# substrate evaluation

The types of materials to be bonded will probably exert a greater influence on adhesive selection than any other factor. The strength and flexibility of each substrate and its relative porosity -- or the lack of it (impervious substrates) -- must be taken into account. Each substrate should be evaluated to ensure that the hot melt will provide adequate adhesion and that the bonds will not degrade on aging. If, for example, five different types of substrates are involved, all five should be bonded and tested under all of the conditions they must be subjected to.

Some special considerations related to substrates are these:

- *Are the substrates coated?*
- *Can they, or should they, be cleaned?*
- *Can they be preheated for adhesive application?*

# hot melt adhesive types

Hot melt adhesives are 100% solids materials based on thermoplastic polymers, which can be repeatedly heated and cooled without a significant change in their chemical structure. By far, the most popular thermoplastic polymers for hot melt adhesives are polyolefins, copolymers, polyesters, and polyamides.

A copolymer commonly used in adhesives is ethylene-vinyl acetate (EVA), which is also used in petroleum wax blends for paper coatings and lacquers and paints. Polyolefins and copolymers are usually modified with paraffin, tackifying resins, inert fillers, and antioxidants, either alone or in combination.

Polyamide hot melt adhesives, which are chemically similar to nylon, are used in specialty applications that require unique bonding properties. For example, polyamide adhesives, because they have good strength at low viscosities, are used for bonding the side seams of metal and composite cans.

Polyester adhesives are used to produce bonds with high strength and excellent solvent resistance. They are fairly high in price, but they have good chemical resistance and form strong structural bonds on a variety of materials.

# 9 benefits of hot melt adhesives

Hot melt adhesives offer many benefits to those involved in packaging or product assembly.

1. They are more economical to use than many cold glue systems.
   - Since these thermoplastic materials are 100% solids, many problems associated with solvents or water-borne adhesives are eliminated.
   - They form unusually strong bonds for packaging and offer the capability for patterned applications -- solid or broken beads or dots -- to provide adequate strength with minimal adhesive coverage.

2. Very fast production rates are possible.
   - Rapid setting times and very short compression cycles are achieved.

3. Less floor space is needed for closure.
   - Their fast set time eliminates the need for long compression sections.
   - The need for ventilation equipment is generally reduced.

4. Maintenance and clean-up costs are reduced.
   - Machine downtime is reduced and production is increased.

5. The appearance of products or packages can be improved.
   - Their solid composition, fast set time and superior adhesive line control can be utilized to make a more attractive package or product.
   - On porous substrates, their fast set times can reduce bleeding and staining.

6. Impervious substrates are more easily bonded.
   - Hot melt adhesives can bond many nonporous substrates that would act as barriers to water of solvent evaporation.
   - Many wax coated substrates can be satisfactorily bonded with suitable hot melts -- without loss of vapor barrier properties.

7. Hot melts can reduce the hazards of pollution, contamination and fire.
   - Most of Western's adhesives may lawfully be used in compliance with FDA and USDA regulations pertaining to food packaging applications.
   - Most are essentially odorless in the solid state.
   - Hot melts offer reduced pollution and fire hazards compared with solvent glues and PVC.

8. Hot melt adhesive bonds have excellent moisture resistance.
   - They contain no residual emulsifiers or water soluble components to absorb moisture and weaken the bond.

9. Since hot melts are 100% solids, they are 100% usable as adhesives.
   - They cost less to ship and store.
   - Less warehouse space is required and heated warehouses are unnecessary.

Every Western hot melt adhesive has been carefully formulated from polymers, resins, and other components to provide an optimum balance of properties as dictated by specific end-use requirements.

# adhesive bonds

The ***viscosity*** of the adhesive is probably the most important variable encountered when specifying or designing equipment for dispensing a particular adhesive.

Other important variables which affect the bonding and use of hot melt adhesives include ***compression time***, ***force time***, ***open-time***, and ***line speed*** of the application equipment. The volume and cross-sectional area of the applied adhesives are influencing factors also.

