Technical Bulletin

ENERGY CURABLE COATING INFORMATION

GLOSSARY

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I. Health, Safety and Handling of UV & EB Coatings (liquid form)

For over 30 years now, Energy Curable coatings (UV – Ultraviolet, and EB – Electron Beam) have been successfully used by hundreds of production facilities throughout the USA, and the world as an environmentally friendly, low-VOC technology.

Provided that proper industrial hygiene practices and engineering controls are utilized, Energy Curable coatings can be handled safely. ACTEGA Kelstar, Inc. provides Material Safety Data Sheets (MSDS’s) that give an overview relating to those practices and controls.

An Electron Beam (EB) curable coating is based on a mixture of liquid acrylate monomers and acrylate resins (oligomers) along with various surfactants and additives incorporated to yield the proper application characteristics. An Ultraviolet (UV) curable coating contains those same items, plus a UV light catalyst (photoinitiator). In the ‘finished form’ (i.e., the liquid coating), the coating likely has the consistency and ‘feel’ of motor oil. However, there are several of major differences between motor oil and an Energy Curable coating:

1) Energy Curable coatings do not evaporate or cure under normal ambient conditions.
   Because they do not evaporate or cure under normal ambient conditions, the potential for the material to remain spreadable and not necessarily in one place until it is cured or cleaned up is very high. Often times, contact with an Energy Curable coating may remain unnoticed. As such, the likelihood of spreading the coating remains very high.

   In the event of skin contact, clean-up of an Energy Curable coating can easily be attained through the use of soap and water. The use of solvents to clean skin is never recommended, as solvents remove the natural protective skin oil and can promote irritation. Likewise, waterless hand cleaners should not be used, as they typically contain solvents.

2) Almost everyone is allergic to Energy Curable materials and coatings (in the liquid form). Because the most likely route of exposure to an Energy Curable coating is in the liquid form, the allergic reaction that predominately is produced is “occupational contact dermatitis” (an inflammation of the skin and mucous membranes). Occupational contact dermatitis may or may not occur immediately after contact with the liquid coating. As with most allergic reactions, frequency and severity may increase with increased exposure to Energy Curable materials and coatings due to the fact that Energy Curable materials (and coatings) are sensitizers. Over the years, the Energy Curable industry has worked to produce materials and coatings that are less ‘aggressive’ (lesser sensitizing), and, at all times, ACTEGA Kelstar, Inc., works with our vendors to utilize those materials to create “safer”, less skin sensitizing coatings.
Several studies that compared acrylate monomers (Energy Curable raw materials) to “conventional” solvents like toluene, xylene, 1-butanol, 2-butoxy ethanol, etc., have concluded that the dermal toxicity was, at worst, similar between acrylate monomers and those solvents; and, many times, the dermal toxicity was lesser with the acrylate monomers.

To avoid occupational contact dermatitis, when handling Energy Curable materials and coatings, personal protective equipment such as chemically resistant gloves, goggles/safety glasses, and even clothing outer-wear should be used (refer to ACTEGA Kelstar, Inc. MSDS, Section 8 for more specific personal protections).

3) **Energy Curable materials and coatings have very distinct odors** (even in the very low parts per million level). The nose is an extremely sensitive detector and can detect odors well below any measurable TLV (Threshold Limit Value). “Relatively non-hazardous materials can have a strong odor, and conversely very hazardous materials [like carbon monoxide] can be odorless. Although odiferous materials can be a nuisance in the work place, odor is usually not a concern unless the material detected is an inhalations hazard. To minimize odors, the work place and associated equipment should have proper ventilation maintained to the material supplier’s specifications.”¹ Any and all materials that have an OSHA permissible exposure limit or ACGIH threshold limit value, and their proper ventilation requirements are listed on the corresponding ACTEGA Kelstar, Inc. MSDS.

