Cork Tech Talk News

Manufacturers of Waterbase, UV+EB Curable Coatings, Varnishes and Adhesives

06 /03

ADHESION OR NOT

When coatings and varnishes are applied to substrates the usual premise is that they will stick or adhere adequately and remain in place to perform as specified. Adhesion is defined as "the act of sticking (to something) or the state of being stuck together", Webster. Adhesion is the binding force between two different materials. Cohesion is the binding force between two similar materials. Cohesion is responsible for a coating/varnish products internal strength

Things stick together as a result of mechanisms for adhesion that can be described as mechanical and specific. Mechanical adhesion results when a liquid coating flows physically, corresponding to adsorption into the structure (texture) of the substrate. Adsorption may be described as, "the adhesion of a molecule of a liquid to a surface", Webster. It is the result of one material physically being hooked onto another material. Ideally coatings and varnishes would cover the substrate completely wetting out the entire surface.

Specific adhesion includes electrostatic forces, van der Walls forces (weak attractive forces between electrically neutral atoms and molecules), and chemical reactions that take place between the coating and the substrate.

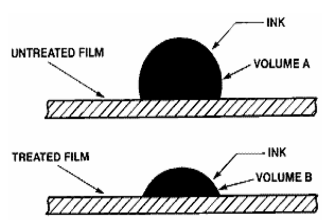
Chemical adhesion occurs when two intimately close materials chemically interact with each other. It is said that true chemical adhesion does not happen often.

Graphic arts coating or varnish systems can be described as liquids that solidify when exposed to triggering heat (catalytic) or cured as with energy curing UV & EB materials.

A key component raw material of a coating or varnish is a carrier, usually a liquid solvent whose role is to assure complete wetting and coverage of the substrate surface. The carrier evaporates during the drying process unless it is a UV/EB product that undergoes polymer-ization, or curing where the carrier becomes an integral part of the solid cured film.

Additional wetting agents may also be incorporated to improve wettability over-coming the non-wetting characteristics of some raw materials in a formula.

The physical and chemical properties of a substrate determine how the substrates surface interacts with its surrounding environment. A reactive surface tends to react with other materials. The less interaction with the environment and other materials the more stable and chemically inert the surface is. The chemical reactivity of a surface is related to its surface energy measured in dynes/cm2. Non-reactive materials tend to be those with a low surface energy. Materials with a high surface energy have active molecules at their surface seeking to interact with other molecules. The surface energy of a substrates surface can be measured by contact angle measurement, which is the angle a fluid droplet makes when contacting a surface. Reactive surfaces having a low contact angle to water readily interact with water allowing complete surface wetting. Non-reactive surfaces having a high contact angle wet poorly.



Reactive surfaces are water loving (hydrophilic) and non-reactive surfaces are water hating (hydrophobic). A surface well wetted will offer good adhesion characteristics while a poorly wetted surface will possess poor adhesion characteristics. A non-reactive surface will shed water while a reactive surface will sheet or wet with water. A non-reactive surface tends to have a low COF and

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feels slippery compared to a more reactive surface. Reactive surfaces will want to grab onto molecules passing by trying to react. Contrarily, a non-reactive surface will not attract molecules to it.

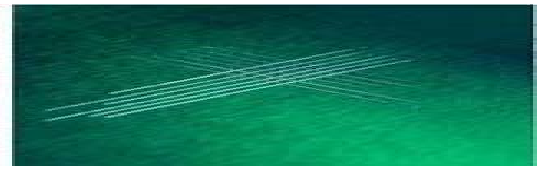
Other factors that disrupt adhesion are differential expansion rates of material due to temperature change and coating/varnish flexibility. When a substrate and a coating/-varnish expand or contract at different rates then the coating/varnish is apt to separate and delaminate from the substrate. If a coating/-varnish is too rigid and lacking in flexibility in its dried or cured state then is will tend to be brittle and crack with bending, flexing or temperature change. Energy curing products can be subject to becoming too brittle due to overexposure to the curing energy causing decreased flexibility and adhesion issues.

Considering adhesives, most act as luting agents (a clayey cement used as a sealant), intimately covering the opposing surfaces and acting to make them fit for mechanical retention creating a hydrostatic seal. This concept can be experienced when two glass slides are placed together with a drop of water between or a smoothly finished piece of china or glass or plastic is placed on a wet counter top. Lifting the object becomes almost impossible and removal must come by sliding the object off an edge of the surface.

Adhesion is critical to the performance of coatings/varnishes/adhesives. Questions related to performance should be, how well is the product adhered, bonded to the substrate? Is the coating, varnish, adhesive susceptible to cracking or de-laminating? Has the coating, varnish or adhesive wet the surface and covered completely or has it fish-eyed resisting complete coverage.

TESTING FOR ADHESION

The adhesion of coatings and varnishes to a substrate is commonly evaluated by a "tape test." The test method for measuring adhesion by tape testing is ASTM D3359. 610 3M tape is recommended for evaluating water and solvent inks, coatings/ varnishes. 810 3M tape is recommended for evaluating UV inks, coatings and varnishes. Peeling the tape from the coated, varnished, inked substrate reveals the degree of adhesion, which is a subjective judgment of the amount of product removed, if



any. Utilizing this method a lattice pattern with either six or eleven cuts in each direction is made in the film (coating) to the substrate using a sharp razor blade, etc. The pressure sensitive tape is applied over the lattice of cuts, smoothing with into place by a finger, then ensure good contact by rubbing the tape with the eraser end of a pencil. Remove the tape pulling at an angle close to 180 °, at a steady rate of speed, not at 90 ° as shown here. Subsequent examination of the grid area of the coated substrate and tape is then done to determine if there has been any removal of coating, ink or varnish.

Converters of plastic and foil substrates that are impervious must always be concerned about adhesion since absorption is not a factor. Proper surface energy is always required but alone does not guarantee acceptable adhesion. As a general rule, considering all substrates, the surface energy of the wetting liquid, coating, varnish or ink should be about 10 points lower than the surface energy of the substrate. Generally the ability to lower the surface energy of the wetting liquid product is limited. Therefore, it is common to treat the substrate to raise its surface energy to yield the target 10-point difference. Sometimes what is seemingly the proper substrate surface energy does not produce acceptable adhesion. This can occur because corona treating to burn off contamination creates polar sites that contribute to the creation of bonding sites to assist adhesion. Higher polar energy is desirable for energy curing materials. Corona treating also produces a certain degree of surface roughness to allow adhesion.

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