MAY 2015

ADVANCED ADHESIVES REPORT

Your corrugating newsletter from Harper/Love Adhesives Corporation

THE EVOLVING SCIENCE OF BETTER ADHESIVES

By Peter Snyder and Rex Woodville-Price

TEST • QUANTIFY • VERIFY • IMPROVE

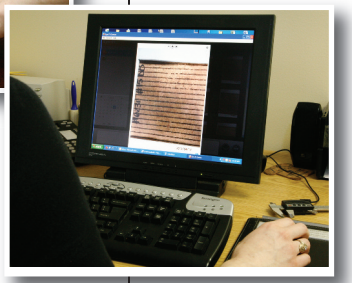
Things change: the needs of our customers (and their customers); the materials we have to work with; the technology of paper, adhesives, moisture resistance, and corrugated production.

It is the function of our in-house laboratories to anticipate these changes and develop products and services that will meet and exceed customer needs and expectations. Here are some of the ways we do that.

Research and development

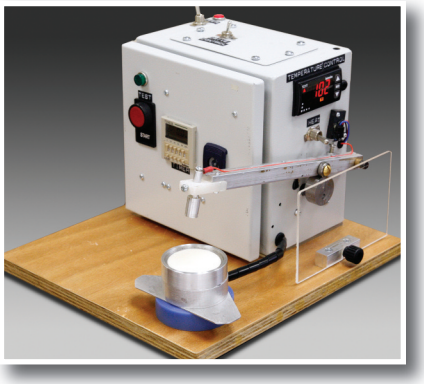
The purpose of R&D is to create and perfect new adhesive products, and to improve existing ones.

This capability includes not only chemical analysis, but also specialized equipment of our own design to simulate and measure adhesive parameters such as filming, transfer and substrate penetration. Other equipment we have developed has the ability to manipulate variables such as time, temperature and pressure so we can observe the effects on the bonding process as it occurs on the corrugator. One tester mimics the behavior of the double backer. Since bonding the top web on double wall or triple wall is generally the most challenging area to form a bond, this tester is very useful to predict behavior on the corrugator.



Chemical testing

In addition to R&D, our chemistry lab allows us to test products for quality assurance. Incoming materials are tested to ensure they meet our standards and specifications. As we typically manufacture using a batch process, we can capture samples at different times during the batch, analyze the findings and make necessary adjustments before continuing. This guarantees compliance and homogeneity of the entire production run. When the batch is finished, it is again tested before it is released to packaging.



We save samples of each production run in storage. In our database, we keep detailed records of the different characteristics and test result data for each lot number. If there is ever a question about product in the field, we can check it against the retained sample.

These samples also allow us to monitor any changes over time, by comparing the new test results to those stored in the database for that lot number. Routine checks of this type allow us to predict accurately the behavior of our products as they age in storage and be sure of their performance even past their anticipated shelf life.

One of our sophisticated tests includes the Brabender evaluation for starches. The Brabender is a device which produces an accurate viscosity and setback "finger print" that is unique to each type of native starch and modified starch product. Sort of like an EKG for starch products. We use the Brabender for both raw material QC and also as an R+D tool to help us develop products with aggressive set back and bonding characteristics.

Board and paper testing

In order to ensure that our products are doing their job in the field, and to help diagnose our customer's problems, we maintain our own board and paper testing laboratory. Here

we run tests that have become standards for the corrugating industry.

Since paper is the major component of a box, we test it to gain understanding of its influence in the process and its role in the structure of the box. We perform tests such as Ring Crush, Cobb and Gurley porosity. These types of tests help us predict behavior of the paper on the corrugator and in the box. With tests like Ring Crush and ECT we can use McKee's formula to extrapolate box compression performance.

Finished board tests determine its physical and mechanical properties. We routinely run such classical tests as ECT and pin adhesion (PAT). We also test board to measure its performance in humid environments with tests such as 24-hour soak, wet pins and FEFCO #9 (AKA the fish tank test).

Where applicable, our testing methods conform to TAPPI standards. This makes the tests standardized and provides results which are easily interpreted.