In any form, liquid or cured, almost every Energy Curable coating and material is NOT regulated by the US DOT as flammable or corrosive – no placards or designations are required for shipping (two exceptions to this are styrene and BCEA, which has a high content of combustible and corrosive acrylic acid). IF either of these materials is contained within an ACTEGA Kelstar, Inc. Energy Curable coating, it will be noted on the corresponding MSDS, and shipped appropriately. Also, Energy Curable coatings and materials are generally not “hazardous waste” (toxic, corrosive, flammable or reactive) under RCRA regulations. This, however, does not mean the coating or material can simply be “thrown down the drain” or put in the trash can. ACTEGA Kelstar, Inc. strongly recommends that all Energy Curable coatings and materials (as well as any other chemical) be disposed of in accordance with federal and local requirements.

In the event of a spill, like with every chemical, the spill area should be contained, to avoid further spreading. Using an absorptive inert compound, the Energy Curable coating or material should then be cleaned up and put into separate containers for proper disposal. The remaining residue can be mopped up with soap and water – which, also should be properly disposed of.

¹”UV/EB Health and Safety, Answers to Frequently Asked Questions”, RadTech Health & Safety committee, Radtech Report, September/October 1999
II. Health, Safety, Handling and US FDA Regulations of UV & EB Coatings (Cured Film)

“When monomers, oligomers and photoinitiators [in an Energy Curable coating] have become part of a polymer, they no longer have the toxicity that they previously had. Therefore, the UV/EB radiant energy can be considered as transforming the composition of a liquid material and thereby changing its toxicological properties. This transformation generally reduces toxicity by making the contribution of each component to overall toxic dosage unavailable.”\(^2\)

As more people have learned about a cured Energy Curable product’s toxicological properties being so small, over the years, the usage of Energy Curable coatings and inks have grown in numerous applications, such as: dental fillings, coatings on compact discs (CDs) and digital video disks (DVDs), eyeglass lenses, wood furniture, credit cards, medical equipment, beverage cans, juice cartons, children’s toys, magazines, books, and folding cartons.

In many of these applications, there are specific regulations as to what may, or may not, be contained in the cured coating. The Consumer Product Safety Commission (CPSC) may regulate consumer products packaging when the package itself has a practical use or has some play value to children. One of the predominant regulated materials that the CPSC looks for in children’s packaging is lead content. Lead has been proven to cause medical issues, specifically with children. As such, the lead content in any paint or coating on a children’s toy has been limited to 0.06% (600 ppm). ACTEGA Kelstar, Inc. has tested, and continues to test our Energy Curable coatings, per ASTM F963 (the American Standard Test Method that checks for lead and heavy metals content in a cured film). In every test, the lead content has either been 0 ppm, or, at most, significantly below the requirement; similarly with heavy metals content, the tested amounts have been either 0 ppm, or significantly below the requirements set forth by CONEG.

In regards to food packaging, interest in Energy Curable products for applications in food packaging has grown dramatically in recent years. As more printers begin looking at Energy Curable coatings and inks to decorate their packaging materials, their most commonly asked question is whether these inks and coatings are approved by the US Food and Drug Administration (US FDA) for direct food contact. Then the question that follows relates to US FDA status for "indirect" food contact, where the coating or ink is on the outside of the package, not in contact with the food contained inside, and is not reasonably expected to become a component of the food under the intended conditions of use.

\(^2\)“EPA Technical Bulletin Ultraviolet and Electron Beam (UV/EB) Cured Coatings, Inks and Adhesives”, prepared by Clean Air Technology Center (CATC), July 2001
The answer to the first question is yes (and no). First, the “NO”: The US FDA does not approve specific inks or coatings. However, the “YES”: In March of 2008, a long and exhaustive study was completed by numerous companies within the Energy Curable industry and the US FDA. In short, the results of that study yielded the US FDA FCN772. That published FCN (Food Contact Notification) related specifically to several UV monomers, one UV oligomer and one UV photoinitiator. Combined, those materials may create a UV curable coating. However, there are many other steps and conditions that must be met, prior to utilizing that coating on direct food-contact packaging. (For more information, please contact your local ACTEGA Kelstar representative)

The answer to the second question is more complex. It is not a question of whether or not a material is approved, but an issue of possible food contact under the intended conditions of use. The US FDA does not regulate exterior printing or coating where the substances are not reasonably expected to become components of food.

