HARPERLOVE

ADVANCED ADHESIVES REPORT

YOUR CORRUGATING NEWSLETTER FROM HARPERLOVE

November 2019

Borax: The Last Manual Addition

by Peter Snyder

Over the last several decades many of the manual aspects of making starch adhesive have been automated. Most starch mixing systems are designed to have water, corn starch, and liquid caustic soda added to each batch of adhesive without any manual operator involvement. The addition of wet strength resins, bonding polymers, defoamers, penetrants, and biocides has also been automated. Each of these ingredients is dispensed and measured automatically from a bulk container. Until recently, the addition of borax has been the only remaining manual step. In many corrugated plants, borax is still purchased in 50-pound sacks that are manually lifted, cut, and emptied into the borax hopper on the starch platform. As the corrugated industry focuses on employee safety, process reliability, speed, and operational efficiency, the transition from powdered to liquid borax is a natural progression. Liquid borax is typically delivered in totes (a.k.a. liquid bulk bins or IBCs) containing approximately 3,000 pounds of product. In the corrugating plant, the totes are often placed in a refill rack assembly similar to the way white glue is managed. One tote can supply the starch kitchen with enough liquid borax to last 2 - 3 weeks, depending on the number and size of batches made each day. This is a significant improvement over the process with powdered borax which requires having an operator climb the starch platform and lift, cut, and dump 50-pound bags of borax into the hopper several times each day.

Borax dust is a potential health hazard

Borax being manually added to mixer

The adoption of liquid borax began in Europe, driven by ergonomic concerns as well as potential health concerns from borax dust exposure. The transition to liquid borax in Europe is substantially complete. Latin America is following Europe's lead, and many plants in that region have transitioned or are currently transitioning from powdered borax to liquid. In North America, the transition is in the early stages with

Accumulation of borax dust in hopper area

a number of plants having successfully switched. In addition to the ergonomic advantages of eliminating the lifting, cutting, and dumping of 50-pound sacks, plants that have switched to liquid borax have enjoyed improved cleanliness and reliability in their starch kitchens from the elimination of borax powder which was frequently the source of clogging in the hopper.

Most new starch mixing systems from the major manufacturers are now designed to use liquid borax as an ingredient. Older automatic starch kitchens from the major manufacturers can be upgraded to use liquid borax. The necessary upgrades may be as simple as a software revision or could require the addition of hardware and equipment to pump, meter/weigh, and inject the liquid borax into the mixer.

Liquid borax improves cleanliness and reliability in starch kitchens

Liquid borax is available in several forms and varieties. It can be purchased as a 45% solution (e.g., LiquiBor) and as a 97% solution (e.g., LiquiBor C). The advantage of the higher concentration is that it requires less volume per batch of adhesive, leading to less material handling and lower transportation costs. In addition to the various concentrations of liquid borax which can be directly substituted for powdered borax, some plants have incorporated liquid boric acid (e.g., HydroBor) into their starch formulas, and others have completely eliminated borax from their starch adhesive formulas by using HarperLove's NoBor™.

Liquid borax is being rapidly adopted by many corrugated board manufacturers, both large and small. This adoption is similar to the corrugated industry's switch from dry to liquid caustic soda many years ago—employee safety and operational efficiency drove the transition. Upgrading to liquid borax is the next step for plants to create a safer, more efficient starch room.

Rheology vs. Viscosity

Viscosity is one of the most common measurements for corrugating adhesive, and it is generally well understood: it is a fluid's resistance to flow. Rheology is related to viscosity but is not the same and is often the source of confusion and misinformation.

The viscosity of starch adhesive is easily altered by varying the amount of carrier starch or water used in the formula. However, altering the rheology has a different impact than changing the viscosity, and it requires a rheology modifier.

Rheology Modifiers

To understand rheology modifiers, we must first understand what rheology is and how it pertains

Checking viscosity using a Love Cup

to starch-based corrugating adhesives. Rheology is an area of physics focused on the study of a substance's change in flow characteristics under applied stress or force. On a corrugator, it refers to how the flow of starch-based adhesive changes under the forces of shear and pressure throughout the adhesive system, from mix to application. The term "rheology modifier" is often used incorrectly to refer to chemicals that modify the viscosity of a fluid. These would be more accurately referred to as thickening agents.

The carrier starch used in an adhesive can be considered a thickening agent because it does increase viscosity. Borax also gives some additional viscosity, but it primarily improves tackiness for proper pickup on the glue roll and transfer to the flute tips. Borax acts more like a rheology modifier, but it is a single ingredient with a specific purpose. Incorporating borax as a component of a compound product limits your formulating flexibility to achieve optimal viscosity and tack.

In the science of rheology, a fluid's characteristics are measured when forces (mechanical shear or pump pressure) are induced on it. From a rheology perspective, there are two basic categories of fluids, Newtonian and non-Newtonian. Newtonian fluids are those, such as water and oil, whose viscosity does not change when shear forces are acting on them. Non-Newtonian fluids are those whose viscosity changes with the strain rate or flow velocity. (Ketchup is non-Newtonian, which is why you shake or smack the bottle to get it to flow.)

Starch adhesive is non-Newtonian

The viscosity of starch adhesive changes under pressure or induced stress. Starch adhesive incurs stresses during mixing, pumping, and application on the corrugator. It is shear thinning, so its viscosity decreases when it is stirred, and its viscosity increases when the agitation stops. Because its viscosity changes when forces are applied to it (such as in the nip between the glue roll and metering rolls), the amount of adhesive applied to the flute tips will change as the speed of the corrugator changes. This phenomenon is part of the reason that glue gaps must be adjusted as the corrugator speed changes.

When evaluating so-called "rheology modifiers" on the market which claim improved bonding with reduced solids, make sure the product is actually a rheology modifier and not just a viscosity thickener. You can increase viscosity with simple adjustments to the amounts of carrier starch and water. However, merely increasing viscosity will not improve bonding and lessen solids. For that you also need the proper adhesive rheology.

Glue Application

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