HARPERLOVE

ADVANCED ADHESIVES REPORT

YOUR CORRUGATING NEWSLETTER FROM HARPERLOVE

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Understanding Starch

by Wayne Porell

As they have been for 80-plus years, today's corrugator adhesives are made up primarily of water, starch (typically corn, wheat, pea, or tapioca), caustic soda, and borax (in powdered, liquid, or boric acid form). While the basic method of making starch has remained the same for 80-plus years, automated starch mixing systems and modern polymers and resins have greatly improved the starch's consistency and performance characteristics. Lower gel points, better control of viscosity and temperature, and specialty liquid additives are enabling corrugator speeds to continue to reach new highs.

> In 1934, Jordan C. Bauer of the Stein-Hall Company developed a starch-based adhesive using cooked starch as a carrier agent to keep the remaining starch suspended. Today, this Stein-Hall method continues to be the basis of modern starch adhesives.

In a completed batch of starch, the cooked or "carrier" portion of the batch acts as a suspending agent for the raw uncooked starch and prevents it from settling out. It, therefore, helps control the viscosity. Caustic soda is added to control the gel point and provides the chemical energy to dissolve and cook the carrier starch. Borax is needed to impart viscosity and tack, to improve film properties, and to control slinging. Along with caustic, borax determines the penetration into both the liners and medium.

Performance Additives

Liquid performance enhancement products have been advancing to help bond papers at higher speeds on today's newer machines. Products have been developed to improve penetration and adhesion on high compression liners and wax replacement papers. Other products improve drying, water hold out, retack, and other properties to meet the needs of the specific application and equipment characteristics. Specialty products and additives maximize corrugator performance and quality under a broad range of operating conditions.

Moisture and Water Resistance

Moisture resistant adhesive (MRA) and water-resistant adhesive (WRA) are easily attained with the addition of a soluble resin which crosslinks the starch molecules. Depending on the specific resin, water resistance can generally be achieved by adding approximately 1.5% resin by volume to the starch adhesive; moisture resistance typically requires approximately 0.8% resin by volume. When running MRA, the glue lines should be between 0.060" and 0.070"; WRA typically requires glue lines to be between 0.080" and 0.100". To a point, running wider glue lines by increasing the glue application rate will generally improve the overall water resistance.

There are several recognized tests for evaluating the water resistance of combined board. The most frequently used is a 24-hour soak test, performed by soaking a combined board sample in room temperature water

for 24 hours and then pulling the liners away from the medium. The amount of fiber tear determines the degree of wet strength. There are other more objective tests, such as the FEFCO Wet Shear test, and the Linke™ test developed by HarperLove. These tests provide quantitative results which can be evaluated and compared, but they require testing equipment that some plants do not have. Plants that run a lot of water resistant boxes generally have the equipment to perform wet pin testing to ensure their boxes are meeting the customers' specifications and to minimize box failures in the field.

Application

The starch application system is critical in producing consistent, flat, well-bonded, dry sheets. On today's modern machines, operators rely on digital readouts to tell the gap between the metering and glue roll and the gap between the glue roll and the corrugator roll. These gauges must be checked and calibrated weekly to ensure accuracy. Metering rolls and glue rolls that are out of parallel or out of round can cause inconsistent or excessive starch application. In most instances, the variation in starch application will lead to warp and delamination. Variations in starch viscosity can also change the amount applied to the flute tips—lighter starch will transfer less and heavier starch will apply more at the same gap.

Storage

Starch storage is the final critical component of running an efficient corrugator. After a batch of starch is made, it is transferred to a storage tank. It is very important that the storage tank have a properly functioning Temperature Variance Control (TVC) system to maintain the adhesive at a pre-set temperature. Changes in the temperature of the starch will have a direct effect on the viscosity. The resulting viscosity change can lead to inconsistent starch application by changing the film on the glue roll and the flow in the adhesive pans on the corrugator. This ultimately leads to inconsistencies on the corrugator which limits the corrugator speeds and produces a poor-quality bond.

