Cleaner and Greener Flexo Printing: Increasing Profitability Through Environmental Awareness

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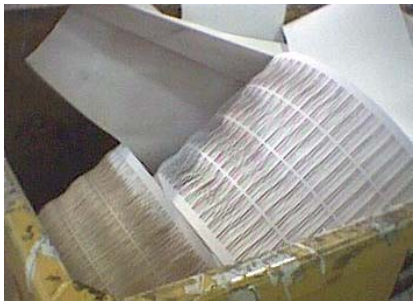
Before we can reduce the environmental impact of a printing operation, (or any industrial facility for that matter), we need an idea how the manufacturing process affects the environment. Most printers would likely point to VOC's (volatile organic compounds) emitted into the air as the primary environmental issue related to printing. Actually, printing impacts the environment in a variety of ways beyond just air emissions. Printing utilizes precious resources including fresh water, paper products and energy; and in the process generates a huge waste stream of both liquid and solid waste.

Traditional approaches to environmental issues have revolved around cleaning up after the fact; after an environmental catastrophe occurs. As every industrial manufacturer is aware, governmental agencies (EPA, DNR, OSHA, etc.) have taken the approach of adopting regulations and forcing compliance through fines or the threat of fines. From the printer's perspective, the seemingly endless stream of regulations represents an unnecessary, time-consuming and expensive, bureaucratic nightmare of paperwork, inspections, documentation, and more paperwork.

Could there be a better approach? Rather than being regulated to death, are there steps printers can take to be more environmentally friendly, while at the same time improving their print quality and profitability? Are there ways printers can take the initiative within their own facilities to improve the environment, while actually seeing a bottom line benefit? The answer is: "Absolutely !"

So where do you start? Take a good hard look in the trash bins. What do you see? If your answer is "trash", you should look again. If you see roll after roll of make-ready waste, ask yourself how much all of that raw substrate cost you to purchase. The substrate is clearly one of the largest variable costs in printing. How much do you spend annually on substrate materials? The numbers are undoubtedly staggering. Now think about how much of the substrate you purchase goes into the dumpster every day.

What about all of the ink that is applied to all of the waste substrate? How many VOC's are released during make-ready? What about all of the electricity (used to run the press itself, dryers, lights and inspection equipment), as well as operator wages and valuable press-time that are squandered in the make-ready process? While you are thinking about all of those costs, consider how much you spend each and every month to have the trash hauled away. You are probably beginning to see that you are not just tossing the trash; you are probably throwing your profits into the dumpster.



Printers generate large quantities of matrix waste. New technologies are available to recycle this material.

Just imagine the savings if you could cut in half the amount make-ready waste you produce. How would that affect your consumable, labor and energy costs? How would it affect your equipment utilization? How much could you save on waste disposal costs? While we are on the subject, how many tons of material could avoid going to a landfill each year from just one printing operation? If you reduce the amount of waste generated, (source reduction), you will reduce costs for consumables, energy, and labor, while saving precious natural resources, reducing VOC emissions and drastically curtailing the waste stream from your operation.

How do you minimize make-ready waste? By getting better control of the print process and making the print process more predictable. This can be accomplished by reducing printing variables. How do you reduce variables? You quit varying them! With the flexographic printing process, there are a myriad of variables, many of which can be controlled by the printer.

Inks

Achieving desired color density requires the correct ink formulation correctly and consistently applied. Establishing parameters for pigment load, viscosity and pH when the print approval is received provides a baseline for setting up the job on subsequent press runs. Viscosity and pH can vary during a press run creating variability in the flow of the ink. This variability highlights the importance of routinely monitor these characteristics. As changes are noted, small adjustments can be made on the fly to insure consistent flow and resulting density. All to often, however, these characteristics are not monitored until the system is so far out of whack that ink dries on the plates and/or anilox rolls, print quality suffers and waste is generated.

Doctoring

Many improvements have been made through the years in doctoring techniques and supplies. Roll to roll doctoring has all but been replaced because it produces inconsistent print results. The hydraulic pressure created by the ink, in conjunction with the variability of the rubber durometer, squeeze (nip pressure), and roll velocity allow variations in the ink film on the surface of the anilox roll. In effect, control is lost because ink is allowed to flow freely across the top of the cells, rather than being contained within them. Ultimately, it was the inability of doctor rolls to adequately and consistently sheer ink from the anilox surface, which caused the migration to doctor blades.

