**ADVANCED ADHESIVES REPORT**

Your corrugating adhesives newsletter
from Harper/Love Adhesives Corporation

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# XM-5 Penetrant

*Our laboratory uses an electronic timer to measure penetration of liquids through various substrates. This sample combination stopped the timer at 1 second.*

XM-5 Penetrant is a conditioning agent which facilitates adhesive release into paper substrates. By reducing surface tension, XM-5 Penetrant assists in the rapid penetration of the liquid phase of starch adhesive into the paper. This third generation penetrant was developed to penetrate and assist bonding of liners coated with synthetic polymers. The chemical composition of XM-5 also allows it to penetrate even the most difficult-to-bond substrates, including preprinted liners with a varnish overcoat.

### *Benefits*

- Enhanced starch adhesive penetration potential
- Low foaming action
- Consistent performance
- Easy to use

### *Features*

- Very effective surface tension reduction
- Precise quality control
- Convenient drum or bucket containers are available

*Plain water bead on right was applied first. At the time of the photograph, it had been sitting on the paper surface for several minutes. The spot on the left shows where water with XM-5 penetrant absorbed instantly.*

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# The evolution of performance-enhancing liquids

## *Older technologies were stepping stones to modern solutions*

For many years, starch adhesive was regarded as little more than a necessary evil in the corrugating business. It began to get serious attention as modernized corrugating equipment raised expectations for productivity and quality. Starch kitchens evolved quickly to high speed, high shear, automated systems, and we all began to focus research and development efforts on how to create effective liquid products to enhance the performance of starch adhesive.

The precision of automatic adhesive systems makes it fairly easy to control viscosity and gel point. More challenging is the process of controlling adhesive penetration, water holdout, and setback on the glue line. Higher corrugator speeds, thinner, hard-to-penetrate papers, and the variable nature of board components demand increasingly sophisticated solutions.

> ***Unlike earlier technology, our liquid systems control both the speed and depth of adhesive penetration, as well as increase or reduce adhesive water retention (hold-out). We can also adjust adhesive setback as needed for a variety of substrates.***

One early solution involved the use of polyvinyl alcohol. PVA is a synthetic polymer made from polyvinyl acetate. Polyvinyl alcohol films are about two to four times stronger than starch films, and under ideal conditions, showed some promise for increased corrugator speeds. Unfortunately, PVA exhibits an extreme gel reaction with borax in alkaline starch adhesives, and has a limited shelf life. It also tends to increase viscosity in storage, to the point that its effect on adhesive properties becomes difficult to anticipate or control.

Paper and chemical companies have been trying for more than 40 years to overcome or control this problem. Specific grades of PVA are relatively more borax tolerant, and PVA can be chemically modified to exhibit less extreme reaction with borax. However such chemical modifications tend to reduce adhesive bonding with starch because the substitute chemical groups form weaker hydrogen bonds with starch. Current PVA liquid offerings perform better than plain starch adhesives, but plant trials demonstrate they still do not compare with more modern developments.

As we began to develop liquid performance enhancers, Harper/Love Adhesives explored the pluses and minuses of PVA and concluded the technology did not merit further attention. Still, it provided a valuable starting point for research and development that led to better solutions.

Today our liquid performance products represent third and fourth generation products developed to answer specific customer needs. They provide a valuable, cost-effective production tool that allows the corrugator to control independently several key adhesive parameters. Our liquid systems can control both the speed and depth of adhesive penetration, as well as increase or reduce adhesive water retention (hold-out). We can also adjust adhesive setback as needed for a variety of substrates.

The proprietary technology we've gained through the development of four generations of performance enhancing liquids allows us to suspend both natural and synthetic ingredients in liquid form. We achieve a synergistic effect which modifies the rheology of the starch and dramatically improves the film-forming characteristics of the adhesive to promote better pick-up, transfer and application. This allows higher solid formulations to be used without increasing the applied cost.

These higher-solid formulas improve and accelerate the bonding process in both high performance and recycled substrates. They also promote a flatter, drier sheet because there is less water to remove in the corrugating process.

As good as they are, our current products will someday be regarded as stepping stones to something better. When that day comes, we'll be the first to tell you not to buy outdated technology. It will be an easy sell.

Looking to the near future, we are developing at least two liquid performance products for gluing such difficult substrates as heavily varnished, pigment-coated preprint liners and high speed gluing of plastic coated medium or liner for wax replacement.

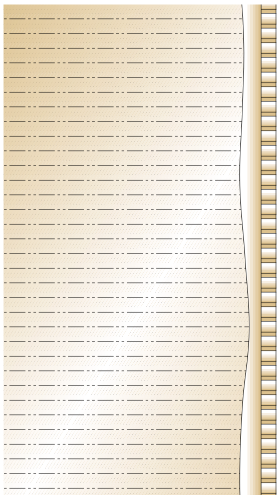
Stay tuned.

*by John Swafford*
*R&D Chemist*

# Solving loose edges

### *How to cure a loose edge on the bottom liner side of the combined web.*

*by Chris Polster and Bill Nikkel*



A loose edge on the bottom liner usually (but not always) occurs on one side of the web, 2" to 6" in from the edge. It happens most often while trying to get higher speeds running heavyweight combinations.

