



Test. Quantify. Verify. Improve.

The evolving science of better adhesives

by Rex Woodville-Price

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.



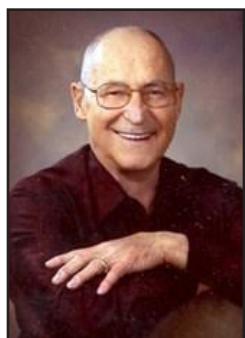
As we typically manufacture using a batch process, we can capture samples at different times during the batch, analyze the findings and make necessary adjustments before continuing. This guarantees compliance and homogeneity of the entire production run. When the batch is finished, it is again tested 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.

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Ron Harper, 1932-2012



From the earliest days of Harper/Love, Ron Harper was an innovator and articulated a vision that our company should lead by being not just a supplier, but a resource for the corrugating industry.

He foresaw that the company would succeed by putting the needs of our customers first. This same dedication to others motivated his involvement in industry associations such as TAPPI; if the industry flourished, we would too. Ron extended this philosophy in his personal life with his generous donations to many causes such as the Smart Board program. He and Katherine will long be appreciated not only for their business acumen but also for their desire to give back to the people and country that allowed them to accomplish their goals and dreams.

Ron Harper will be remembered as a mentor and a friend to all who knew him. Harper/Love will continue to be guided by his spirit of innovation and his commitment to the ever-changing needs of our industry.

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).

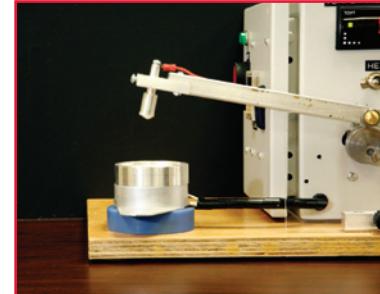
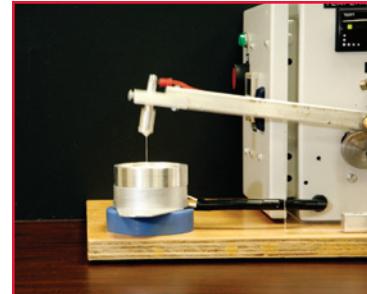
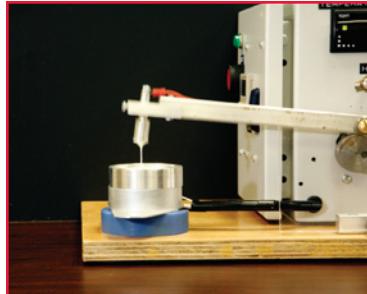
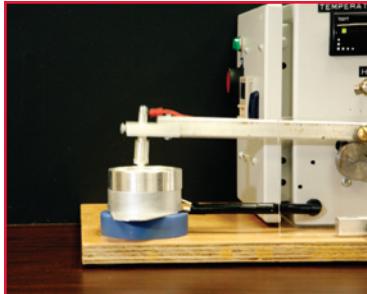
Where applicable, our testing methods conform to TAPPI standards. This makes the tests standardized and provides results which are easily interpreted.

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.

Some useful tests

and the equipment we use for accuracy and repeatability

by Rex Woodville-Price



Stringiness

One of the attributes of an adhesive that affects its behavior on the corrugator is its propensity to form strings as it is pulled apart. This is particularly important at the point where the flute tip leaves contact with adhesive film on the surface of the glue roll. Excessive stringiness is often associated with slinging at the glue machine.

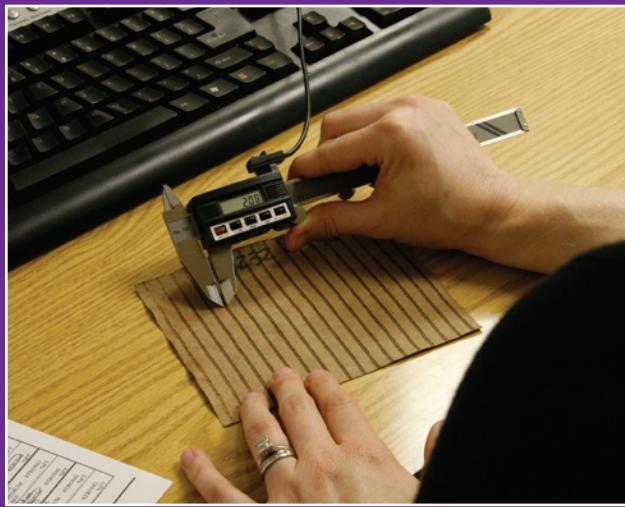
This characteristic is often described as *tack* or *leg*, but for now we'll call it stringiness. Although it is sometimes implied to be part of the adhesives rheology, that term really describes something else. Since this behavior of the adhesive is something we can manipulate through formulation and with the use of additives, we want to be able to measure it.



