter distance between top and bottom dryers. A well-made pin seam is needed to prevent any disturbance at the transfer from the press section to the dryer section.

Transfer between drive sections

The point of sheet transfer between an unrun section and a conventional double-felted section or between two double-felted sections is normally an area of high sheet flutter. Different methods have been tried to stabilize this area. One method is to use a "lick down" transfer using the top fabric of the trailing section to "kiss" the last dryer of the leading section. The top fabric then wraps the first bottom dryer in the trailing drive group.

This arrangement is shown in Fig. 6. It has had limited success. Sheet flutter at the first open draw is common, tail threading problems have occurred, and drying capacity is reduced.

Figure 7 shows a transfer arrangement that is working successfully at high machine speeds. The felt rolls are rearranged so that there is a short distance between the lead-out roll of the top fabric and the lead-in roll of the bottom section. A blow box is used to pull the sheet off the top dryer and hold it tight to the fabric. The sheet will tend to follow the dryer and bubble without the blow box in place. The sheet is transferred from the top fabric to the bottom fabric over a short, controlled draw distance. A minimum draw is needed.

Double-felted groups

Sheet flutter in dryer groups that use conventional top and bottom dryer fabrics is almost always a problem at high machine speed. The boundary air layer carried by the fabric is the main cause of sheet flutter. Good control of the boundary layer will produce stable sheet runs with low humidities in the pockets.

Figure 8 shows the conditions at the felt roll in a double-felted dryer configuration.

On a high-speed machine, a considerable amount of air travels in a boundary layer with the fabric. As the fabric leaves the dryer, a negative pressure is formed by the diverging nip. A positive pressure zone is formed as the fabric comes into contact with the felt roll. The combination of the diverging and converging nip tends to move the boundary layer air through the fabric and into the pocket. On the exiting side of the felt roll, the opposite conditions occur. The fabric tends to pump air out of the pocket.

The amount of boundary layer air pumped into the pocket exceeds the drying requirements when high-permeability fabrics are used at high machine speeds. The high volume of air that is pumped into the pocket by the fabric results in severe sheet flutter. The obvious way to control this problem is to reduce the fabric permeabilities. Many high-speed machines use permeabilities below 100

ft³/min in the double-felted groups.

Low fabric permeabilities help the sheet flutter problem but cause other problems. More air is pumped out of the pocket than is pumped into the pocket when fabrics of low permeability are used. The pocket is placed under a negative pressure, and insufficient air is forced into the pocket to take care of the evaporation requirement. The result is pocket humidities that are high in the center and low at the edges, which causes variation in sheet moisture profile.

The solution is to use a pocket ventilation nozzle design that removes the incoming boundary layer carried by the fabric. Higher fabric permeabilities can be used without excessive air pumping or sheet flutter. Figure 9 shows a pocket ventilator based on these principles.

High-velocity nozzles are used to force air in reverse of the incoming fabric travel and opposite to the direction of the felt roll rotation. This arrangement effectively removes the air boundary layer. The correct amount of air is provided by the pocket ventilation nozzle and is forced through the fabric in a controlled fashion. Air flows around the pocket are controlled, and humidities in the pocket are kept low and uniform. The key is the removal of the ingoing boundary layer and a controlled introduction of pocket ventilation air.

Sheet stabilization in double-felted groups

These principles of pocket ventilation will produce a stable sheet run in the double-felted dryer groups in most cases. However, on many older machines the dryers are configured with a long sheet run between the top and bottom dryers. It is difficult to achieve a stable sheet run over the long unsupported length, and this problem is the main limitation that is faced with many older machines.

A method has been developed to stabilize the sheet in the draw between the dryers in a double-felted fabric configuration. The arrangement is shown in Fig. 10.

The felt rolls are relocated toward the wet end of the machine and are brought tangent to the sheet run. The pocket ventilator creates a negative pressure on the ingoing side in a similar fashion to the unrun blow boxes. The sheet is pulled off the dryer can, is held tightly to the fabric, and is released from the felt roll in a uniform manner. Not only is the length of unsupported draw reduced, but the boundary layer effects are also completely eliminated. The sheet run between the dryers is stable.

The pocket is ventilated by pressurizing the fabric on the outgoing side of the pocket. Air is forced through the fabric at a location that does not create a sheet disturbance.

Steam control and dryer drainage

Improper control of the dryer steam pressures and poor drainage of the dryers can have serious effects on the runnability of the sheet in the dryer section. This area is one of the most overlooked causes of runnability problems in the dryer section.

Poor control of the steam pressure in the unrun group often leads to runnability problems. Older machines often have problems when unrun sections are added without the dryer drainage system being redesigned. The top unrun dryers need to operate at low pressure yet at a

high drying rate. Many machines are operating with partially flooded top unorun dryers. These machines are not taking full advantage of the unorun concept. The unorun is intended to support the sheet while it is dried. For this reason, all top unorun dryers should operate with the highest efficiency possible, so the sheet is at its maximum dryness before the unsupported sections.

The top unorun dryers must also operate at low pressures to prevent serious sheet picking. The combination of low steam pressures, high condensing loads, and high machine speeds—along with the need for high drying rates—creates a difficult problem in dryer drainage design. Properly designed siphons, lines, and joints are critical. Extremely good results have been achieved by optimizing the drainage of the top unorun dryers. Sheet dryness as the sheet enters the double-felted sections has been increased, and runnability has been improved.

It is important to have individual control of the first two bottom dryers after the unorun section. Since the sheet has only been dried by the top dryers to this point, there is considerable free water available on the top of the sheet. The free water will flash under the sheet if a hot bottom dryer is contacted immediately after the unorun. The sheet will lift off the dryer, resulting in a disturbance in the open draw.

Graduated steam pressures down the entire length of the machine are important. Machines that have large steam pressure differences between adjacent steam groups will have sheet flutter problems in the area of the steam

section splits. This is critical toward the wet end of the machine.

Inconsistent dryer drainage will also cause runnability problems. Flooded dryers in the middle of a steam section will cause sheet bagging.

Summary

There have been many advances in dryer section sheet runnability for older paper machines. It is now possible to reach competitive speeds with an older dryer section design.

Sheet stabilizing devices are commonplace on most high-speed dryer sections. Improvements in this area continue to be made. Proper attention to both the air movements and the design of the dryer drainage system are needed to achieve the best results.

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