One means of determining “indirect food contact” (where the Energy Curable product is not reasonably expected to become a component of the food under the intended conditions of use) is through the Functional Barrier Doctrine. A simple interpretation of the doctrine identifies only the need for a functional barrier to exist between the exterior printing and the foodstuff. The most significant question of this doctrine is whether a true “functional barrier” exists. This question may be answered by considering the packaging structure, the exposure conditions anticipated for the package, or, where necessary, by performing properly conducted extraction testing.

In the case where it is possible for an Energy Curable product to become an “indirect additive” (an additive that is not intended to, but, nevertheless becomes a component of food as a result of use in articles that contact food), one method of satisfactory US FDA status is to establish a rational basis on which to conclude that there is no reasonable expectation of the product or component in the product to become a component of the food (through the “No-migration Exemption” – in which a properly conducted study yields a “non-detected” finding). If a substance is not expected to become a component of the food, through this “non-detected” finding, it is not a food additive by definition, and therefore, may be used without the need to obtain US FDA clearance.

By these exemptions as noted by the US FDA’s food additives regulations, if an Energy Curable product is being used under or meets these conditions, the product meets the regulations for “exempt status” and does not require FDA clearance for its use on indirect food packaging applications.
III. Environmental Issues, Recyclability and "Carbon Footprint" of UV & EB Coatings

With the ever growing awareness of the environment around us and the impact of our actions upon our world, the use of Ultraviolet and Electron Beam energies offers the printer and converter an environmentally friendly means of drying inks, coatings and adhesives. The development of these technologies, although not primarily driven by these concerns, does offer the user an alternative to conventional technologies.

Conventional inks and coatings contain petroleum-based solvents which are emitted to the atmosphere, incinerated or recovered during drying. The exhausting of solvents into the atmosphere is a cause of air pollution and is being regulated by the United States Environmental Protection Agency (US EPA). Incineration satisfies US EPA regulations by destroying the solvent vapors but requires large amounts of gas in order to combust the solvent vapors properly. The emission to atmosphere and destruction of the costly solvents has led some industries to recover and reuse the solvents. This is not always viable and requires expensive equipment, significant maintenance and further energy to recover and refine the recovered solvents. The use of Energy Curable materials eliminates all this by addressing the basic problem and eliminating the solvents. This also eliminates the health hazards associated with the solvents.

Energy Curable coatings are listed by the US EPA as complying with Clean Air Act requirements for Reasonably Available Control Technology (RACT), Best Available Control Technology (BACT), and Lowest Achievable Emission Rate (LAER) on the Agency’s Clearinghouse (http://cfpub1.epa.gov/rblc/htm/bl02.cfm).

Energy Curable technology was awarded by the South Coast Air Quality Management District (SCAQMD) in Los Angeles in 2005 with the “Excellence in Advancement of Air Pollution Technology”. This award recognizes that Energy Curable technology is a pollution prevention technology that minimizes waste, saves energy and is generally considered more productive and safer to use than other processes.

The question of biodegradability and recycling of Energy Curable (and aqueous) coated materials was addressed in 1992 by RadTech (the industry group for companies involved in UV and EB processing), when they commissioned blind studies by the Beloit Corporation, Fiber Systems Division, in Pittsfield, Massachusetts. The studies represented a series of pilot deinking trials performed on printed and coated paper containing a variety of ink and coating combinations – including heatset, aqueous, EB, UV, and conventional inks, coated with aqueous, waterbase-catalyzed, and UV and EB coatings. The results of that study found the following:

3"Recyclability of UV and EB Printed and Coated Paper", David J. Korn, Radtech Report, May/June 2005
1) **UV and EB inks and coatings are easily repulpable** (capable of being defibered)

2) All of the materials used in the study (and all combinations put together) could be recycled into low-quality board grades.

