Gluing

The gluing or sealing of a carton is the last link in a long chain of operations for converting paperboard into a functional and attractive package. The last link must be as good as the others. Gluing is not difficult but negligence in performing it can be very costly.

Side-seam gluing involves applying glue to a side flap, pressing it to a side panel and maintaining the pressure until the glue seam has set. The glued blanks are then usually packed into boxes in such a way that a certain pressure over the glue seam is maintained. The blanks are allowed to dry in the boxes. This production procedure must be extremely well controlled so that unexpected trouble is prevented. The glue should be well proven for the particular type of construction, and the application of glue should be controlled.

Side-seam gluing with hot melt glue requires precise machine settings. The glue seam must be fully developed after the application of pressure.

For end-fed cartons that are sealed with water-based glue, it is important that the glue seam sets quickly and the wet-strength of the paperboard is sufficient to hold the end flap in position until the glue seam has dried. Hot melt glue seams do not need this additional requirement because the bond strength is obtained by rapid cooling.

Top-fed cartons that are erected in the machine may be mechanically locked or glued. Heat sealing is predominant for plastic-coated paperboard in the erecting unit. The closure of the package is very often done with hot melt glue because the counter-pressure in the contact areas for the gluing is often insufficient for heat sealing.

The temperature of the product also affects the gluing operation.

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<tr>
<th>Glue type</th>
<th>Description</th>
<th>Applications</th>
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<tbody>
<tr>
<td>Water-soluble glues starch/protein</td>
<td>The glue is a starch or protein solution which may contain rubber additives.</td>
<td>Uncoated and pigment-coated surfaces in relatively slow operations when pressure time is sufficient to develop the bond.</td>
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<tr>
<td>Dispersion glues or white glues</td>
<td>Contains small plastic particles dispersed in water with various additives to soften, to wet, and to provide tack.</td>
<td>General use for slow to medium speed operations. The white glues are reasonably cheap and the consumption is low. Also used to some extent for one-side PE-coated paperboard.</td>
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<td>Hot melt adhesives</td>
<td>Consists of thermoplastic material and additives such as resin, wax, and antioxidants. The application temperature is 100–200 °C depending on formulation.</td>
<td>Very widely used in high-speed operations for almost all types of surfaces and when pressure time or counter-pressure is insufficient for other bonding. Low heat resistance.</td>
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The type of glue is important. It must suit the paperboard and the machine. The glue must not have an odour or affect the packed product. The glue must be able to adhere to the paperboard and must develop tackiness and sufficient bond strength within the brief period of time that pressure is applied to the glue seam. Most glue suppliers offer detailed advice. They are familiar with the different paperboard types, the most common gluing and packaging machines and glue applicator systems.

The applicator applies the correct amount of glue with precision and is available in various types. Open time must not be too long and pressure time must be long enough. Important facts to consider when gluing are:

• The glue must wet and adhere to the substrate.
• There must be enough glue to form a bond but not so much that it squeezes out.
• The glue must be applied in the right place.
• The pressure must be maintained until the bond is strong enough.

Description of gluing methods
The glue is applied to the first paperboard surface with an applicator. The glue wets the surface and starts setting. The second paperboard surface is applied under pressure and a bond forms. If the glue is water based the paperboard first absorbs water, enabling the glue to set. Hot melt glues are cooled to solidify.

Open time is the time between the glue application and the application of the second surface.

The open time depends on the packaging machine and will affect the selection of glue and amount of glue required. It may even affect the choice of applicator and application pattern. Let’s take an example. Hot melt glue is used. However, the existing wheel applicator puts on too thin a layer which tends to solidify before pressure can be applied. An attempt is therefore made to increase the amount of glue. This results, however, in an uneven and tailing (stringing) application. A nozzle applicator should instead be selected. This applicator applies a controlled pattern of glue which retains the heat longer, thereby sealing correctly.

Pressure time must be sufficient for the bond to develop before pressure is released.

Glue type
The type of glue must suit the paperboard and the machine. The substrate is of key importance because it governs the type of glue. Most glue suppliers offer detailed advice.

