A Cooperative Project between the U.S. Environmental Protection Agency and the Printing Trade Associations Nationwide

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design FOR THE ENVIRONMENT

SCREEN PRINTING PROJECT BULLETIN 1

SCREEN PRINTING

TECHNOLOGY ALTERNATIVES FOR SCREEN RECLAMATION

The screen reclamation process can be one of the most hazardous operations in a screen printing facility. Typically, highly volatile solvents are used which may be hazardous to the health of employees if inhaled, ingested, or absorbed through the skin. These products may also be hazardous to the environment if they are not disposed of properly. Traditionally, when reclaiming screens, employees vigorously scrub the screens in a wash-out booth, with their faces close to the reclamation chemicals. This increases the likelihood that they will inhale the chemical vapors.

To reduce the hazards of screen reclamation to workers and to the environment, screen printers can use alternative techniques for screen reclamation. These technologies help to reduce the employee exposure to hazardous chemical vapors either by speeding up the reclamation process, or by enclosing the process, or by eliminating the use of volatile solvents.

The DfE Screen Printing Project identifies several potential substitute technologies that can be environmentally safer than traditional screen reclamation, including: high pressure water blasters, automatic screen washers, sodium bicarbonate spray, media blasting, pulse light energy technologies, stripping technologies, and emulsion chemistry. This bulletin highlights three of these technologies:

- High pressure screen washers
- Automatic screen washers
- Sodium bicarbonate (baking soda) spray

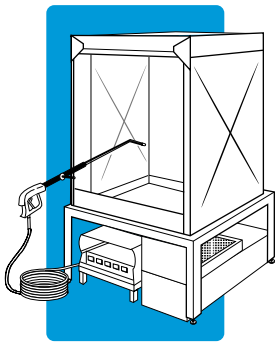
High pressure screen washers and automatic screen washers are two commercially available technologies that can reduce a facility's usage of traditional solvent-based ink removers. Sodium bicarbonate spray is a technology now under development that could further reduce the costs and potential health risks of screen reclamation. This bulletin provides comparative cost, performance and risk information for these reclamation technologies, when available.

It should be noted that these technologies were evaluated using a case study approach; these were not rigorous, scientific investigations. Instead, much of the information presented here is based on printers' opinions of these technologies as they are used in production. This bulletin compares the alternative screen reclamation techniques to manual application and scrubbing of traditional screen reclamation chemicals. The traditional system used in the comparison consists of: lacquer thinner as the ink remover, a sodium periodate solution as the emulsion remover, and a xylene/acetone/mineral spirits/cyclohexanone blend as the haze remover. These chemicals were selected because screen printers indicated they were commonly used in screen reclamation.

High Pressure Screen Washers

High-pressure screen washers reclaim screens using pressurized water, usually in conjunction with some reclamation chemicals. Typically, excess ink is carded off the screen prior to cleaning. No ink remover is applied to the screen. An emulsion softener or remover is applied and allowed to work, usually for from ten seconds to one minute. The ink and stencil are then removed with a high pressure water blaster sprayed on both sides of the screen at pressures of up to 3,000 pounds per square inch (psi). If necessary, a haze remover is then applied and allowed to work. Again, the high pressure water blaster is used to rinse off the haze and the haze remover. Cleaning usually takes place in a washout booth where the rinse water can be collected.

While this technology may require significant water use, in the systems evaluated, the emulsion and haze removal products were formulated to allow discharge to sewers. Where ink residues in the rinse water exceed wastewater permit concentration limits, such as for suspended solids, manufacturers also supply a variety of filters. The greatest environmental benefits are realized for systems using improved filtration systems which allow rinse water to be reused. Filter wastes are typically disposed of as hazardous waste.



High Pressure Washer

Risk

In general, the benefits of high pressure washers are that they reduce both chemical use (eliminating ink removers) and worker exposure (less scrubbing required). The DfE Screen Printing Project found that the occupational risks of this system were notably lower than the risks associated with the manual application of traditional solvent-based reclamation chemicals. For the traditional screen reclamation system, health risks associated with both daily inhalation and skin contact with the chemicals, particularly organic solvents, were significant. For the high pressure screen reclamation system, health concerns were related to unprotected skin contact with the reclamation chemicals. Dermal exposures could be reduced dramatically, however, by wearing gloves.

Switching to this type of screen reclamation technology can reduce both your facility's releases of hazardous materials and your regulatory burden by reducing the amount of cleaning solvents you use. Contact your state and local regulatory authorities for information specific to your location.