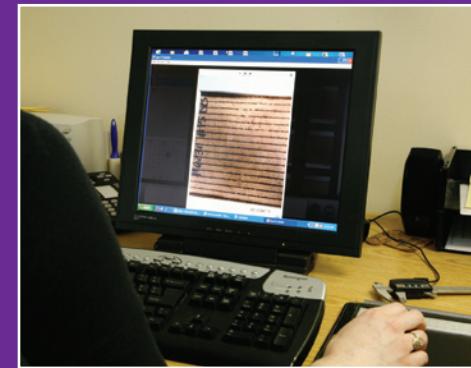
We have all seen someone dipping their thumb and finger in the adhesive and then pulling them apart to make a little string between them. This is a quick and useful test but it is very subjective and inconsistent. We need something that can consistently put a number on this and remove the tester's subjective judgment from the equation. We turned to industry legend Willem (Bill) Nikkel to design this apparatus for us. Now we have a scientific, repeatable test to quantify this important parameter.



The test apparatus heats an adhesive sample to maintain it at the temperature at which it will be run on the machine. The end of the arm has a test probe, which is dipped into the adhesive sample and then withdrawn to create the string. When the probe touches the liquid, a digital stopwatch is started as electricity begins to flow through the string. When the string breaks, the circuit is interrupted and the timer stops, measuring the elapsed time. Since the arm travels at a controlled and constant speed, it is easy to calculate the distance and thus assign a linear dimension to the string.



Glue line recording and measurement



Glue line width is an important component of board quality and a parameter that has a high correlation to adhesive application rate. It is therefore important to measure and monitor. Most of us are aware that, aside from being wasteful and slowing the machine down, excessive application usually brings with it washboarding or warp problems. Insufficient application can degrade pin adhesion values and drastically lower the performance of the board in humid environments (WRA).

When we break the bond with the pin adhesion test, we force the chain to break at the weakest link. Using the proper adhesive we seek to ensure that the adhesive itself is not that weakest link. We want the break to occur at the paper, usually indicated by sufficient fiber tear. Since the typical box that costs a dollar, has about 80 cents worth of paper in it and only about 2 cents worth of adhesive, it then makes sense to try to maximize the performance potential of our most expensive raw material. Measuring and examining glue lines is an important check in this endeavor.

Water drop test (penetration)

This test measures how fast water penetrates into paper. Since starch based corrugating adhesive is 75 percent water, it is of crucial interest to us how this water moves through a particular paper. The quick and dirty way the water drop test is usually done in the field is to place a drop of water on a piece of paper and then count the seconds until the water is seen to penetrate to the other side.

In order to automate the test and increase its accuracy and repeatability, we use a special test apparatus designed by Willem Nikkel. The apparatus employs a thermostatically controlled heating element to maintain the desired target temperature for the paper. The instant the test solution is placed on top of the test sample, the liquid activates the chronometer. When the test solution penetrates to the other side of the sample, a circuit is completed and the timer stops, thus precisely measuring the time required to soak through. The result is recorded in seconds.

For hard-to-penetrate papers we test with our proprietary penetrant, XM-5. Papers that take minutes to wet through with water will do so in just seconds with the addition of a little XM-5. This is significant because on the corrugator you only have a fraction of a second to make the bond after the application of the adhesive.

So we find it very useful to record the width of glue line with its corresponding pin adhesion value. To measure the glue line width we use an electronic vernier caliper, which is hard wired to the computer and can record the width, at the press of a button.

To complement the glue line width measurement, we also photograph the sample using a specially designed camera fixture. The setup assures consistency by always having the same distance and same lighting angles. The digital photographs are automatically stored in a database and tagged with the corresponding sample number.

These pictures can then be e-mailed along with test results allowing someone to analyze them at a later date and from a remote location. The shape of the edges and the consistency of the glue lines are of particular interest when the glue line dimensions were less than recommended and when pin adhesion values are below expectations.



Our penetration tester has the ability to heat the paper sample to be tested, in order to more closely replicate machine conditions. Certain papers react differently at room temperature than they do at the 150 degrees to 200 degrees to which they are generally heated on the preheaters. With the current trend to use coated paper or wax replacement mediums, it becomes more important to study their absorption at realistic machine temperatures. The insights gained from these tests help us determine optimum machine setting to run these papers.

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The evolving science
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Leaders in the science
of making



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.