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Case Study
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Toxics Use Reduction Case Study

Conversion to UV Curing Reaps Benefits for Fit to Print

Summary

Fit To Print Advertising Inc. found many benefits when it converted from conventional printing processes using solvent-based inks to ultraviolet (UV) cured inks. The UV process is now used in 80% of the company's production and, as a result, Fit To Print has increased productivity, opened new markets, reduced labor-intensive cleaning processes, and achieved compliance with wastewater regulations. The company's managers say the switch to mostly UV inks resulted in a 60% reduction in the amount of solvents used in their production processes, and a 20% increase in business. Annual savings to date have amounted to nearly $25,000 and available production time has increased by 33%. Fit To Print managers directly credit the switch to UV curing with their ability to win a large contract with a leading U.S. retailer, creating the need to hire five additional staff. The company's long range plans are to convert 100% of their operations to UV cured systems, but those plans are dependent on advances in UV ink technology by manufacturers.

Background

A screen printer located in Weymouth, Massachusetts, Fit To Print employs 12 people and has been in business in the Bay State for more than 10 years. The company prints decals, posters, and labels on non-textile products, serving customers across the country. Typical of most commercial printers, Fit To Print developed photographic images in a darkroom, and then used a dry etching process to transfer the images to polymer screens. Solvent-based ink was then applied to the polymer screens, and the images were

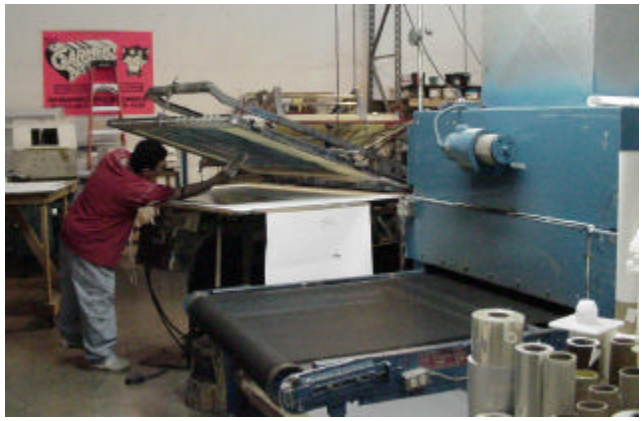

Figure 1: solvent-based printing system

mechanically pressed onto the substrates and cured in a drying oven to drive off the solvents. Solvent-based chemistries also were used to clean the screens for reuse.

Toxics Use Reduction Planning

The company found that its wastewater discharges were exceeding the limits for lead, total petroleum hydrocarbons (TPH), and pH set by the Massachusetts Water Resources Authority (MWRA), the regional sewer authority. Fit To Print called on the Office of Technical Assistance (OTA). After visiting the shop and reviewing Fit To Print's processes, OTA staff suggested that the residue from inks and solvents found in the inks and also used in the screen cleaning process were likely sources of the discharge problems. OTA suggested that Fit To Print investigate switching to UV curing, which uses non-solvent based inks, and also reduces solvents used in the screen cleaning process.

Dennis Prifti, Vice President of Fit To Print, said that he had heard about UV curing systems from reading trade magazines and from discussions with other printers prior to receiving OTA's recommendation, but he thought of such systems primarily as high-end equipment used for improved print quality and detail, and ease of operations. "We just weren't aware that there were environmental benefits from UV as well," he said.

Toxics Use Reduction Modifications

Prifti spent about three months investigating the feasibility of installing a UV curing system. He spoke to several equipment vendors and toured other print shops already using UV systems. Prifti found that there were a variety of systems available, from low-end that would work for very basic print jobs, to high-end that would cure printing on three-dimensional parts. In the fall of 1994, Fit To Print purchased a UV system. UV curing consists essentially of an ultra-violet light suspended over a conveyer belt.

The system cost $13,000, but Fit To Print was able to sell its existing infrared dryer for $6,000 to help offset the cost. The same supplier the printer used for buying conventional inks has been able to supply the solvent-free inks specifically developed for the UV process.

Figure 2: UV curing system

UV curable inks have three main components: unstable liquid oligomers (polyesters); liquid monomers (generally acrylates); and photoinitiators (reaction activating components). There are basically four steps to the process (see Figure 3). In the first step a wet film design is "inked" onto the substrate. Next the substrate is passed under a UV light and photoinitiators in the liquid

ink film absorb the energy, splitting into chemical fragments known as radicals (small lines in the film in the diagram). This is called free radical polymerization. The initiation of the curing reaction, or polymerization, then proceeds, as the free radicals attach to monomers (small circles in the film in the diagram) and oligomers (large circles), acting to link them and also producing new radicals.

