

What determines if a product is

environmentally

friendly?

A product is

considered

environmentally

friendly if it uses the

12 Principles of Green

Chemistry.

1. Prevent waste: Design

chemical syntheses to

prevent waste, leaving

no waste to treat or

clean up.

2. Design safer

chemicals and

products: Design

chemical products to

be fully effective, yet

have little or no

toxicity.

3. Design less

hazardous chemical

syntheses: Design

syntheses to use and

generate substances

with little or no

toxicity to humans

and the environment.

BioVu Inks: Changing the Color of Superwide Printing to Environmentally-Friendly Green

Introduction

The oil crisis of 1973 started a flurry of interest in the environment, conservation and alternative forms of fuel. Over the last few years, escalating energy costs worldwide continue to heighten consumer awareness in the environmental arena as people seek out bio-friendly alternatives such as bio-fuel and hybrid cars.

Governments worldwide also are doing their parts by creating and tightening their environmental regulations, causing corporations to undertake “green” initiatives as a way of doing business in more eco-savvy ways. In the printing industry, many companies are moving to chemistry-free printing plates — using soy-based inks, offering recycled papers, recycling waste and taking other steps to reduce their environmental footprint.

In the superwide industry, environmental challenges still exist with solvent-based inks, which are used outdoors to produce those vibrant, durable pieces seen on billboards, bus wraps, etc.

In addition to ozone issues, the emissions from conventional solvent-based inks need to be limited to avoid potential health and safety issues for workers using these inks. Now, with the commercial availability of VUTEK’s BioVu™ inks from EFI™, the world leader in color digital print servers, superwide format printers and inks, and print management solutions, the health, safety and environmental picture for this high-growth print segment has changed dramatically.

This whitepaper identifies the various ink types in superwide format printing, including their respective environmental impacts, and explains why BioVu inks promise to make a positive impact in the environmental footprint of superwide format print applications for generations to come. The whitepaper

also includes one customer’s feedback on how BioVu inks impact his business.



Market Demand and Challenges for Environmentally-Friendly Inks

The market for environmentally-friendly inks is growing globally as governments worldwide continue to address the health and environmental concerns associated with conventional solvent-based inks. Their new regulations call for dramatic reductions of volatile organic compounds (VOCs) containing Hazardous Air Pollutants (HAPs) into the environment. At the same time, customers are making it clear that they want to print superwide graphics directly onto uncoated substrates without installing expensive ventilation systems. These businesses still are looking for the same durability and substrate selections that they get from solvent printing for same costs. However, in today’s market, many of these eco-solvent or aqueous inks fall short in versatility and performance compared to traditional solvent inks.

Ink Categories for Superwide Printing

By definition, a solvent is a liquid substance – any liquid, even water – capable of dissolving another substance. In the digital inkjet world; however, the term “solvent” is used to describe any ink that is not water-based.

4. Use renewable feed stocks: Use raw materials and feed stocks that are renewable rather than depleting. Renewable feed stocks are often made from agricultural products or are the wastes of other processes; depleting feed stocks are made from fossil fuels (petroleum, natural gas, or coal) or are mined.

5. Use catalysts, not stoichiometric reagents: Minimize waste by using catalytic reactions. Catalysts are used in small amounts and can carry out a single reaction many times. They are preferable to stoichiometric reagents, which are used in excess and work only once.

Other industry-related terms used to describe solvent inks include soft, mild or eco as well as hard, strong or true. The most confusing of these terms may be eco-solvent ink. To most people, “eco” is short for ecological; however, most eco-solvent inks available on the market today are neither derived from a renewable resource nor created through an ecologically sound process.

Before discussing the ink categories available in the superwide market, it is important to understand a few key terms and acronyms that are commonly used in the inks industry:

- HAP: Hazardous Air Pollutants.
- VOC: Volatile Organic Compounds.
- TAP: Toxic Air Pollutants.
- Cyclohexanone: a common solvent used in full solvent ink.
- NMP: n-methyl pyrrolidone, a very aggressive solvent that has a poor toxicological profile.
- PEL: Personal Exposure Limit as set by OSHA, a limit to protect the health of printer operators.

