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ADVANCED ADHESIVES REPORT

Your corrugating newsletter from Harper/Love Adhesives Corporation

Optimizing adhesive viscosity

Tweaking the formula; diagnosing and correcting adhesive issues

By Rex Woodville-Price

As field techs visiting different box plants, we are often asked what adhesive viscosity to run. While there are generally established values for viscosity, it is often possible to optimize the viscosity for a specific machine. Several factors can affect the viscosity requirements for a machine:

- **Type of mixer:** Older mixing equipment, with marine type propeller, will deliver adhesive that will lose viscosity due to mechanical stresses. Often, with this type equipment, the batches are deliberately finished at a higher viscosity in order to compensate for viscosity losses as the adhesive is consumed.
- **Adhesive delivery system**: Adhesive loops with constant circulation, numerous elbows or gear type pumps will shear the adhesive over time.
- **Restrictive plumbing:** Glue machines (DB or SF) may have restricted piping and may require lower viscosity to ensure sufficient adhesive supply during high-demand operating conditions.
- **Applicator roll surface:** An anilox type glue roll with cells may need an adhesive with different viscosity than one with a sandblasted surface.
- **Penetration:** To a small degree, viscosity affects penetration and water holdout, so it may be manipulated to help bond certain papers.

Generally, single facers tolerate or even prefer lower viscosity than double facer glue machines. This is partly due to the differences in how the bond is made, with higher pressure and temperature. With older finger type machines, slightly lower viscosity is beneficial in allowing the adhesive to flow and bridge the gap left by the fingers (the so-called finger lines). Using separate formulas in the SF and DB is usually called running dual viscosity formulas. Despite this name, these formulas vary more from each other in solids content and gel temperatures than they do in actual viscosity.

Keeping viscosity stable adds consistency to our process because viscosity affects application rate. Higher viscosity adhesive will typically have a higher application rate, for the same glue roll to metering roll gap, than a less viscous adhesive. On the other hand, there are additional factors that affect application and bonding as well. Tack and filming properties are examples of this; they are generally classified as the rheology of the adhesive. They can be modified through formula adjustments, which are largely unrelated to viscosity.

External factors

Most viscosity problems are caused by external factors that affect a formula that started out with proper viscosity. These factors are usually related to a temperature change in the adhesive, dilution with water because of a leak, or even bacterial attack. These problems must be identified and remedied at their source, not covered up by altering the formula. In other cases, when variances in the raw materials (such as caustic sensitive starch) are responsible for viscosity instability, modifications to the formula may be the only way to consume these materials.

There are signs and diagnostic tools, which will aid us in determining if we have the right viscosity. Iodine stains are particularly useful in seeing viscosity related problems since glue line integrity is compromised by improper viscosity. Other signs of improper viscosity include slinging, foaming or glue pans that run out of adhesive at speed.

It is important to understand viscosity can be manipulated independently of other formula parameters such as solids content and gel point. Viscosity has to be formulated for a specific temperature since viscosity changes with temperature. Conversely, a given formula is designed to have a target viscosity within a relatively small temperature range. If the adhesive is not at this temperature, the solution is to correct the temperature problem and not to try to fix the problem by changing the formula. Most modern adhesive storage tanks have a system to maintain the adhesive at a constant temperature; it is referred to as the Temperature and Viscosity Control or TVC. Most plants in the U.S. choose a temperature range of 100° F to 105° F (37.7° C to 40.5° C). If the system is capable of holding the adhesive within a five-degree range, the viscosity should not vary more than ±3 seconds Stein Hall.

Although modern starch mixing equipment is very good at delivering consistent adhesive, there will always be some variation. When setting a viscosity target range it advisable to set a realistic goal. If the range is set too tight, even acceptable adhesive will constantly appear to be out of specification. Implementing an appropriate range is particularly important when trying to comply with quality programs such as ISO 9000.

Correcting out-of-spec adhesive

Additionally, there must be procedures in place to deal with adhesive that is found to be out of spec. Adhesive with a small deviation in viscosity may still be runnable and may require special attention from the operators only to compensate for application rate. A larger variation will require some corrective action such as making a new batch to mix with the out-of-spec adhesive in order to correct it. These procedures should be documented with the viscosity ranges at which certain actions must occur.

Although correcting high viscosity with the addition of water is a common practice, care should be taken to avoid adding too much water, since it dilutes the chemical properties and will cause bonding problems. Under no circumstances should borax be added to low viscosity adhesive to increase its viscosity. The only acceptable way to correct low viscosity adhesive is to mix it with higher viscosity adhesive. Adhesive that is out of spec, because it sat over the weekend for example, is often segregated in a separate tank and then slowly mixed with fresh adhesive as the machine runs. If you must adopt this practice, avoid blending it when running more challenging board such as double wall; instead do so when running lighter weight industrial board.

Calibrating thermometers for accuracy

Simple tests reveal whether your thermometer is telling the truth

By Rex Woodville-Price

Thermometers, like most precision equipment should be calibrated on a regular basis. In a box plant, they should be checked every other week.

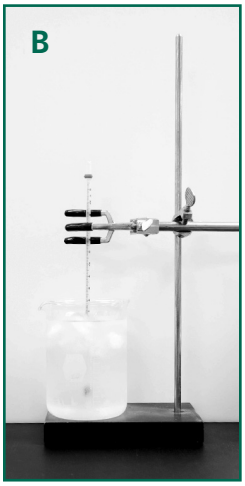
Although they are not adjustable, you should know how much they vary from a true reading. This will help you compensate for a small variance or decide to discard the thermometer if it is no longer accurate enough.