The root cause of the problem is steam created as the board is heated. Moisture from the bottom liner and the adhesive is flashed off into steam. This steam migrates through the flute cavities to the edges where it is released from the board. The prolonged presence of steam makes it difficult for the double face glue lines to dry at the edges, leaving soft, green bonds which are easily disturbed and separated.

### *What to do about it:*

1. Make sure the board edges are kept in good contact with the hot plates for optimal heat transfer and drying of the glue lines. On a double backer operating with ballast rollers, check to see if the belt edges are worn thin. On machines operating with other types of belt loading mechanisms, make sure the edges are held down with enough pressure.
2. Eliminate conditions which can cause the board edges to flex. Flexing can cause the still-soft green bonds to shear apart.

Some examples:

- A belt lifter bar protruding above the hot plates will cause the board to hump over it, flexing the soft edge.
- A shear set too high can force the board exiting the pulling section to hump up, causing the soft glue bond at the edges to separate.
- Trim knives at the slitter-scorer can also cause glue bonds to separate at the edges–especially if the flat side of a conventional bottom knife is facing inward, which tends to peel the bottom liner edge downward.

3. Another solution may be to increase the solids of the adhesive, which will produce stronger bonds in less time.

## *Fourteen Go-to Guys have more than 10 years serving Harper/Love customers*

The rapid expansion of our field service staff in recent years is built on a foundation of longevity and low turnover. Our congratulations and thanks to these veterans who set a very high standard.

Augusto Cavallini
Sales Representative
10 years

Jim Carbone
Tech Representative
11 years

Lou Cuccia
Region Manager
16 years

John Curieli
Tech Representative
12 years

Bill Gerard
Region Manager
17 years

Roger Holzmeyer
Sales Representative
12 years

Bill Loppnow
Sales Representative
11 years

Mike Manion
Sales Representative
22 years

Greg May
Sales Representative
10 years

Archie Miller
Sales Representative
10 years

Barry Mitchell
Sales Representative
11 years

Fred Rekola
Sales Representative
15 years

Phil Smith
Sales Representative
11 years

Peter Snyder
National Sales
Representative
15 years

# Backward is better

It is common practice in our industry to group the hot plates of a double facer into two or more sections, and to operate with higher steam pressures and temperatures in the first section, and lower pressures and temperatures in the later sections.

It is also customary to use more ballast on the leading hot plates than on those downstream.

These practices may seem to make sense, but they are inconsistent with some important thermodynamic principles. Scientific inquiry long ago established that for heat energy to flow, a temperature differential must exist. The greater the differential, the faster the transfer of heat.

In our conventional arrangement, we use lower-temperature hot plates toward the end of the line. Since the paper is getting hotter as it encounters cooler plates, the result is lower temperature differential between the two, and less overall transfer of heat.

We also know that heat transfers best when there is intimate contact between two surfaces. This is called conduction. The better the contact, the faster the transfer of heat.

In our conventional setup, we use less ballast toward the end of the line, which reduces intimate contact between the paper and the hot plates, and slows heat transfer.

**From these facts, we conclude that "backward is better."**

If we reverse the conventional arrangement, putting higher temperatures and greater ballast toward the end of the line, rather than at the beginning, we achieve greater overall heat transfer.

The benefits can include better adhesive bonding, faster running speeds, and dryer, firmer, flatter board.

*"Backward is better" was pioneered by Bill Nikkel and Bud Stickle of Stickle Steam Specialties Co. To learn more about the research that led us to these conclusions, ask your Harper/Love technical representative for a copy of the video, "Backward is better," available in both English and Spanish.*

### *A little story about heat transfer*

To understand heat transfer, it might be helpful to compare it to the flow of electrical energy. The flow of heat energy follows basically the same rules as the flow of electrical current, except that it is very much slower.

When a resistor is inserted in an electrical circuit, it causes a voltage drop across itself. When an insulating substance is inserted in a heat transfer circuit, it causes a temperature drop across that insulator.

For electrical current to flow (amperage), there must be a difference in voltage: the higher the difference, the higher the flow (amperage). For heat energy to flow, there must be a difference in temperature: the higher the differential, the more rapid the transfer of heat.

This explains why the conventional approach of reducing the temperature of the last hot plate sections is not productive, as this reduces the temperature differential between the already heated paper and those plates and thus slows down the rate of heat transfer. It makes more sense to put the hottest plates toward the end, to maintain a greater heat differential between the plates and the heated paper (See "Backward is better," left).

Like electricity, heat flows (transfers) most rapidly when there is intimate contact (low resistance), so it can transfer by conduction.

To promote intimate contact in the hot plate section of a corrugator, the board needs to be pushed down firmly onto the hot plate surfaces, evenly across the machine.

Paper is in essence a porous mat containing cellulose fibers and air, both of which have a high resistance to heat flow. Even a thin, 0.001" layer of air between the heating surface and the board drastically reduces the rate of transfer.

Because heat transfer through an insulator is slow, the exposure time of the board to the heating surface is an important factor.

Think twice before shortening a hot plate section, as the shorter exposure time will make it harder to achieve the temperature needed to gel and set starch-based adhesives. The shorter heating time also requires a starch adhesive to be heated to a higher temperature to achieve acceptable gelatinization.

*by Bill Nikkel*