Through the years, several improvements have been made in doctor blade technology including reverse angle blades, closed cavity systems, and refinements in blade materials and edge finishes, all designed to reduce the variability of ink delivery. Of course, for the system to work properly, it is incumbent on the printer to insure that the doctor blade system components are properly adjusted and maintained, and blades regularly replaced. Poorly adjusted and/or maintained doctor blades not only result in waste due to inconsistent print quality, but can also damage the anilox rolls resulting in even more waste.

Anilox Rolls

The anilox engraving has three main variables: linecount (LPI) refers to the number of cells per inch, engraving

angle refers to the spatial orientation of the cells in relation to one another, and cell volume (BCM) refers to the ink carrying capacity of the cells.

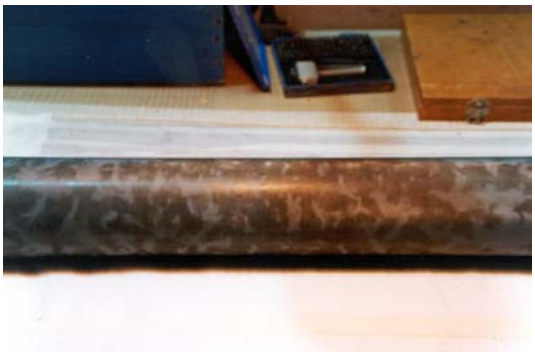
A fourth, and often overlooked, variable pertains to the condition of the engraved cells. If the wall surface is worn, the cell carrying capacity will be diminished. The same holds true if the cells are plugged with dried ink or other material. In this case, some of the useable volume is occupied and not available to carry liquid ink. If the cell walls deteriorate or become damaged, ink may pool across several cells instead of being contained within them. This can lead to an uncontrolled, artificially high delivered ink density.

The following can reduce print process variability from the anilox rolls: proper roll selection, standardization of the roll inventory, and proper roll maintenance.

Proper Roll Selection

There are those that would argue that VOC emissions could be reduced by reducing ink film thickness, and thereby substantiating an argument for shallower depth anilox cells. While it is true that an unnecessarily heavy ink deposition will result in greater VOC emission, a 2 BCM delivered volume is still a 2 BCM delivered volume, whether it is applied by a shallow, dished out 500 LPI engraving or a deep, steep walled 1000 LPI engraving. The ink film thickness of a given density of ink does not change significantly based on the cell configuration. The bigger issue is in obtaining the correct ink density, but at the highest possible line count to insure the finest distribution and easiest drying.

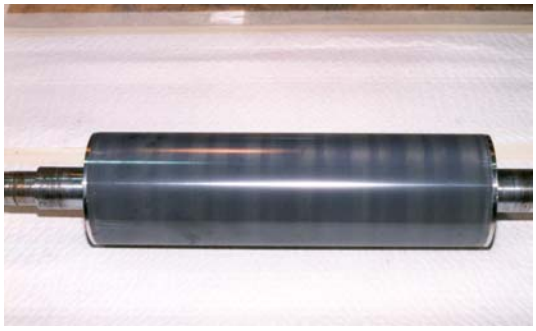
Proper roll selection begins with developing job sheets for each print job. These job sheets contain all relevant information on job requirements, as well as the press parameters from when the print approval was first received. The parameters include ink (formulation, pH, viscosity, solids content), anilox specifications and plates used at each print station. Because anilox rolls are often swapped between presses or may be unavailable for other reasons it is important to include linecount and cell volume specifications.



Rolls can take on a camouflaged appearance in the ultrasonic cleaning process as ink is removed from some areas of the roll more quickly than others. Contributing causes include: inconsistent cavitation, a poor chemistry match (cleaning solution to the ink being removed), saturated chemistry (cleaning solution can no longer function properly because it is so heavily contaminated with ink components), or loss of roll rotation in the ultrasonic bath. Excessive exposure under these conditions can etch this type of pattern into the engraving causing permanent damage.

As ink resins harden in the cells, they may trap some pigment causing a visible tint to the roll surface.

Metal imbedded in the cells occupies cell carrying capacity and creates a visible defect in the print. Printers can reduce make-ready waste by identifying damaged rolls and getting them out of circulation.



Inconsistent cleaning can cause streaks which are visible on the roll and show up in the print. Color variations on the roll surface will often show up in solids, vignettes, and tints.