Performance

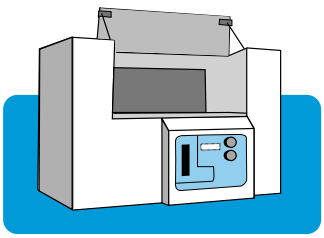
Performance of a high pressure water blaster was evaluated by DfE staff at a volunteer printing facility where the technology was in place. Overall, the high-pressure screen washer reclaimed the screen efficiently and effectively. When demonstrated on screens with solvent-based, water-based inks, or UV-curable inks, the stencil dissolved easily, leaving no emulsion residue. Ink stains on these screens were completely removed by the haze remover even before the waiting period or pressure wash.

Cost

The DfE Screen Printing Project also estimated the cost of equipment, labor, and chemicals for the high pressure wash. Assuming that 6 screens are reclaimed daily and each screen is 15 ft^2 in size, the cost estimate for the high pressure washer totaled $4.53 per screen reclamation. This estimate was compared to that of the traditional screen reclamation system (using lacquer thinner, sodium periodate, and a solvent blend). Using the same assumptions, the estimated reclamation cost of the traditional system is $6.27 per screen; 30 percent more than the high pressure wash, with the greatest savings coming from the reduced labor costs for the high pressure washer. Equipment costs, estimated at $5,300 (installed) account for just 12 percent of the per screen costs. This estimate does not include filtration units, which range in price from $1,300 to $12,000, or maintenance and operating costs which may also vary widely.

Automatic Screen Washers

There are several different types of automatic screen washers, and although most are used for ink removal only, automatic systems for emulsion and haze removal are also available. The major benefits of automatic screen washers are reduced solvent losses, reduced labor costs, and reduced worker exposures. The DfE Screen Printing Project identified a wide variety of automatic screen washers on



Automatic Screen Washer

the market and found significant differences in the chemicals used and costs. Costs vary based on the level of automation (such as conveyors), system capacity, and complexity of the equipment.

The basic component of the automatic screen washers is the wash unit, an enclosed box that can house a variety of screen sizes (up to 60 in. by 70 in.). After a screen is clamped inside the wash unit and the top closed, the cleaning process begins. A mobile mechanical arm sprays solvent onto the screen through pressurized nozzles (30 to 150 psi) for any preset number of cleaning cycles. Since the systems are enclosed to reduce solvent losses, volatile solvents, such as mineral spirits, are often recommended because of their efficacy. There are, however, a number of alternative formulations offered by equipment manufacturers. Used solvent drains off the screen and is directed to a filtration system to remove particulates (inks and emulsion). Following the filtration step(s), reclaimed solvent is typically reused. Some systems have separate wash, rinse, and air dry cycles or separate tanks for washing and rinsing. Solvent reservoirs must be replenished intermittently and changed once or twice a year. Filter wastes are typically disposed of as hazardous waste.

Risk

Compared to manual application of the traditional screen reclamation chemicals, the DfE risk evaluation of automatic screen washers found that worker inhalation exposures to the volatile organics used in solvents (mineral spirits and lacquer thinner) were reduced by as much as 70 percent. Although the health risks associated with skin contact of the chemicals remained high, these risks could virtually be eliminated if gloves are worn while handling the screens. Since the automatic screen washer evaluated was used for ink removal only, the risks associated with emulsion and haze removal remained the same as the traditional system's risks for these steps.

Performance

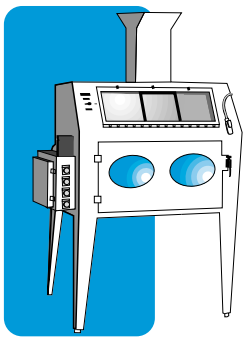
As described above, there are several types of automatic screen washers, and for each type there are several manufacturers. Because of the resources required to do a full demonstration of all the equipment that is commercially available, performance demonstrations of automatic screen washers were not conducted in this project.

Cost

The DfE Screen Printing Project estimated costs for two automatic screen washers, assuming that the washers were used for ink removal only and that six screens (15 ft^2 each) were reclaimed per day. Screen reclamation costs using an automatic screen washer ranged from $4.13 to $10.14 per screen compared to $6.27 for traditional reclamation. The largest cost component, and the cause of the variability in costs, is typically equipment cost. For many print shops, especially higher volume printers, the equipment pays for itself through savings in reduced chemical use. Additionally, the savings of switching to this technology would be greater if this costing accounted for the labor savings of workers moving on to other tasks once the screen is loaded in the washer. It is important to note that the cost per screen of the more automated, higher cost washer would be much lower if it operated nearer to its capacity of over 100 screens per day.