How to check accuracy

Water changes from a solid to a liquid and from a liquid to a gas at very specific temperatures. This phenomenon provides us with an accurate and convenient way to check a thermometer at both ends of its range. Thermometers need to be immersed to a minimum depth to read accurately, this distance is usually marked with a line near the bulb. (Photo A)

Ice water. Fill a one-quart container with crushed ice and water. Allow it to sit for one minute. Place the thermometer in the center of the container past its minimum insertion mark. After one minute the column should stop moving and the temperature should read 32° F or 0° C. (Photo B)

Boiling water. Place the thermometer in the center of a container with boiling water (past its minimum insertion mark). Ensure it doesn't touch the sides or bottom of the container. After one minute the column should stop moving and the temperature should read 212° F or 100° C. (Photo C)



Compensate for altitude

Make sure to compensate for the altitude of your particular location. Water boils at lower temperatures as altitude increases, because at higher elevation barometric pressure drops and as a result, vapor pressure is decreased. Therefore it takes less heat energy to get the water to boil.

ELEVATION	BOILING POINT
1,000 ft	212° F
2,000 ft	210° F
3,000 ft	208° F
4,000 ft	206° F
5,000 ft	204° F
8,000 ft	203° F
10,000 ft	194° F
12,000 ft	190° F
14,000 ft	187° F

Choosing and using thermometers

Tools and techniques for measuring adhesive gel temperature

By Ronnie Littleton

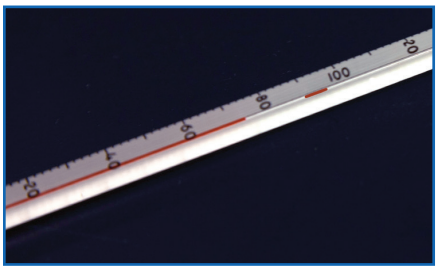
Gel temperature is one of the primary quality checks performed on corrugating adhesive. When you have that right, you're a long way toward producing high quality board and avoiding various corrugating problems. Obviously, you can't check gel point without a thermometer you can use with confidence. Here are some ideas for choosing, checking, and maintaining this basic tool.

Thermometer types and their characteristics

- Older glass thermometers were filled with mercury but those have been getting phased out over the years due to the health hazard concerns associated with mercury. Newer thermometers are commonly filled with a colored mix of alcohol and water or sometimes other chemicals such as kerosene.
- Small digital thermometers work well but it is critical to avoid touching the test container wall because the reaction time of this type thermometer is much faster than a glass thermometer and you can easily miss the gel temperature altogether.
- More expensive thermocouple digital probes are also very accurate but, like the digital instruments, are often misused due to excessive contact with the container wall.
- Analog cooking thermometers are sometimes used, but these aren't as accurate, especially the small pocket type.
- Standard alcohol thermometers are very accurate and easy to use, which makes them by far the most popular choice. Common problems with this type are slow column rise and slow reaction time. These issues can be difficult to recognize but should be checked if the gel temperature reading seems too low.

To check for slow column rise you will need another thermometer for comparison. Simply place both units in a hot liquid and see if they react at about the same rate. Unfortunately, there's nothing that you can do to correct slow column rise except replace the thermometer.

Column separation is another problem with glass thermometers that can have a significant impact on your results and can easily go undetected. The separation itself is often caused by mechanical shock. Depending on where the separation occurs in the column, the effect on your reading will be more or less dramatic. Your thermometer could be anywhere from 2° F to 5° F low. If this goes unnoticed, it can cause unnecessary formula changes to be implemented, such as removing caustic to raise the gel on an adhesive that has nothing wrong with it.



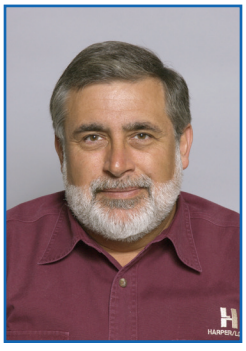
Column separation in glass thermometers can have a significant impact on results.

Column separation might be fixable

Fortunately, column separation can sometimes be fixed. One of three methods might work: tapping, centrifugal force or heating. (Always wear appropriate eye protection when using any of these methods.)

- If the separation is slightly above the main column, tapping will normally join the columns back together. Holding the top of the thermometer with bulb end down and tapping against a firm but not too hard surface (like a roll of liner) can work. Obviously there is some breakage risk to this method, so it should be performed with caution.
- Centrifugal force is another option for separation that is near the top of the main column. For this method simply grasp the top of the thermometer and sling with a downward force of the arm. Again this method comes with an obvious risk. Care needs to be taken to have a good grip on the thermometer and make sure that you aren't swinging into harm's way. Caution is advised but this method is slightly less risky than the tapping method.
- Heating is also an option if the separation is near the expansion chamber. Normally the thermometer's maximum temperature will be 220° F to 240° F. So boiling water (212° F) will not take the column to the expansion chamber. However, placing the thermometer bulb against a hot light bulb may move the temperature up to the expansion chamber. Do not allow the chamber to fill or the thermometer may burst. Once the column connects to the separation, remove the heat source and allow the thermometer to cool.

If none of these methods work you will need to replace the thermometer.



Ronnie Littleton, technical representative, has been with Harper/Love for nine years

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of making
good adhesives better™

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SOME THINGS NEVER CHANGE

Vision
Innovation
Service

We honor the memory of our founders, Ron and Katherine Harper, and remember with gratitude their legacy of vision, innovation and service. Their contributions to the corrugating and flexo printing industries have created opportunities for many, and set enduring standards of excellence.