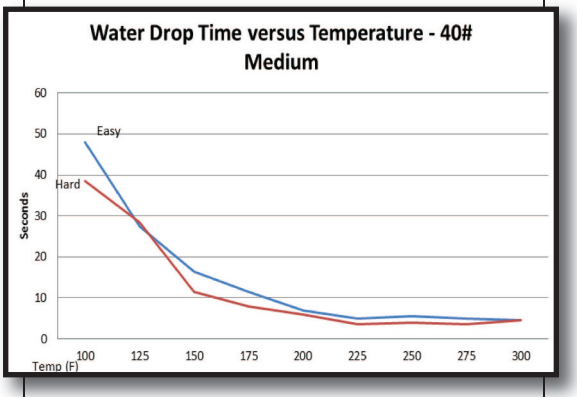
We also use test results to help customers select product solutions to overcome bonding challenges they are facing. Before-and-after comparisons demonstrate the effectiveness of the recommendation.

WHAT DETERMINES MEDIUM RUNNABILITY?

By Rick Bird

For many years now the old, simple test method of putting some water on medium and seeing how it absorbs has been used as an indicator for how well it will run. There are even some TAPPI standards for both water drop and float curl testing available for measuring absorption if you want to be scientific about it. While there certainly is truth to needing a good absorption for adhesive penetration, the way that we test often doesn't simulate what actually happens on a corrugator. Most of this testing is done at room temperature. However, as we all know, many papers tend to open up as their temperature is increased. Before we bond it on a corrugator, the paper is typically heated to between 140 and 210F. The graph below shows the water drop results of a known difficult to run 40 lb medium and a known easy to run 40 lb medium at various paper temperatures:

This graph in a lot of ways tells a very unexpected story. The hard to run medium actually had a better water drop time than the easy to run medium. I wouldn't read too much into that though because these are just two samples and there's certainly not enough data to say that this is anything other than an anomaly, but what I do find telling and I have seen repeated on multiple paper samples, is that as we approach corrugating temperature, both mediums have practically the same absorbency. It does make you wonder if our old absorbency test is really telling us what we think that it does about runnability.



This got me to thinking if the real world difference in absorbency is so small from one medium to the next, then what else might be measureable that could affect runnability? This led me to think about flute formation. Absorbency can play a part in flute formation because moisture is needed to make the fibers pliable, but so does fiber orientation and paper caliper.

Another common test in paper testing is the ring crush test. Typically for this test you cut samples in both the machine and cross direction and measure the force needed to cause them to buckle. These results are then combined into a final ring crush number. In thinking about flute formation, the cross direction is the direction in which the paper is bent to form a flute. This begs the question then, would we get an enhanced determination of medium runnability by testing the ring crush in the cross direction? So out of curiosity, I decided to perform this test on the very same mediums used in the water drop graph. The hard to run medium had a 112.2 RCT and the easy to run medium had a 97.4 RCT in the cross direction.

So the hard to run medium was about 15% more difficult to bend. This, of course, is only two samples. So we can't say for certain that we've proven anything about cross direction ring crush and its relation to medium runnability. Nor established any guidelines about what RCT levels are difficult to run. Other factors certainly would have to be taken into consideration as well as a lot more testing, but the results are at least interesting to consider.

PAPER TENDENCIES

By Rex Woodville-Price

The liners and mediums we run on our corrugators today differ from those we used to run even a decade ago. Their properties are different and they behave differently on the machine. Like many things that evolve in an already mature science, these changes occurred gradually. In part, the drive was a need to reduce costs and keep corrugated boxes competitive when compared to other alternatives.

The raw materials for paper making have changed from the traditionally, exclusive use of virgin fiber, to an ever increasing content of post-consumer recycled fiber. Many types of papers are made entirely of recycled fiber, including fiber from nontraditional sources, such as office waste.

As papermaking technology continued to improve, mills were able to reduce the amount of fiber in the sheet while at the same time, improving its physical and mechanical properties. This led to increased performance of the liners and mediums, resulting in stronger combined board and as a consequence, a more resistant box. This increase in strength has allowed box makers to use lighter weight papers and obtain the same ECT and BCT values. Some paper grades have almost entirely been replaced by lighter versions. We see very little 69 pound per MSF liner these days because it is often substituted by a 57 or even 52 pound liner. At the other end of the spectrum, it is not unusual for some plants to run liners as light as 18 pounds per MSF.

One of the methods that has been implemented to improve the mechanical strength of the paper, (specifically Ring Crush Test values), is to make the it more dense. This is done by pressing it or essentially squeezing it together. This can make the paper stronger as well more resistant to deflection.