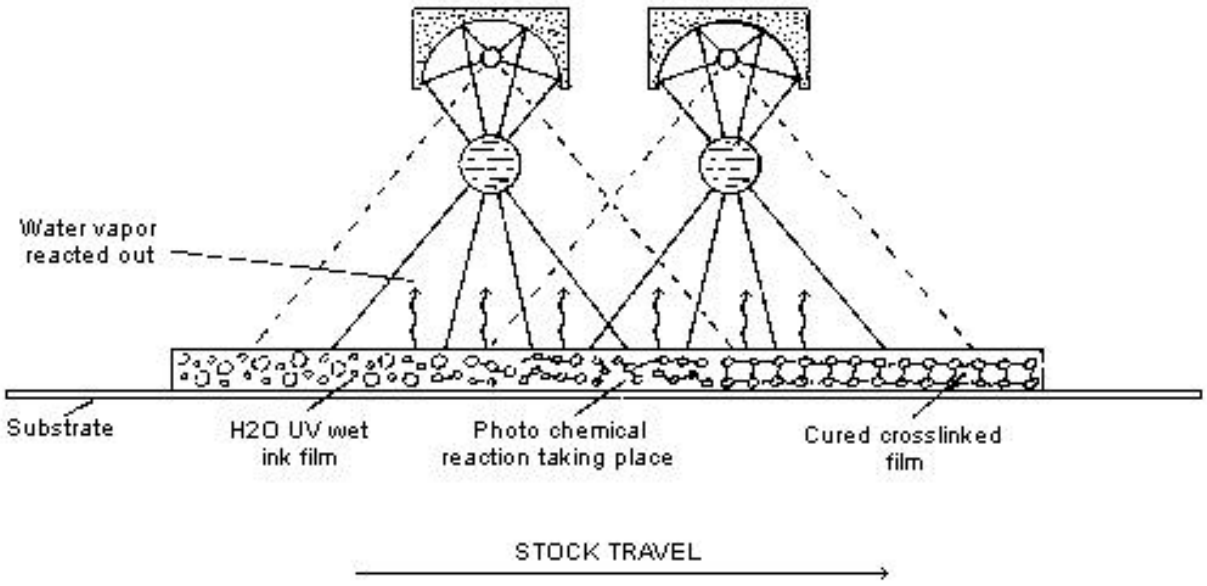

Figure 3: the UV curing process

These new radicals then react together to form longer chains, turning liquid to solid. Finally, completion of the reaction results in a solid cross-linked stable network in the film. Once the process begins, and as curing proceeds, water present in the original wet film is expelled.

Results

Reductions Achieved: Fit To Print has reaped many benefits by installing a UV system, including:

- Compliance with wastewater discharge limits: The switch to predominately UV cured inks and the reduction of solvent use in screen cleaning solved the compliance problem with the MWRA. The amount of TPH discharged went from a high of 170 ppm when using the conventional system to less than 15 ppm, which is the MWRA limit. Lead also decreased to well within allowable limits.
- Production and labor savings: With the conventional solvent-based system, print runs have to be interrupted and the screens cleaned every 100 to 150 sheets printed to ensure that ink will not dry on the screens. The frequent interruption affects the consistency of the batch in terms of color shades and clarity. With the UV system, there is no need for frequent cleaning. Consistency and quality remain constantly high throughout an entire print run. As a result, production time required per run has decreased significantly as labor for cleaning and inspections has been greatly reduced. In addition, the new system has reduced the use of solvents and solvent-based inks. Since installing the new system, solvent use for thinning

inks and cleanup of screens has dropped from 60 to 100 gallons per month to only 10 gallons per month.

- Improved health and safety for employees and better community relations: Reducing the use of solvents in the curing and cleaning processes has created an improved working environment for the employees. Offensive odors have virtually disappeared eliminating complaints previously received from the company's neighbors.

New Markets: The UV curing system has given Fit To Print the ability to produce high gloss printing. This fact has resulted in the firm being able to compete with offset printers, both in quality and durability, for short runs. Offset printers now send work to Fit To Print for a clear gloss finish over their products. By advertising that it now uses UV inks and curing, Fit To Print's business has increased by 20%. This new ability has enabled Fit To Print to win a large contract with G.T. Interactive Software, a supplier of electronic games to the largest retailer in the United States. This, says Dennis Prifti, means his shop will create five new jobs.

Figure 4: OTA staff and Dennis Prifti of Fit To Print

Economics: The exact difference the UV system is making in Fit To Print's bottom line is somewhat difficult to determine after only one year of operation, but is obviously very favorable. The company buys its inks and other supplies in bulk to save money. Since the ink supplies may last for a period of years, the first year will show the lowest profit margin, while the last year before new supplies are purchased will show the greatest profit, assuming that business remains steady. To date, annualized savings due to reductions in solvent use have averaged $12,600. Savings due to elimination of labor associated with cleaning averaged $12,000. The labor saved also increased available production time by 2 hours per day, based upon the current single shift operation. By allowing Fit To Print to serve new markets in addition to reducing the need to purchase and use solvents, conversion to UV curing has produced financial as well as environmental benefits for this small printer. Additional benefits are expected in the coming months and years.

This case study is one in a series prepared by the Office of Technical Assistance (OTA), a branch of the Massachusetts Executive Office of Environmental Affairs. OTA's mission is to assist Massachusetts facilities with reducing their use of toxic chemicals and/or the generation of toxic manufacturing byproducts. Mention of any particular equipment or proprietary technology does not represent an endorsement of these products by the Commonwealth of Massachusetts. This information is available in alternate formats upon request. OTA's **nonregulatory** services are available at **no charge** to Massachusetts businesses and institutions that use toxics. For further information about this or other case studies, or about OTA's technical assistance services, contact:

Office of Technical Assistance, 251 Causeway Street, Suite 900, Boston, MA 02114-2136
Phone: (617) 626-1060 Fax: (617) 626-1095 Website: http://www.state.ma.us/ota