Sodium Bicarbonate Spray

A sodium bicarbonate (baking soda) spray technology was evaluated by the DfE Screen Printing Project to determine if it is potentially adaptable as an alternative screen reclamation technology. This technology is currently used for removing coatings, such as paint, grease, or teflon from metal parts. In these applications, the technology has been successful in replacing hazardous cleaning chemicals. Based on the success of the sodium bicarbonate spray in other applications, it appears to be a promising substitute for chemical screen reclamation systems. Because the sodium bicarbonate spray technology had never been tested for screen reclamation, DfE staff conducted a one-day site visit to the equipment manufacturer's facility. Three imaged screens were inked with three types of ink. Each inked screen was individually placed inside an enclosed cleaning booth, and the screen was passed, back and forth, under the sodium bicarbonate spray. No chemicals other than the sodium bicarbonate were used during the reclamation.



Sodium Bicarbonate Spray Enclosure

Risk

The DfE project did not undertake a risk assessment of this spray technology for a number of reasons. Sodium bicarbonate has been shown to be a fairly innocuous chemical and it is not a skin irritant. In addition, it is a common ingredient in baked goods, toothpaste and detergents. If this technology proves to be a viable alternative for screen reclamation in the future, a detailed assessment of the human health and environmental risk should be conducted.

Performance

Several different methods for screen reclamation with the pressurized sodium bicarbonate spray were demonstrated. Performance was best when the sodium bicarbonate spray was delivered through a pressurized water spray. Typically, the emulsion came off in stringy rolls, and ink flaked off rather than dissolved. A 100 in^2 area took approximately 15 minutes to clean. Following this cleaning, haze or ink residue spots remained. Cleaning of UV-curable inks was ineffective. No evaluation of subsequent use of these screens was made.

Based on these limited demonstrations, initial results indicate that with further testing and research, this may develop into a promising new screen reclamation technology. Modifications are needed to reduced the cleaning time required for reclamation and to reduce the possibility of screen damage. For example, the physical support behind the screen greatly reduced the stress on the mesh. Use of hot water was suggested as a means of improving emulsion removal. Other modifications may include decreasing the sodium bicarbonate particle size, or modifying the delivery rate and pressure of the sodium bicarbonate and water sprays. Further testing is needed before a definitive evaluation of performance can be given.

Cost

Since the available equipment was not designed specifically for screen reclamation, it was assumed that the cost of equipment modified for screen reclamation would be similar to the cost of the equipment used in the performance demonstration. The cost of the available equipment ranges from $32,000 to $52,000, including a filtration system. The sodium bicarbonate itself costs between $0.65 to $0.75 per pound, based on amount purchased, and approximately one pound is sprayed per minute. If this technology proves to be a feasible alternative for screen reclamation after further developments, a more detailed cost analysis can be conducted.

What is the Design for the Environment Screen Printing Project?

U.S. Environmental Protection Agency's (EPA) Design for the Environment (DfE) Screen Printing Project is a voluntary project that encourages printers to consider environmental concerns along with cost and performance when purchasing materials. Replacing hazardous chemicals with environmentally-safer substitutes is one way to reduce the impact of printing on the environment while maintaining product quality. Many printers, however, may not have the time to identify and test environmentally-safer substitutes.

That's where DfE fills the gap. EPA has teamed up with screen printing industry representatives (including trade associations, printers, and suppliers) in the DfE Screen Printing Project. The Project's goal is to evaluate and publicize pollution prevention opportunities in screen printing, particularly in the screen reclamation process.

For More Information...

For more information on the technologies discussed here, contact your equipment suppliers. For more detailed information on other technological and chemical alternatives, see the summary booklet, *Designing Solutions for Screen Printers — An Evaluation of Screen Reclamation Systems.* Additional bulletins are also available.

Pollution Prevention Information Clearinghouse (PPIC)
U.S. Environmental Protection Agency
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Washington, DC 20460
Telephone: 202-260-1023
Fax: 202-260-4659

or

Screenprinting and Graphic Imaging Association International (SGIA)
10015 Main Street
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You may also contact the DfE Home Page at: http://www.epa.gov/dfe/ or the SGIA Home Page at http://www.sgia.org/

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