ADVANCED ADHESIVES REPORT

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Your corrugating adhesives newsletter from Harper/Love Adhesives Corporation

Hook warp: diagnosis and cure

It's all about differences in moisture content. Here's how to track it down and fix it.

by Bill Kahn and Bill Nikkel

The basic cause of hook warp is a moisture differential between the two liners at one edge of the web. If the top edge of the web is wetter than the bottom, the board will hook up; if it is wetter on the bottom, it will hook down.

Possible causes of this are:

- The edges of the paper are wet when received from the mill or become wet during unprotected outdoor storage of the roll stock.
- There is excessive adhesive on the edge(s) of the board due to worn glue roll and/or metering roll, or a scraper blade on the metering roll not cleaning the metering roll in one area.
- The edge of the paper is not making good contact with the preheater due to misalignments on the machine.

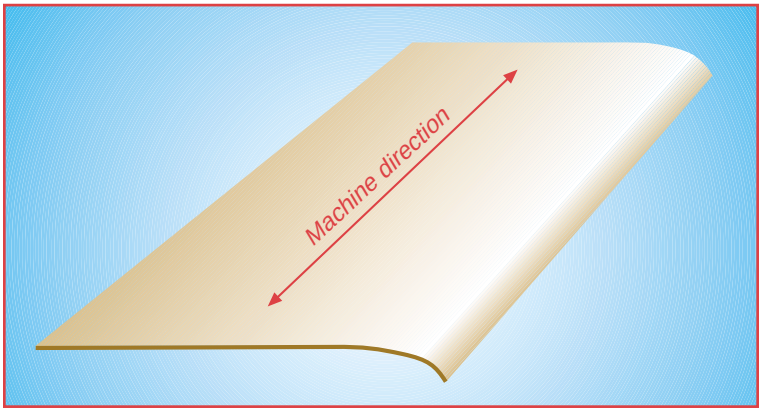
Continuous improvements in paper mill technology have decreased significantly the occurrences of a roll shipped with nonuniform moisture content. Sufficient protection both underneath rolls and those on top in outside storage will minimize and possibly preclude a wet edge from outside storage.

The most common cause of hook warp from the adhesive system involves a scraper blade which is functioning improperly, resulting in the metering roll not being wiped clean in a specific area. This adhesive left on the metering roll will add to the adhesive film on the glue roll and thus result in additional adhesive being applied from the glue roll in that specific area. Another common culprit is a metering roll that is worn or damaged on one end, resulting in increased adhesive application on that side of the web.

On vacuum type fingerless single facers, insufficient vacuum can cause the edges of the fluted medium to fluff away from the lower corrugating roll, resulting in prolonged contact with the glue roll surface. This causes excessive adhesive to be transferred to the medium.

If both the paper and the adhesive system are found blameless, the next task will be to inspect thoroughly the paper path of both webs prior to the entrance to the double facer. The goal is to identify any misalignments or out-of-parallel conditions which are causing one edge of the web to receive less heat than the balance of the web.

Let the shape of the hook guide your troubleshooting:



Hook warp: if the top edge of the web is wetter than the bottom it will hook up. If it is wetter on the bottom it will hook down (above).

The basic premise is that the paper will warp towards the side the moisture left last, i.e., the wetter side of the sheet.

Armed with an infrared heat gun and a machinist's level it is imperative to check each roll that may affect the intimate contact between the paper and the preheaters.

And then there's twist warp

Twist warp can be a machine problem or a paper problem. If it occurs consistently—that is, nearly all the time, and in the same shape—look for a machine condition such as roll misalignment.

If it comes and goes, or changes shape, chances are the paper is to blame. Twist warp often occurs when there is a mismatch greater than 5 degrees between the polar angles of the single face and double face liners.

Polar angle is defined as the angular difference between the machine direction and the average fiber direction of the paper.

There are five basic combinations of polar angle mismatch. For a detailed explanation, ask for a copy of our *Technical Information Bulletin* on twist warp.

For a quick test to see if your paper is at fault, see page 3 of this issue.