For example, a job was last run with 600 LPI @ 1.8 BCM for the magenta station. On a subsequent press run the 600-1.8 was in use (in another press) and the only rolls available were a 500-3 and a 700-1.5. The operator would look for the closest linecount / volume combination to run in its place. In this case the operator would choose the 700 LPI anilox to run in that station because the 1.5 BCM would lay down an ink film much closer to that delivered by the 1.8 BCM roll with much less ink manipulation.

As new print jobs do not have an established approval history, it may be beneficial to perform a press characterization. A press characterization involves using a standard set of plates with specific ink formulation to test various anilox rolls for resulting ink densities. The plates typically contain solid coverage areas, as well as various screen values, text in a series of font sizes in direct and reverse, and a process image. The plates provide measurable values that quantify the quality of the ink delivery, dot gain, trap and tonal ranges. These values serve as a benchmark of expectations from each anilox roll, to be used as the basis for roll selection on future print jobs with similar elements.

In cases where the print shop significantly deviates from routine print jobs (new type of work, new substrate, different ink system, etc.), the existing anilox roll inventory may not provide an accurate prediction of expected ink delivery results. In such a case, the printer should consider ordering a banded anilox roll. A banded roll is an anilox roll, which has more than one engraving pattern on its face. By having multiple engravings on one roll, the printer is able to test a variety of engraving patterns, cell volumes, or linecounts at the same time, without the expense of purchasing separate test anilox rolls. The number and width of the bands varies depending on the

specific test design criteria. Although a few manufacturers offer "standard" banded rolls, most prefer to provide custom banded rolls engraved specifically for the test design.

Banded testing can be very beneficial. To insure the success of the test:

- Specify engraving parameters far enough apart to prevent overlap of results from normal process variations and tolerances.
- Make sure the width of the bands is large enough to provide an accurate representation of expected print results.
- The first and last bands of the roll should be identical. Comparable ink densities between the first and the "control" band helps insure even impression with the plate cylinder.

Standardization of the Roll Inventory

Over time, a company's anilox inventory can become very large, with rolls ordered by different individuals, produced by different suppliers, or purchased for very specific print jobs. Supplier's specifications and tolerances may even change over time. Because anilox rolls should last for many years, it is possible for a print shop to end up with a variety of different specifications for rolls of the same linecount. The press operators may only know that one 800 LPI roll does not print like another, never realizing that one was purchased at 1.0 BCM, while another was ordered at 1.8 BCM. Even rolls that were ordered to the same specifications may not print the same if they are worn or plugged.

To reduce roll-to-roll variation, print shops should establish standard purchase criteria for anilox rolls including such things as linecount, cell volume, engraving angle, and width of unengraved edge bands (if applicable). These parameters should be clearly communicated on each purchase order to the anilox manufacturer.

There is a level of variation inherent in any process including the anilox roll production process. Consequently, it is recommended to order rolls in batches of the same LPI / BCM specifications whenever possible.

Proper Roll Maintenance

Proper roll maintenance begins with ascertaining the current condition of the anilox rolls and associated press components (gears, bearings, doctor blade system components, etc.) This can be accomplished during the course of routine press maintenance or in conjunction with troubleshooting problems during make-ready. Condition of press components can also be determined in the context of a formal roll audit. The audit process typically includes a microscopic examination of the engraved cells, but also includes a careful visual inspection of the rolls' surface, providing a means of documenting the severity and types of damage noted.

In its broader sense, the roll audit or SPEAR (Systematic Process Evaluation and Review) is a diagnostic tool for identifying potential sources of damage and developing corrective actions to prevent future occurrences.

Following are a few examples of issues typically identified during a properly conducted roll audit: Loosely fitting, damaged, or worn bearings can result in uneven impression in the web direction. Worn or damaged gear teeth result in poor registration and regular, repeated banding across the web. Damage to the roll surface alters the

available cell volume in the affected area, resulting in a visible defect in the print. Improper or inadequate cleaning practices can damage the anilox rolls and often results in loss of ink density, as well as streaks, drip marks, and various blotches in the print.

When these defects are found during make-ready, it is too late. The production process has to wait while the cause is isolated and the offending component replaced. In the meantime, more raw materials are used and more printed waste is generated. Many of these issues can be mitigated through routine maintenance, careful handling of press components and proper cleaning techniques.