Let’s also take a closer look at the common terms applied to the various ink types in superwide format printing and the health, safety and environmental issues associated with each:

- Ultraviolet (UV) Curable Inks: These inks have no VOCs, and they do exhibit low PELs and typically have poor health and environmental profiles. This situation means that there are safety issues with relatively low exposure levels.
- Water-based Inks: These inks are extremely limited in application since they tend to be less durable, less weather-resistant, and generally need to be applied to a coated stock.

- Eco-Solvent Inks: These inks are the same as light solvent inks. They are less aggressive, but they exhibit poor health and environmental profiles. They contain HAPs and VOCs.
- Mild/Light Solvent Inks: These inks are the same as traditional solvent inks, but with slightly less aggressive solvents. However, the solvents still have poor health and environmental profiles, contain HAPs and VOCs, and have low PELs.
- Full Solvent, traditional inks: These inks use aggressive solvents with poor health and environmental profiles. They contain HAPs, TAPs, VOCs and have low PELs.



In an entirely new approach to solvent-based inks, EFI’s VUTEK® has developed the first solvent-based inks made from a renewable resource (namely, corn) for use in the VUTEK product line. BioVu is the only solvent-based ink recognized by the U.S. Environmental Protection Agency (EPA), creating an entirely new class of inks – Bio-Solvent inks. The definition of Bio-Solvent inks is:

- Inks that contain no harmful VOCs and have the best health and environmental profiles available. These inks have high PELs – meaning employees must reach high exposure levels before being concerned about any health or safety issues.

6. Avoid chemical derivatives: Avoid using blocking or protecting groups or any temporary modifications if possible. Derivatives use additional reagents and generate waste.

7. Maximize atom economy: Design syntheses so that the final product contains the maximum proportion of the starting materials. There should be few, if any, wasted atoms.

8. Use safer solvents and reaction conditions: Avoid using solvents, separation agents, or other auxiliary chemicals. If these chemicals are necessary, use innocuous chemicals.

Despite its earthy origins, BioVu ink delivers all of the benefits of traditional solvent inks without the compromises inherent in eco-solvent and aqueous inks. These benefits include the same color gamut as traditional solvent inks, so users seamlessly can switch to these environmentally-friendly inks with no workflow or prepress process modifications.



Ink Properties for Outdoor Displays

A majority of superwide images printed for outdoor display are printed on low-cost, nonabsorbent, uncoated materials such as self-adhesive vinyl and banner material. The resulting prints need to be weatherproof and UV and scratch resistant. In order to meet these performance criteria, solvent inks use a pigment in powder form, and as the media is nonabsorbent, a resin or glue to adhere the pigment onto the substrate surface.

The solvent is used only as an agent to make the ink into a fluid for jetting. Non-water-based liquids are often used as the solvent, since they produce a waterproof image easier than using resins that are not water-soluble. Once the ink has been applied, the solvent evaporates (releasing VOCs), leaving only the pigments on the material. Most printers use on-board heaters to speed the drying process.

True solvent inks dry faster, need fewer heaters built into the printing system, and soften the substrate surface for better bonding with the pigments. Graphics printed with solvent inks bond better to a wide range of uncoated substrates, are more durable, offer better UV resistance,

and withstand a greater degree of mechanical wear. What's more, uncoated vinyls cost dramatically less than vinyls used with traditional water-based inkjet printers and up to half as much as specially treated substrates required with first-generation eco-solvent inks.

Like other true solvents, BioVu inks are durable, provide strong bonding to uncoated substrates, and resist mechanical wear and UV light. BioVu inks are designed specifically to run in high-production environments, provide high print quality, and print on a wide variety of pressure-sensitive and textile materials and rigid media. Ongoing testing on additional substrates will expand the available range over time.

Other BioVu benefits include:

- Decreased disposal costs, since there are no hazardous materials (hazmat).
- Reduced odor on final printed materials.
- Have less negative characteristics than solvent inks for employees and the environment.

In new shops or installations, special ventilation and burner systems may no longer be required, since there are no OSHA regulations or government occupational, safety or health requirements for special treatment of the harmless VOCs emitted by BioVu during the drying process.

The Ink Makes the Difference

Eco-solvent and aqueous inks often use slow-drying solvents; therefore, need more heaters to aid the drying process. This requirement increases the likelihood of some substrates puckering under the heat. For this reason, eco-solvent and aqueous ink usually have to be printed on coated materials, which are often more expensive than non-coated materials, so the printer can put more ink on the substrate. The ink receptive coating modifies the surface tension so the ink applies to the media without causing print artifacts.

