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Adhesive Selection and Screening Testing

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INTRODUCTION

Selecting a proper adhesive for a given bonding application can, at times, appear to be an overwhelming task, but it need not be. The purpose of this chapter is to help in the selection process by:

1. Listing and briefly describing key material and system factors which should be considered during adhesive selection.
2. Outlining steps in the preliminary adhesive selection process.
3. Describing basic test methods which are useful in screening the candidate adhesives, once they have been chosen.

GENERAL CONSIDERATIONS IN ADHESIVE SELECTION

An adhesive should be compatible with the materials it will join (i.e., its substrates/adherends):

1. When a liquid adhesive is involved, the adherend(s) should allow the carrier (solvent or water) to escape as needed for proper film forming and hardening.
2. The adhesive should not significantly attack or corrode the adherends.
3. If the adhesive’s hardening involves significant film shrinkage, the system (adhesive and/or adherend) should allow for dissipation of the shrinkage stresses rather than locking them in and prestressing the joint.
4. The rheology of the hardened adhesive film, especially its elastic modulus and toughness (versus brittleness), should be compatible with those of the adherend and the nature of joint stresses to be applied, etc.
5. The adhesive should wet the adherend, i.e., be able to establish extensive and intimate (molecular scale) interfacial contact with the substrate.

The adhesive should work efficiently with the equipment which will be available for bonding (clamps, presses, heaters, etc.) and not have pressure, temperature or curing requirements which are beyond the limits of that equipment.

The adhesive must have adequate basic strength for its intended job. This often means strength as determined under short-term loading (most standard strength tests are in this category), but long-term loading (creep tests), shock loading (impact tests), and cyclical load-
ing (fatigue tests), or combinations of these, may also be needed.

In addition to adequate basic strength, the adhesive must be sufficiently durable to provide adequate load bearing ability when the joint is exposed to hostile elements of the environment in which it will serve.

The physical properties (e.g., color, density, solids or filler content, electrical properties, etc.) and working properties (storage life, pot life, viscosity, etc.) often need to be considered and subjected to screening testing too.

Last in this list, but often foremost in the user’s mind, is bonding cost. Although many factors influence the ultimate bonding cost, the price per unit of adhesive is significant and must be considered early in the selection process.

**BASIC STEPS IN THE ADHESIVE SELECTION PROCESS**

**Step 1**

*Define* pertinent material, joint stress, joint exposure, processing and service variables relating to adherends, to joint design and loading, and to available bonding equipment. Of particular interest are the following:

A. **Composition and properties of the substrate or substrates to be bonded.** Included are such factors as chemical composition (type of metal, plastic, ceramic or wood, etc.; special surface treatments, etc.); porosity and absorbency; hygroscopic and/or thermal expansivity; and strength properties.

B. **Joint design and associated glue line stresses** (shear, tension, cleavage, creep, shock, vibration, etc.).

C. **Hostile elements of the joint’s service environment** (temperature and moisture extremes, chemicals, light, etc.).

D. **Heating, pumping, and dispensing capabilities** of adhesive handling and application equipment available or affordable.

E. **Clamping, pressing, and heating capabilities** of the available or affordable bonding equipment.

**Step 2**

Based on the above determinations and in consultation with potential adhesive suppliers, select, first, the candidate adhesive group(s) and then the specific adhesives which may meet your requirements, i.e., be compatible with your adherends, joint design and stresses, exposure requirements, bonding equipment, physical and working property requirements, and cost limitations. This search can be aided by published articles, books, and catalogings of adhesives but, most importantly, by adhesive supplier recommendations, literature, and data sheets. In addition, occasions may arise when the services of an adhesives consultant may be in order, especially if they are also capable of performing needed screening testing.

A list of general adhesive information sources is given in Appendix 1 of this chapter. Several of the references cited give specific adhesive supplier names, addresses and phone numbers and product use listings. These listings can be a good starting point in making initial supplier contacts and in beginning to generate a list of candidate adhesives.

**Step 3**

Carefully compare your material and system characteristics with the relevant properties of selected or recommended adhesives.

Your suppliers will have already thought through the previously listed considerations relative to their products and be glad to discuss them with you. The adhesive composition and properties factors of primary interest include the following:

1. **Adhesive form and, if a liquid, the nature of any solvents or carriers involved.** Most adhesives are supplied and used as liquids. However, they may also be supplied as meltable solids in many forms (e.g., chunk, pellet, rope, cartridge, etc.) and as flowable or fusible powders or films. Some liquid adhesives may be essentially 100% reactive and contain little or no solvent or carrier. However, most liquid adhesives contain significant portions of carrier (water or other solvents) which normally must be largely gotten rid of during hardening.

2. **The adhesive’s hardening mechanism and**