

ADVANCED ADHESIVES REPORT

YOUR CORRUGATING NEWSLETTER FROM HARPERLOVE

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Caustic Soda

by Peter Snyder and Tim Church

Sodium Hydroxide, commonly referred to in the paper industry as Caustic Soda, is one of the primary ingredients used to make starch-based corrugating adhesive. Starch-based corrugating adhesive is primarily a mixture of water, cooked starch, uncooked starch, caustic soda and borax. This remarkable collection of natural, renewable ingredients is fundamental to the operation of almost every corrugator. While caustic soda has not changed, the use of this corrosive chemical has evolved during the past 40 years.

Over 80 years ago as starch scientists were evaluating the ways that starches could be used in industry, it was discovered that when starch was added to water and heated over 160°F (72°C) the starch would dissolve (or gelatinize) to form a sticky paste. Scientists also found that when the mixture of starch and water was treated with certain chemicals, like caustic soda, the starch also dissolved (or gelatinized). This information was used to create glues for paper products including envelopes and basic paper packaging tape. The use of starch-based glue continued to expand and ultimately replaced sodium silicate adhesive in the manufacturing of corrugated board after World War II.

Caustic soda is a commodity chemical widely used across many industries. It is made from saltwater via an electrolysis separation process that also produces chlorine gas. Caustic soda is generally supplied as a powder or a solution of a specified concentration. The most common solution is 50% solids (½ water, ½ sodium hydroxide).

There are several physical properties of caustic soda solutions that need to be considered when used in industry:

1. Sodium hydroxide is very corrosive, which is why it



is commonly called “caustic soda.” It can cause severe burns, so extreme care must be taken to avoid exposure.

2. The density of 50% caustic soda is 12.75 pounds per gallon. This is more than 50% heavier than water.
3. The storage temperature of 50% caustic soda is critical. The solids of this solution will begin to crystallize and fall out of suspension when its temperature goes below 54°F (12°C). Although not technically accurate, many people refer to this as the “freeze” temperature of caustic. As the temperature of the solution reaches this point, caustic becomes very difficult to pump.
4. As the percent solids of caustic soda solutions decreases, the temperature stability improves:
 - A 30% solids solution is stable to 36°F (2°C).
 - A 25% solids solution is stable to 0°F (-18°C).

While most corrugator plants use the maximum

concentration of 50% solids for efficiency and reduced transportation costs, some plants in colder climates use 30% or 25% solutions to minimize the risk of crystallization and pumping issues.

Corrugator plants in cold climates must maintain their caustic soda solution above its crystallization temperature. If the temperature of the caustic soda falls below its crystallization temperature, solids will begin to crystalize and fall to the bottom of the vessel. When this happens, the resulting solution is weakened below its specified strength, and the gel temperature of your adhesive will increase. As the level in the caustic storage vessel gets lower, the percentage strength of the solution can rise sharply due to the increased concentration of solids at the bottom. When this product makes its way into the mixer, the gel temperature of your adhesive will decrease. If this situation occurs and your gel temperature is not being monitored, the first indication could be a significant increase in waste coming off the corrugator in the form of “zipper board”.

The temperature of the liquid caustic soda in the storage vessel is not the only concern. Crystallization can also occur in the pipes used to transfer liquid caustic from the delivery point to the storage vessel, and the pipes from the storage vessel to the mixer. Some plants install heat tracing to warm the pipes and to help prevent the caustic soda solution from crystallizing when the plant is not running.

For plants that need to consider improved storage temperature stability for their caustic soda solution, there are a couple of options to consider:

- Maintain the TVC system for the caustic soda storage tank to keep the solution at 75°F - 80°F (24°C – 27°C).
- Use a lower concentration of Sodium Hydroxide (e.g., 25% or 30%). This will require a formulation change to the adhesive.
- Use a blend of Sodium Hydroxide and Potassium Hydroxide. This will likely not require a formulation change to the adhesive.

A winterized blend of caustic soda which contains a mixture of 50% Sodium Hydroxide (NaOH) and 45% Potassium Hydroxide (KOH) delivers improved temperature stability along with the high caustic concentration desired by most corrugating plants.

As illustrated in the table, the trade-off when you blend KOH with caustic is that as the KOH percentage increases you lose alkalinity. While you gain ever increasing temperature stability, that loss in alkalinity must be offset by using more pounds of the blend in the adhesive to keep your gel temperature the same.