9. Increase energy efficiency: Run chemical reactions at ambient temperature and pressure whenever possible.

10. Design chemicals and products to degrade after use: Design chemical products to break down to innocuous substances after use, so they do not accumulate in the environment.

11. Analyze in real time to prevent pollution: Include in-process real-time monitoring and control during syntheses to minimize or eliminate the formation of byproducts.

Run the Cost Savings

Most true solvent printers are equipped with bulk ink delivery systems to reduce running costs. The running costs for BioVu inks are within the same range as conventional solvent inks, while yielding the additional benefits for the printer, employees and the environment. In fact, BioVu inks running costs are lower overall due to a number of factors including:

- Elimination of costly, specialized ventilation systems and burners to dispose of harmful VOCs.
- Reduced substrate costs because there is no need to use specialty or coated substrates.
- Increased employee satisfaction as a result of a healthier work environment.
- Reduced energy costs due to faster drying times by heaters in the drying process.
- Decreased compliance costs related to governmental occupational, safety, health and environmental regulations.
- Recaptured production space for revenue-related use because special ventilation and burner systems are no longer required.

Solvent Versus BioVu Inks' Composition

Superwide format printers have traditionally used solvent inks that contain EB Acetate that is classified as a HAP substance. BioVu's primary ingredient contains a biologically derived solvent with a far more positive health and environmental profile than commonly used solvent ink chemicals. BioVu is free from ethylene glycol ethers, cyclohexanone, NMP, aromatic hydrocarbons, vinyl esters and other hazardous ingredients.

BioVu ink uses over 60% Ethyl Lactate, which is approved by the FDA as a flavor additive for use in food. Ethyl Lactate is an alternative solvent that is non-toxic and biodegradable. Since BioVu ink is over 80% bio-based, it may be the best

ink on the market for the environment. Keep in mind that with all of the publicity and buzz around bio-friendly fuels, bio-based diesel contains only 5% of volume derived from corn, with the other 95% being diesel.



The BioVu inks' other components include the binder — derived from cotton and wood pulp — and Jet Wash, a blend of Ethyl Lactate, and another solvent derived from soybeans.



With a flash point greater than 141° F, BioVu ink also has a very low volatility and potential for flammability, so it can be safely shipped by all transportation methods.

EPA Recognizes BioVu

BioVu is the first and only solvent ink to be recognized by the U.S. EPA's Design for the Environment (DfE) program. This partnership is part of a DfE safer chemical use initiative for commercial formulators. The initiative's goal is to seek, assist and promote innovative chemical products, technologies and practices that benefit human health and the environment.

12. Minimize the potential for accidents: Design chemicals and their forms (e.g., solid, liquid, or gas) to minimize the potential for chemical accidents including explosions, fires, and releases to the environment.

Source: Paul Anastas and John Warner, *Green Chemistry: Theory and Practice*, Oxford University Press: Oxford UK, 1998.



Formulated in partnership with the Design for the Environment Program.

A key purpose of the partnership is to recognize and encourage environmentally preferable chemistry based on the "12 Principles of Green Chemistry" (see sidebar). BioVu inks, developed under a Memorandum of Understanding (MOU) with the EPA's DfE initiative, are a set of patent-pending printing inks based on the special properties of its bio-solvent formulations.

Since BioVu inks are a biologically-based product and contain a solvent derived from corn, they reduce dependency on oil reserves, benefit local farmers, are safer for the environment and protect workers' health. Additionally, the corn-based solvents used in BioVu inks are not HAPs, pose no threat to the ozone layer, and are biodegradable surfactants with byproducts.

In addition to EPA recognition, VUTEK's BioVu inks from EFI have been tested by an EFI vinyl substrate partner in a biodegradation test with their biodegradable media. The preliminary results of that test showed that both the media and ink biodegraded in landfill.



BioVu Carries the EPA's DfE Logo

Authorization to carry the EPA DfE logo means that the DfE review team has screened each product ingredient for

potential human health and environmental effects and that - based on currently available information, predictive models, and expert judgment - the product contains only those ingredients that pose the least concern among chemicals in their class.