Anilox Roll Cleaning

There have been numerous approaches developed for (or applied to) the cleaning of anilox rolls including ultrasonic (conventional and multi-frequency), media blast (baking soda, plastic media, and cryogenic), jet wash, chemical, and even cleaning laser engraved cells with a laser. A discussion of specific cleaning methods is beyond the scope of this article. Suffice it to say that anilox cleaning methods often rely on harsh, hazardous chemistries, (which pose safety and hazardous waste disposal issues); or aggressive cleaning actions, (which can damage the microscopic cell walls).

Prompt attention is a key to the success of the cleaning operation. Taking steps to prevent cell plugging can reduce the need for aggressive cleaning action and/or harsh chemistries, thereby improving the success of the cleaning operation, and reducing the amount of hazardous waste byproducts, potential damage to the anilox rolls, and safety hazards for press operators. It is important that the disposal of hazardous waste be done properly after having obtained the proper permits and in observance of all local and federal (EPA) regulations.

Additional suggestions:

- Application of permanent non-stick fluorocarbon coatings to the ink pans (or use of disposable ink pan liners) can greatly speed the clean-up process and reduce cleaning chemical (solvent) use and ink waste water.
- Resurface worn anilox rolls rather than replacing. As long as journals are in good shape, rolls can usually be resurfaced at a considerable cost savings. In many cases, even rolls with damaged journals can be resurfaced (and journals repaired).
- Stress to press operators and helpers the importance of cleaning press components (particularly anilox rolls) before ink is allowed to harden. This will speed the cleaning process, reduce water consumption and wastewater generation, and reduce the need for use of harsh chemicals or solvents.
- Look for ways to reduce the waste stream through recycling of paper, cardboard, packaging materials, office paper, magazines, cardboard boxes, outdated literature, newspapers, junk mail, etc. Even some matrix waste can be recycled.
- Combine partial gallons of left over latex paint to use for future painting projects.
- Contact trade magazines to eliminate names of former employees from the circulation list.
- Establish a central library of trade magazines and industry directories.

- Recycle waste metal: old file cabinets, metal shelving, worn gears and bearings, parts from outdated doctor blade systems, solid core rolls (when replacing with hollow), rolls with broken journals, banding iron, shavings from machine shop operations, aluminum soft drink cans, etc. By working with your local recycling center or scrap yard, it is possible to divert all of these materials from the land-fill, while generating additional income.
- Be creative in finding alternative methods for disposing of pallets, crating materials, windows, doors and carpet from remodeling projects, and even old office furniture. Many of these items can be given away, used in other areas or sold rather than land-filled.
- Printing on film generates unprinted film waste from trim stock. Cumulatively, this waste stream can be significant. Because it has not been contaminated with ink, this material can be melted down to form new pellets, which can then be blown into new film. Another source of waste material that can be used in this fashion is outdated rolls of film stock, which would otherwise be disposed of. Film waste that has been printed on can also be melted down and remanufactured into pellets. Because the ink components have not been removed, this material can not be printed on, but can be sold to be used in the manufacture of a variety of products including flower pots, garden edging, park benches and flexible plastic pipe.
- Install energy efficient lighting. A flexographic printing firm with multiple locations, upgraded to energy efficient lighting, which reduced energy use by 146,916 KWHS per year. Annual emission and production of the following pollutants was reduced by:

Carbon Dioxide	30561 lbs
Sulfur Dioxide	2571 lbs
Nitrogen Oxide	1205 lbs

This was accomplished in conjunction with help from the US EPA through a program entitled “Green Lights” that encourages companies to install energy efficient lighting. (Additional information can be obtained by calling 1-800-831-3324).

Certainly, this is not meant to be an all-encompassing list. It is intended more to illustrate the tremendous and various opportunities to reduce the waste stream. While you may not believe these “small-scale” recycling efforts will have much impact, they can reduce your operating costs and generate additional income, (potentially saving thousands of dollars each year). The question to consider is “how many thousands of labels, or forms, or boxes, or newspapers do you have to print in order to make $1000.00 of profit?”

Efforts aimed at source reduction and recycling can improve equipment utilization and reduce operating and waste disposal costs, consumption of natural resources, generation of VOC’s, and the overall waste stream from your operation. In addition, these efforts can be a source for a significant amount of added revenue. Clearly, there are ways we can positively affect both the environment and the print shop’s bottom line.