A glue must usually meet the following requirements:

• The glue must be reliable with almost any available application technique.
• The glue must maintain a satisfactory bond on all paperboard products.
• The applicator must be easy to clean.
• The glue in combination with the technique employed must not add odorous or toxic substances that could impair the quality of food or other sensitive products.
• The glue must endure the environment of the product, for example in hot or deep freeze applications.

Glue applicator
The task of the applicator is to apply the correct amount of glue in the right place. The glue may be applied in various patterns depending on the application and the applicator.

The designer of a package needs to know what will be packed, so that the design will meet all needs through to the consumer. One example is a top-fed carton filled with a product that offers no resistance, so counter-pressure for the sealing must be provided. The most common methods of applying a suitable amount of glue are described below.
Finger applicator is a matrix of fingers which are dipped into a glue pot. The fingers are lifted and a carton blank is brought into position. The fingers are brought down into contact with the blank and a pattern of glue is transferred.

This type of applicator is used in slow machinery for gluing cartons. The equipment is robust but needs continuous surveillance to make sure that glue is transferred by all fingers successfully. The amount of glue tends to vary so this type of applicator system is regarded today as more or less obsolete.

Wheel applicator is a rotating wheel which is dipped into a glue pot so it is continuously covered by an amount of water-based or hot melt glue. The glue is transferred to a blank that passes in contact with the wheel. This is a sturdy and very popular type of applicator.

The main drawback is the difficulty in controlling the amount of glue. The scraper tends to clog, so the glue layer becomes too thin, resulting in either a weak glue seam or the operator setting the scraper for an excessively thick glue seam. This applicator is best for white glue.

Nozzle applicator which pumps the glue from a storage tank to a nozzle provided with a high speed valve. The amount of glue can be set very accurately and the equipment can apply a predetermined pattern of glue in lines or dots. This is the most expensive type of applicator. It offers precise glue metering and glue pattern and has a built-in function control, so in the end it will usually pay for itself, due to its consistency and reliability.

Key paperboard characteristics
The gluing or bond forming is usually the last operation performed on a package or graphical product, so here the function is critical. The paperboard must be suitable for the technique in question and the built-in properties must be predictable, both within an order, and between orders. This means that once the glue is selected and the machine is adjusted, the machine will only need routine supervision to ensure safe functioning.

The paperboard ply construction is of great importance because it governs the creasability. High elongation-to-break in the surface will permit the use of deep and narrow creases with low spring-back force after folding. This in turn facilitates good gluing because the carton’s side flaps will not place an excessive load on the newly formed glue seam, so it can dry and develop final strength with full surface contact in the glue seam.

Key properties
Since the gluing operation is influenced by the surface ply, the surface strength properties are critical.

The importance of the design
The crease resistance in the glue flap needs to be balanced as both a too high or a too low resistance may give a weak seam.
**Gluing paperboard to other materials**
Fitting a window on a paperboard blank involves gluing cellulose acetate or oriented polypropylene film to the reverse side of the paperboard. Usually a tacky dispersion glue is used, but hot melts are also employed. It is important to select a suitable glue that really sticks to the film and does not absorb into the paperboard thus reducing the bond strength. The glue must dry completely before the next operation and must remain flexible and tough. The glue must be suitable and the applicator must give a precise amount of glue: too little and the window will not stick, too much and the blanks will distort and may require an extended period to dry.

**Process settings**
Every single procedure in the gluing process must be documented so that settings can be repeated. It may be hazardous to change glues without careful testing. The same applies for mixing glues. Minimise the number of glues used. The optimum is of course to use only one type of glue.

The glue is applied to the most difficult surface in order to first to obtain the best gluing result. Since the glue is in a tacky state during the open time it is important that the environment is constant with regard to temperature and ventilation so that the tack remains predictable.

The glue seam will become stronger if it is applied adjacent to an edge and far from a crease.

**Process features**
The following factors are essential for good gluing:
- the amount of glue
- the open time
- the pressure and pressure time.