This logo means that if a DfE-recognized product contains a surfactant, then that surfactant must biodegrade readily to non-polluting byproducts. Many surfactants found in conventional products biodegrade slowly or biodegrade to more toxic and persistent byproducts, which threaten aquatic life.

BioVu Inks: The Time is Right

As the world's resources become increasingly constrained in the 21st Century, private citizens, governmental and non-governmental agencies, educational institutions and corporations are becoming more focused on reducing their environmental footprints. As a result, "bio-based" is a current buzzword, drawing a lot of attention from the media to the boardroom. Oil-based products — and the solutions that allow people to migrate away from them — are receiving extensive attention because of escalating costs and unstable supply of energy resources.

As businesses continue to compete in today's market, they still are producing highly visible outdoor advertising. This demand puts the superwide format printing industry under increasing pressure from many of its constituencies to reduce their environmental footprint. The chain reaction is causing customers to be more willing to pick up incremental costs of doing business in a more environmentally-friendly way.

For instance, the U.S. government passed the Farm Security and Rural Investment Act of 2002 in January 2005, making it mandatory for any government agency to buy bio-based products when available. An example would be materials used in military recruiting advertising. In addition, the U.S. and many other countries are enacting, or considering the enactment of, tighter occupational, safety, health and environmental regulations that make it more

difficult for superwide format printing businesses using solvent inks to stay in compliance and in business.

BioVu inks represent a technology whose time is right. Market demand and awareness are building, pushing businesses and other organizations to migrate away from petroleum-based products to bio-based solutions wherever possible. Businesses producing superwide format products, especially for outdoor use, can differentiate themselves and gain a competitive advantage by using BioVu inks, while also reducing their operational costs.

What Businesses Are Saying about BioVu Inks

The Big Print, a leading provider of superwide printing services with production operations in Seattle and San Francisco, has adopted BioVu inks as a key element of its trademarked BioGraphix product line.



Founded in 1999 in a garage in Marin County, CA, Big Print boasts a client base of national retailers, large agencies and other businesses requiring indoor and outdoor display graphics and signage. The signage includes bus and building wraps, banners, billboards and more.

“Many of our customers want to lessen their environmental footprint,” said Jon Zinsmeyer, Big Print’s founder and president. “To meet that need, we have sourced a variety of environmentally friendly materials, including fabrics manufactured in VOC-free factories and pressure sensitive vinyl alternatives. Until now, the missing link was environmentally-friendly inks for superwide format printers. BioVu inks have filled that gap.”

Zinsmeyer adds, “We can now offer a total environmental solution to our customer base. Combining BioVu inks with our new VUTEk 3360 solvent printer and our range of environmentally- friendly substrates is as good as it gets. We

look forward to EFI’s VUTEk expanding availability of these inks to the rest of its solvent-based VUTEk superwide format printing products.”

BioVu inks are available in eight colors (cyan, magenta, yellow, black, light cyan, light magenta, light yellow and light black) and are specifically formulated for superwide format inkjet printing operations.

Substrates that Work Best with BioVu Inks

BioVu inks can be used on a wide range of flexible substrates. Results achieved on pressure sensitive vinyls have been outstanding. Excellent results have also been achieved on a wide variety of rigid media with no pretreatment. BioVu inks deliver good results on coated papers, photo substrates, blue-back, and poster materials. Products produced with BioVu inks are outdoor durable for two years, and have five-year durability with a topcoat. The inks’ abrasion and chemical resistance are also good.

What’s Next for BioVu?

BioVu inks currently operate with the VUTEk 3360 product line from EFI to achieve excellent color density and adhesion to a wider range of substrates, increasing the number of flexible applications. EFI plans to extend BioVu applicability to other printers within its currently-available VUTEk solvent product family.

What’s Next for EFI’s Green Initiatives?

BioVu inks are a key staple in EFI’s long-held environmental commitment. The inks are part of the company’s Green Initiatives, which strive to make print products more eco-friendly. In addition to BioVu inks, EFI Fiery® digital print servers were among the first to be RoHS-compliant to meet worldwide regulations. In addition, EFI’s corporate headquarters, which is 10 stories and 300,000 square feet, is designed to harness the Earth’s natural resources to aid in heating and cooling the space. EFI’s energy conservation measures save the equivalent of 783 kilowatts of energy per day, which is enough to power approximately 600 homes.