Another outcome of being subjected to more pressure at the press, is that paper has less air pockets in it. Since air acts as an insulator, these papers transfer heat more quickly. Furthermore, because they have less caliper for the same basis weight, the heat has less distance to travel. At the machine this translates to paper that picks up heat more quickly and requires less wrap to achieve optimum bonding temperature. The upside to faster heat transfer is that it can also promote faster run speeds.

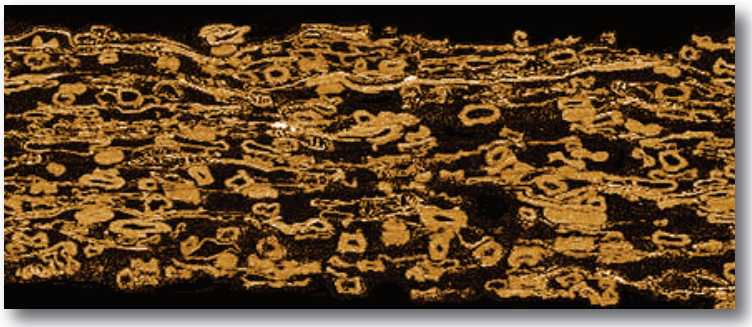
One more way the strength of the paper has been improved is by manipulating the fiber orientation. More of the fibers can be oriented a certain way to make the sheet stronger in that direction. In some cases, this can come at the expense of lower tensile strength in the other direction. More care needs to be taken with these papers to avoid tearing out during splices. This places greater emphasizes on having good tension control and ensuring the machine is parallel.

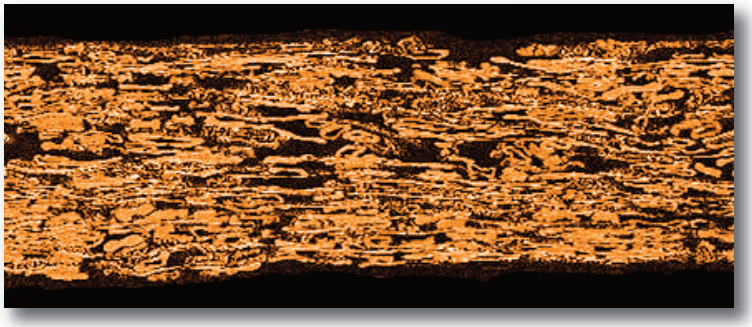
Lower tensile strength can also lead to cracked scores, since the liner is subjected to large forces when it is folded at a score. The problem is exacerbated by overheating the papers, which can be easy to do, since they transfer heat more efficiently. Too much heat will drive of the moisture and weaken the fibers.

Something else that has changed is the manner in which water is absorbed. Some papers will absorb water very quickly, they have high Cobb values and low Water Drop values. Other “closed” papers have more additives and sizing, this reduces their porosity and slows water absorption. A particularly interesting challenge is bonding these two different papers together in the same corrugated sheet. One paper tries to absorb all the water leaving none for the other. Water absorption can impact bonding since typical starch adhesives are 75% water. If water can’t get in, neither can the adhesive. On the positive side, these papers often require less adhesive to bond them.

Papers have changed, this has become a fact of life when running a corrugator. Now more than ever it is imperative to manage temperatures, control tensions and ensure machine alignment is correct. However, these changes have also allowed our industry to stay competitive and “green” by making more efficient use of our resources.

These pictures show two papers with the same basis weight, however, the one on the right is more dense and has less caliper. They will exhibit different behavior on the machine.





Leaders in the science
of making
good adhesives better™

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In this issue:

XM-5 PENETRANT

XM-5 Penetrant is a conditioning agent which facilitates adhesive release into paper substrates. By reducing surface tension, XM-5 Penetrant assists the liquid phase of starch adhesive to migrate rapidly into the paper substrates to be bonded. 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.

XM-5 also helps retain moisture in the sheet to prevent overdrying and reduce the risk of score line cracking.

Benefits

- Enhanced starch adhesive penetration potential
- Helps reduce score line cracking
- Helps sheet retain moisture
- Low foaming action
- Consistent performance
- Easy to use

Features

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

Our laboratory uses an electronic timer to measure penetration of liquids through various substrates.

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.