The pressure and temperature are essential for good sealing.

**Gluing of plastic coated paperboard**
A plastic coating is “a solid oil” and has a surface chemistry as such. An untreated PE surface will have a surface tension of about 30 dynes/cm and will not be wetted by emulsion glue, because the surface tension is too high due to the water content. In order to glue a one-side PE-coated paperboard with emulsion glue it must be corona treated to make the surface layer more polar with a higher surface tension than the glue.

The corona-treated surface has to be handled with great care so the one-side PE coating is not abraded or contaminated, which would cause the surface tension to fall below 40–41 dynes/cm. Gluing is actually more demanding with regard to surface tension than printing on a PE surface. If printing causes problems, it will be obvious as soon as the ink has dried, but problems with dispersion gluing are less obvious and faults may only show up after packaging.

If in any doubt whatsoever about the predictability of side seam gluing of a one-side PE-coated paperboard, the safe way out is to select hot melt gluing at a small extra cost, rather than to take any risk.

**Cold glue**
Cold glue requires one absorbent surface for best functionality. For the non-absorbent surface (e.g. the plastic coating), it is essential that surface tension is high enough for the glue to wet it. Normally the surface energy on the plastic coating is too low because of the chemical nature of the plastic. Therefore the plastic coating must always be modified by an oxidising treatment such as an electrical corona discharge or similar, to give the plastic a more polar nature by the introduction of oxygen into the surface molecules.

Plastic-coated paperboard has a limited lifespan and is sensitive to handling, storing and mechanical damage.

<table>
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<th>Problem</th>
<th>Cause</th>
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| Brittle glue seam | • Too little glue  
• Too short a time for setting under pressure |
| The glue seam opens up (glue on only one paperboard surface) | • Too low pressure  
• Too little glue  
• Application temperature too low (hot melt)  
• Open time too long |
| The glue seam opens up (glue on both paperboard surfaces) | • Too much glue  
• Too short pressure time  
• Application temperature too high (hot melt)  
• Open time too short |
| Cartons stuck together after side-seam gluing | • Too much glue – squeezing out from side seam  
• Skewed glue seam  
• Glue line too close to edge of carton |
Hot melt
After heat sealing (see the separate section on this topic), hot melt is the alternative method of sealing a two-side plastic-coated paperboard. This is because the functionality of the hot melt method is not dependent on the presence of a corona discharge. On a two-side plastic-coated board, the corona discharge is normally applied on the side intended to be printed, to allow the ink to wet to the surface. It is not recommended to add corona discharge on both sides as the risk for blocking is unavoidable.

Testing the glue result
Maintenance of gluing equipment is very important because if a failure occurs here, the production chain stops and the product may be ruined.

In the converter’s plant, gluing is a major part of the operation and is usually given great attention. However, risks do exist, like clogging of an applicator so that it does not apply the correct amount of glue.

The packer’s operation is different: the production of the consumer product is the main focus of interest. The packaging line is often leased and is given only periodic maintenance. It is expected to run with minimum attention. This is not a satisfactory situation; all machines need continuous care by skilled personnel to ensure a safe and reliable function. For example hot melt glues may be overheated for long time periods, causing them to oxidise, even carbonise, with the result that they lose adhesive strength.

Test performance
A common way to evaluate a glue seam is to cut the carton into approximately 20 mm wide strips over the glue seam. The strips must be in temperature- and moisture equilibrium with the surroundings before testing. Separate the strips and grasp each one in turn between the index finger and thumb of both hands.

Now, very slowly roll the glue seam apart across its direction. If this can be done repeatedly with several glue seams without rupturing the paperboard, this glue seam/hot melt seam may well break open during transport or when the pack is handled frozen. Something is wrong. Go back to the process and check all the critical points.

If on the other hand, all the glued strips fail in a manner that continues into the paperboard and results in fibre tear, the glue seam will probably prove satisfactory.

The situation corresponds to a favourable ratio between the glue seam strength and the internal strength of the substrate. The adhesive itself is the strongest part of the bond.