One of the keys to successful storage is to make no more adhesive than is needed. If not used promptly, the starch viscosity can change due to temperature variances and shear from the agitator in the storage tank. The gel point will also increase over time, which can all lead to slower speeds and bonding issues on the corrugator.

Conclusion

While the basic formula for making starch-based adhesive has been around since early in the last century, chemical additives and automated starch mixing systems have improved the consistency and performance characteristics of the finished adhesive. Combined with modern corrugator technology and sound operating practices, today's starch adhesives can deliver unprecedented quality and speed.

Starch Mixers

One of the most important machines in the plant is one that is often overlooked: the starch mixer. It is usually installed in an enclosed room or a back corner somewhere close to the corrugator and is generally taken care of by the bailer operators or clamp trunk drivers or sometimes the supervisors. Their other jobs take precedence over the starch mixer in most cases, and the mixer is often neglected or ignored until a problem arises. Careful attention to preventative maintenance can minimize the occurrence of problems.

The mixer should be cleaned daily. If it is not cleaned thoroughly and regularly, the buildup of materials can cause an overweight alarm. A clean mixer also helps ensure accurate weights and volumes of the raw materials being added to the batch. When cleaning the mixer, it is important to clean the inside top of the mixer where dried starch can build up. A water hose can be used for daily cleanup. For weekend cleanups, a formula should be set up to add enough water to fill the mixing tank to within 10"

of the top. With the mixer running, this water helps remove the buildup from along the sides of the mixing tank and will splash the inside of the top to remove buildup there. Heating the water will better help remove the dried portion of the buildup. To prevent potential safety issues, do not use water hotter than 120°F. After cleaning the mixer, the water should be transferred to a non-running storage tank to clean it as well.

The vent sock should be replaced with a clean one at least once a month. The starch transfer sock from the silo to the mixer should be changed yearly. When these socks get dirty with buildup of starch on the inside and dust on the outside, the fibers in the socks clog and can't breathe. The socks also wear and degrade over time. If the mixer tank is not able to vent when ingredients are added, the addition amounts will be inaccurate and will result in out-of-spec starch which can cause bonding issues at the corrugator. The filters for the electrical cabinet should also be cleaned weekly.

The load cells should also be checked weekly and cleaned, if needed, to prevent anything from interfering with weighing the ingredients correctly. It only takes one load cell not working correctly to create issues with the starch formula.

The mixer and associated systems should be checked regularly for steam, caustic, water and air leaks. Particular attention should be paid to the steam valve that heats the water. If this valve is leaking, it can cause small gel balls in the starch which will get transferred to the storage tank. When these gel balls get pumped to the corrugator, they can get lodged between the glue and metering rolls and cause dry streaks in the combined board which will result in increased waste. If the valve fails sufficiently, it can start blowing though and can gel an entire batch of


Dirty Load Cell


Dirty Mix Tank

starch in the mixer. It can also blow the starch out of the mixer if the lid is not clamped down. The resulting hot starch blowing out can cause severe burns if any employee is in the area at the time.

The borax hopper should be checked not only for cleanliness but also to ensure it is securely attached to the mixing tank. If the bolts for the hopper become loose from vibration, the scales will not measure correctly which will lead to viscosity issues. It's also important to check the chain and sprockets for the borax hopper for wear.

Several preventive maintenance tasks should be performed regularly to ensure the reliability of the system. The bearings on the system need to be greased and the load cells inspected for debris. The electrical cabinet should be vacuumed to remove dust buildup which could be a fire hazard. The mixer should be calibrated semi-annually according the manufacturer's instructions.

When checking the components of the starch kitchen, don't overlook the remote computer. It is usually located at the dry end of the corrugator with the knife and slitter controls. This is a very useful tool for troubleshooting the system. You can get data from the system to see when any issue started and why the issue happened.

Most of this doesn't take much time to perform, but when completed on a regular basis will make the starch kitchen more reliable and the starch more consistent from batch to batch. This will lead to fewer alarms, less down time, and better combined board at the corrugator.

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