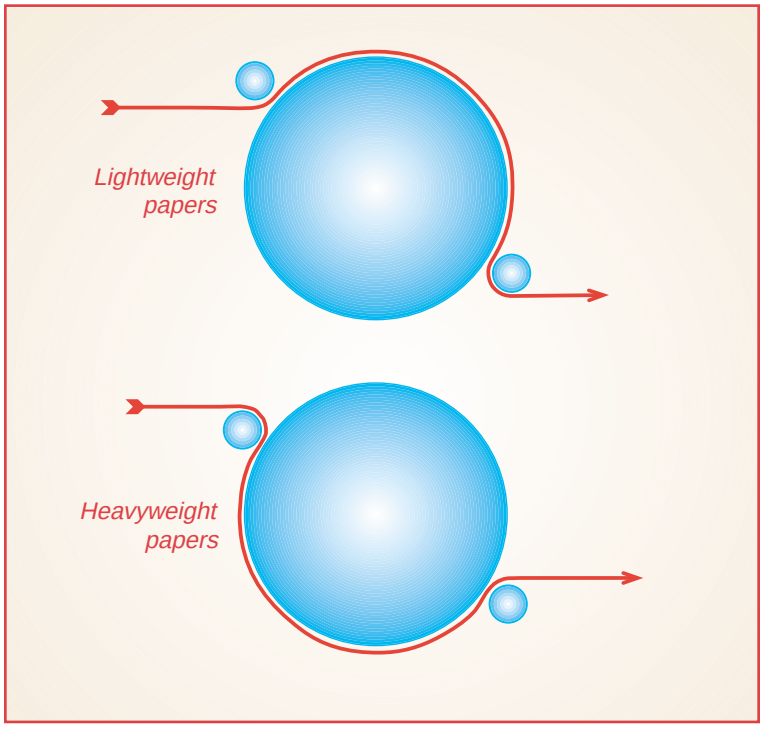
Wrap over, wrap under: does it make a difference?

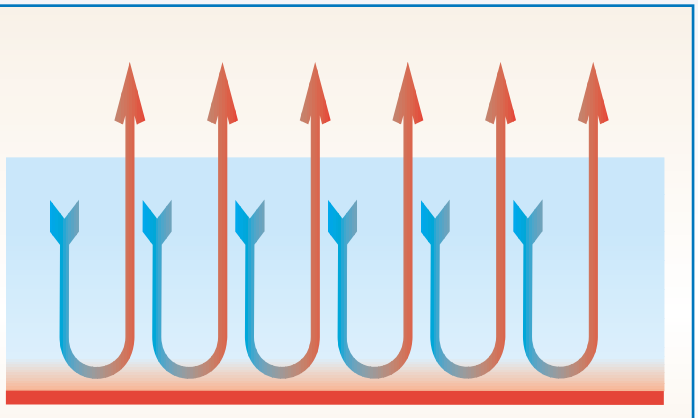
For years, box makers have disagreed over which way certain papers should be wrapped on the preheater to use the available heat most efficiently. We have experimented with various configurations which were intended to drive moisture toward—or away from—the glue line.

Considerations include how the moisture is evaporated from the sheet and how efficiently or inefficiently heat is transferred to the paper. One general conclusion is that the rate of heat transmission through paper is inversely related to caliper.

The physics of heating the liner will always cause the side away from the preheater to be lower in temperature than the contacted side by 1^0 to 1.5^0 F for each 0.001" of caliper. So a sheet that is 0.010" thick will have a temperature differential of 10^0 to15^0 F.

This heat differential is probably the reason we find most plants wrap the double face liner *over* the preheater for lightweight paper and *under* the preheater for heavyweight paper.





Moisture moves first toward the heat. As it becomes vapor, it escapes away from the heat, through the porous paper.

Quick, which way does the moisture go?

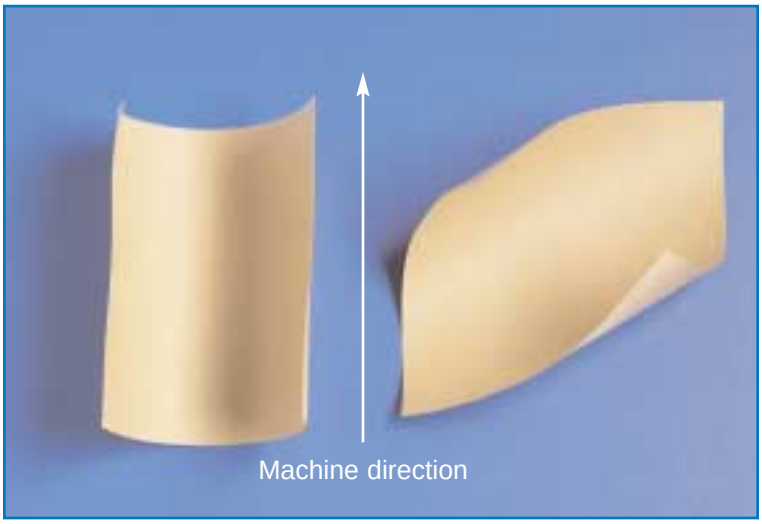
When a sheet of paper containing moisture comes in contact with a hot surface such as a preheater drum, the moisture present at the contacting side will be heated and turned into water vapor which will escape through the porous sheet. The dry area thus created will attract moisture still present in the adjacent areas. As this moisture migrates into the dry area it will also be evaporated and escape through the sheet. This creates a flow of moisture towards the hot surface until all this moisture has been evaporated.