HarperLove has conducted extensive laboratory studies using 95%/5% and 90%/10% blends of Sodium Hydroxide and Potassium Hydroxide, and we have found no impact on the carrier cooking process and very minor impact on the gel temperature. In most cases if an increase in gel temperature is observed, merely adding 0.5 - 1.0 extra pounds of the caustic blend in a full-size batch would return it to the original gel temperature. These blends provide good temperature stability with minimal impact on gel temperature.

Winter Grade Caustic								
50% NaOH Percentage	100%	95%	90%	80%	75%	70%	65%	60%
45% KOH Percentage	0%	5%	10%	20%	25%	30%	35%	40%
Alkalinity Reduction	0.0%	1.8%	3.6%	7.2%	9.0%	10.8%	12.6%	14.4%
Data provided by and used with permission of PVS Nolwood Chemicals, Inc								

How Accurate Is Your Test Equipment?

by Wayne Porell

The equipment you use to test and evaluate your starch should be checked and calibrated regularly to ensure your starch will deliver the results you expect. If your test equipment is not accurate, you will make poorly informed decisions in your attempts to address productivity and quality issues.

Thermometers

Thermometers are often assumed to be accurate and, therefore, tend to be overlooked as a potential source of error. Thermometers should be checked at least monthly for separation and accuracy. A good time to

check a thermometer is when you are preparing for a gel temperature test. If a thermometer is reading incorrectly, you will have bad data and will make poor decisions about gel temperature, which can lead to quality issues at the mixer and the corrugator. The best way to check a thermometer is by inserting it in boiling water - if it doesn't read 212°F, it should be discarded.



If the gel temperature of your starch is actually higher than you think it is, you will likely get delamination issues, especially with heavy liners because you won't

heat the board sufficiently to gel the starch. To counteract this problem, you would need to slow the corrugator. The result will be either loss of quality or loss of productivity. If the gel temperature of your starch is lower than you think it is, you can get swelled or gelled starch. If the starch swells, the increase in viscosity would likely lead the operators to reduce the amount of carrier starch to lower the viscosity, but this may lead to other problems. The lower gel temperature can also create issues with gelled starch in the starch pans. Gelled starch in the starch pans may cause the starch to be wiped off the glue roll which will result in dry streaks on the board. The gelled starch can also prevent the glue dams from working correctly, allowing starch to remain on the glue roll outside the starch dams. This can result in starch getting on the corrugator rolls and will lead to blow-out issues.

Test Tubes

The test tubes that are used for checking gel temperatures should be checked for chips and cracks every time they are used. In addition to the potential hazard of shattered glass, a cracked tube may allow water to leak into the starch during the gel temperature test. The additional water will cause the gel temperature test to indicate higher than what the actual gel temperature is. Reacting to this errant data by adding caustic soda will lead to a lower-than-desired gel temperature and could result in a gelled batch or even a gelled storage tank and lines.

Stein Hall Cup or Love Cup

If the Stein Hall Cup or Love Cup is not calibrated

correctly, you will believe the starch viscosity to be different than what it actually is. This disparity can create runnability issues on the corrugator. If the starch is thicker than your target viscosity, it will not flow through the pans and lines well. This can cause an overflow that will create a mess on the floor and a safety issue. At the doublebacker, it can overflow out of the starch pan onto the bottom liner creating starch build up on the hot plates and idler rolls. This buildup can result in the bottom liner breaking out and wrapping itself around the idler rolls or preheater prior to the hot plate section. If the increased viscosity slows the flow in the lines to the starch pan, the pan may run out of starch resulting in the board not bonding properly. In addition to waste, this generally leads to jamming up the machine and additional downtime. Furthermore, if the starch is more viscous than normal, the normal gap settings will lead to excessive starch being applied to the board, which will create warp and bonding issues. If the starch is thinner than desired, it can sling starch off the glue roll onto the medium resulting in wet or warped board.

A properly calibrated Stein Hall Cup will read 14.5 – 15.5 seconds from pin to pin with water. A properly calibrated Love Cup will read 6.0 – 7.0 seconds with water.



Storage Tank Temperature

The storage tank temperature gauge is another potential source for errors. If the digital readout is not reading accurately and the starch is hotter than the readout indicates, the viscosity will be lower. Similarly, if the starch is cooler than you expect, the viscosity will be higher. The viscosity differences will lead to the same issues that were highlighted above.

If your equipment is accurate, your starch will perform as you expect, and your tests will tell you what needs to be changed. Making the correct adjustments based on accurate data will keep your starch consistently within the desired specifications and make it easier to troubleshoot corrugator bonding issues. Good troubleshooting starts with accurate test equipment.



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