Adhesive ***temperature*** and ***heat-sink properties*** of the substrates being adhered influence the open time of an adhesive. The higher the temperature of the adhesive at application, the longer will be the time before the adhesive becomes too cold to bond. Heating substrates to be bonded will lengthen open time of the adhesive and improve adhesive wetting. The ***viscosity*** of an adhesive may be decreased by increasing the temperature of the melt. However, to avoid possible charring or degrading of the adhesive, particularly in open-reservoir applicators, the maximum temperature suggested should not be exceeded; thermal breakdown will occur if extremely high temperatures are maintained for long periods of time.

Compression force and time are important variables for controlling the extent and quality of a bond for a given application. Generally, just enough pressure should be applied to bring the two substrates to be bonded into intimate contact and spread the adhesive to the desired width and thickness. The substrate should not be allowed to shift during compression; otherwise, stresses will form in the bond and possibly cause bond failure.

Open distance and line speed of the application equipment determine the necessary open time of the hot melt adhesive. The distance between the point of application of the adhesive and the point where firm pressure is exerted on the substrates being bonded is the open distance; the time in seconds between point of application and compression is the open time. Line speed affects the time lapse between the two points. Softening the open distance and/or increasing the line speed results in a higher adhesive temperature when the substrates are joined.

# set time

Over the years, the term "set time" of hot melt adhesives has been somewhat confusing to customers. The reason for this confusion is due to the number of variables that affect the set time of hot melt adhesives. Some of the variables are the size of the package or the springback forces involved, adhesive application temperature, amount applied, and how applied (dots, stripes, etc.). Probably one of the most important variables is the environmental conditions surrounding the packaging line. For instance during the winter months, the average temperature in a production area might average 50 - 75'F, whereas, in the summer months, the average temperature might range between 75 - 100'F. During the summer months, the adhesive will tend to set slower due to the warm substrate which is the heat sink for the adhesive.

A test to measure the relative set time of hot melt adhesives under controlled conditions has been developed in our laboratory. A graph has been prepared comparing the set time of adhesives at temperatures of 73'F and 85'F. The adhesives have been grouped into four different categories; very fast, fast, medium and slow set. The medium set adhesives have adequate set time for many applications at 73'F but would possibly set to slowly at 85'F. Therefore, it is suggested that the set time characteristics of an application be studied very carefully before selecting an adhesive. For example, a medium or slow setting adhesive should not be selected for an application that has a relatively strong springback force exerted on the flaps and is under compression for less than three seconds.

Generally, the adhesives listed in the chart were assigned to one of the four categories based on how each performed in the "Clevage-Set Time" test. The general guide is shown on the chart.

# thermal stability

Western hot melt adhesives have good thermal stability at the suggested application temperatures. At 350'F (177'C) most adhesive formulas show less than 15% viscosity change after 100 hours. However, at temperatures significantly above the application temperature, the adhesives degrade rapidly as the temperature increases. Degradation of the adhesive can usually be detected by a change in viscosity. The viscosity of polyethylene-based adhesives increases as the adhesive breaks down, while that of polypropylene-based adhesives decreases with degradation.

Good application practice dictates controlling applicator hoses at a temperature no higher than that of the reservoir, and either reducing applicator temperatures or shutting them down during periods of extended non-use.

# adhesive selection

Before bond testing is even begun, some preliminary considerations can help to narrow down a list of potential candidates:

- *Will the adhesive be sufficiently economical?*
- *Does it have the right viscosity range?*
- *Does it have an objectionable odor in the melt phase or release noxious fumes or smoke?*
- *Does it have adequate heat stability for the required application conditions?*

Other adhesive requirements that should be taken into account are bond strength over the entire temperature range to which bonds will be subjected, compression, set time, open time, impact strength, aging requirements, hardness, flexibility, and resistance to attack by solvents and environmental agents.