Is there time for all this to happen?

At full wrap, the paper can contact a common 36" preheater for about 7 feet. At a high speed of 840 fpm or 14 feet per second, the contact time would be 0.5 seconds. A 33# liner is approximately 0.010" thick. For the moisture from one side to travel through the sheet to the other side, it would need to move at a speed of only 0.020" per second or 1.2" per minute.

So there is plenty of time for this to happen, but what actually limits the heating and drying rate is the fact that transferring the necessary heat energy from the hot surface to the paper is a relatively slow process.

A quick test for polar angle



When you experience twist warp, a simple test will indicate if the problem could be the result of one or both liners having a significant polar angle.

- Cut a square sample, about 6” x 6” from the liner material. Mark the machine direction.
- Dampen one side with a spray bottle, a wet rag or sponge.
- Lay the sample wet side down and observe how it curls.

If the polar angle of the paper is low (fewer than 5 degrees) it will curl symmetrically (sample on left). If the paper has significant polar angle, you will see it curl on an angle (sample on right).

You can demonstrate this effect for yourself by cutting two samples from good liner material. Cut one sample square to the machine direction, and the other at a 45 degree angle. Wet them both and watch what happens.

How to use a machinist’s level to help prevent warp

An out-of-level preheater, wrap arm, preconditioner, or idler roll will act as an out-of-parallel roll. This will cause uneven heat transfer to the liner and single face web. When there is uneven heat transfer in the corrugating process, it can produce warp because of moisture imbalance in the finished board.

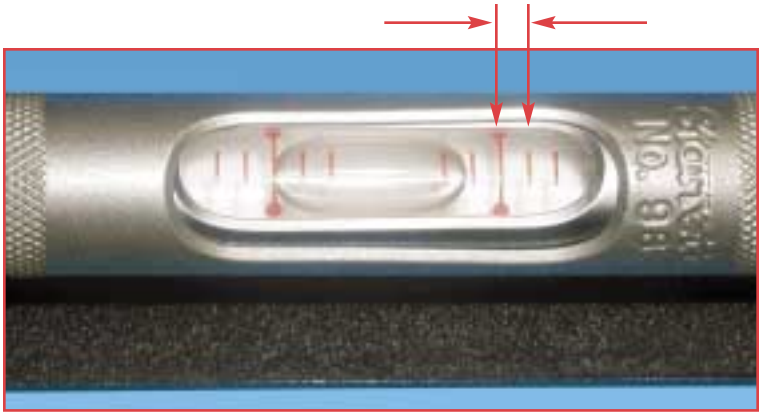
A simple way to check rolls and wrap arms for parallel is to use a machinist’s level. Different readings indicate an out-of-parallel condition.

The standard precision machinist’s level has graduation marks scribed on the bubble vial to determine the amount of elevation on the surface being measured. For levels of 6” to 18” in length, a bubble movement of one mark indicates an elevation of 0.005” per foot.

This number may seem small, but when multiplied by the full width of the corrugator, the error becomes significant. Corrugators range from 87” to 110” wide. By multiplying the width of the machine in feet by the number of graduations on the level, you find the total elevation of the roll or vessel. (You also need to include the length of the journal at the end of the roll or vessel. This makes the overall length of the roll 6” to 8” longer than the width of the corrugator.)

Another thing to consider is if a preheater is out of level in one direction and a wrap arm is out of level in the opposite direction. It is also useful to check each wrap arm at different points through its travel. There is a tendency for the gears to wear unevenly over time.

Each graduation on the bubble vial equals 0.005” elevation per foot



TOTAL ERROR ACROSS MACHINE WIDTH

Graduations	87” machine	98” machine	110” machine
1	0.040”	0.045”	0.050”
2	0.080”	0.090”	0.100”
3	0.120”	0.135”	0.150”
4	0.160”	0.180”	0.200”

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