3) For recycling into tissue grades, in general, a system containing flotation and centrifugal cleaners is required. UV inks (when utilized at 100% as-supplied level) and conventional inks with aqueous coatings also required dispersion.

4) For recycling into fine paper grades, most ink and coating combinations require dispersion to further break down the ink specs, and subsequent flotation to remove them. (One possible exception to this was the heatset ink with aqueous coating, which may only require additional cleaning without the need for dispersion.)

5) The sample tested that contained aqueous ink with aqueous coating may not be possible to recycle into fine paper due to the unacceptable brightness (difficulty in removing enough very fine ink particles, even with infinite washing).

**Carbon Footprint**

One definition of “**Carbon Footprint**” is: the measure of the impact human activities have on the environment in terms of the amount of greenhouse gases produced, measured in units of carbon dioxide. An alternative definition of the “**Carbon Footprint**” is the total amount of carbon dioxide attributable to the actions of an individual (mainly through their energy use) over a period of one year.

A "Carbon Footprint" is made up of the sum of two parts, the direct/primary footprint and the indirect/secondary footprint:

1. The primary footprint is a measure of our direct emissions of CO₂ from the burning of fossil fuels including domestic energy consumption and transportation (e.g. car and plane).

2. The secondary footprint is a measure of the indirect CO₂ emissions from the whole lifecycle of products we use - those associated with their manufacture and eventual breakdown.

For coating we could make some estimate per pound for the energy use of our factory divided by the number of pounds of material we produce. That would be our contribution. But we have no way of knowing the 'carbon dioxide' generated to make the raw materials and packaging.
One large case study, in particular, pointed to the obvious advantages (and “Carbon Footprint” reduction) of utilizing UV curable inks and coatings as compared to water-borne thermal inks and coatings:\(^4\)

At Coors Brewing Company, Golden, Colorado (Brady et al., 1997), a study was done to compare greenhouse gas emissions (including VOC, HAP, Carbon monoxide (CO) and Carbon dioxide (CO\(_2\))) of water-borne thermal ink, both with and without incineration of those volatiles, to a UV curable ink. Also compared was the energy usage (electricity & natural gas) for each process. The results of that study showed the following advantages for the UV curable ink compared to a water-borne ink with incineration of the volatiles:

- **VOC Emissions** **DROPPED** by 7\%  \(\text{(98\% drop of VOC emissions compared to water-borne ink that was not incinerated)}\)
- **HAP Emissions** **DROPPED** by 48\%  \(\text{(99\% drop of HAP emissions compared to water-borne ink that was not incinerated)}\)
- **CO Emissions** **DROPPED** by 86\%  \(\text{(71\% drop of CO emissions compared to water-borne ink that was not incinerated)}\)
- **CO\(_2\) Emissions** **DROPPED** by 67\%  \(\text{(41\% drop of CO\(_2\) emissions compared to water-borne ink that was not incinerated)}\)
- **Energy Usage** **DROPPED** 80\%  \(\text{(60\% drop of energy usage as compared not incinerating the water-borne ink)}\)

As you will note, by incinerating the emissions, the amount of carbon monoxide (CO) and carbon dioxide (CO\(_2\)) actually **INCREASED**.

This was just one of many studies that have shown the true advantages of using UV curable inks and coatings to reduce your “Carbon Footprint”. All of these add up to a MUCH smaller primary and secondary “carbon footprint”, simply due to utilizing Energy Curable inks and coatings.

**ACTEGA Kelstar, Inc.** has always formulated and manufactured Energy Curable products with both worker safety and environmental impact as its top priorities. We currently supply millions of pounds of Energy Curable products to the graphic arts, commercial and food packaging industries throughout the world. If you have any questions regarding our line of Energy Curable products, or would like to discuss the information contained within this technical bulletin further, please contact your local sales representative or a technical representative.

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\(^4\)“Low-Emission Technologies: A Path to Greener Industry”, Ronald Golden, Radtech Report, May/June 2005