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Center

**Printing
Environmental Technology**

Fact Sheet

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WATER BASED INKS FOR FLEXOGRAPHIC PRINTING

WHY WATER INKS?

The Clean Air Acts have identified solvents typically used as vehicles in flexographic inks as precursors of ground level ozone, a major cause of health problems for people with respiratory ailments. Hazardous waste regulations (RCRA) restrict disposal options for all wastes mixed with solvents from these inks that are easily ignited. Some of these inks are classified as "listed" wastes if specific solvents are part of the composition.

A typical flexographic ink for film substrates, as applied in the ink fountain, has approximately 60%-80% of its weight in solvent such as Ethanol, N-propyl Alcohol, Isopropanol, Heptane and n-Propyl Acetate. These are all VOCs and flammable. Some inks and diluent solvents include Methyl Ethyl Ketone, Methyl IsoButyl Ketone, Toluene, Ethyl Acetate, etc., all of which are listed as (F) wastes.

Waterbased inks provide an alternative to these solvents and a means of eliminating both pollution and many of the regulatory constraints on the printer.

WATER AS AN ACCEPTED CONTROL TECHNOLOGY

The USEPA has developed and published guidelines for state/ local air pollution control agencies that enable them to ascertain which technologies are acceptable to reduce the impact of pollutants in the process. These are called Control Technology Guidelines (CTGs). CTGs set the minimum air pollution control requirements for a given industry or process.

The basic CTG for flexographic printers was promulgated in 1978 and provides for three control technologies:

1. Add-on controls, such as catalytic or thermal oxidizers, carbon absorption or solvent recovery, with a reduction rate of 60%. This was the preferred means of assured control for large sources. The add-on controls have to achieve a minimum destruction efficiency of 90% which means that the capture efficiency must be 67%, since overall control is the product of capture times control.
2. High-solids ink, in which the solvents are no more than 40% by volume of the ink as applied. Solvent-based inks have not been able to provide the high-solids ink required by EPA standards.
3. Waterbased inks use water or some other solvent which does not lead to the production of ozone, as the carrier for ink. The carrier must represent at least 75% of the liquid volume of the ink as applied.

Therefore, when a permit application is reviewed, water is considered as an acceptable control technology.

STATUS OF WATER INKS IN THE MARKETPLACE

The availability of acceptable water inks depends on the substrates that are to be printed on and the end-use characteristics to which the product will be subjected. Paper and paperboard readily accept water inks and coatings. The use of water inks on other substrates such as films and foils vary and may require special treatment in order to have the inks or coatings adhere to it.

Soon after the CTG was promulgated, the transition for paper and paperboard substrates was accomplished with relative ease. All films had posed, and some continue to pose, obstacles that are more difficult to overcome. However, continuing developments of new resins for the inks and technology for printing have provided considerable success in allowing facilities to make a commitment to the alternative technology.

A printer should be aware that what was tried a few years ago with water is quite different today. As each year passes, more water ink technology has come to fruition to meet the challenges. Each passing month brings more technology to ink makers, further enabling them to meet the demands of their customers.

Changes in substrate coatings and new resins and slip additives for films have also contributed to producing substrates that are more receptive to water inks. These include replacements for very popular products now specified that are not very receptive to the water technology.

Water-based inks are now a viable option for flexographic printers. The most important element in a decision to switch to water-based inks is a commitment from management. If management sincerely wants water to work, it will make the necessary changes and provide adequate training of personnel to make it happen.

WATERBASED INK CONVERSION BARRIERS

Waterbased inks have been used for flexographic printing of paper and paperboard since the invention of the process. Printing on these substrates with water was readily successful because of the absorbent nature of the paper fibers. The inks and solvents (water included) are partially absorbed into the substrate, and partially vaporized into the surrounding air.

However, placing a waterborne solution on a film or foil is similar to placing water on a newly waxed car: The water beads up and slides around the surface. Surface tension differences between ink and substrate - particularly stressing the difference between solvent and water inks, requires modification of the substrate surface tension to more readily facilitate the transfer and adhesion of the water inks.

Furthermore, the slip agent and/or EVA component, which are added to introduce specific properties in the film, rise to the surface and pose barriers to the adhesion of the inks. Slip additives provide the surface of the film with an ability to slide easily during filling operations which pose a barrier to the use of water inks.

Flexible packaging is subjected to exposures that are not necessarily demanded of most paper products. Frozen foods, produce, ice cubes and other hard products that can bounce around in the package require films that will withstand these pressures. These are the applications that will also have exposure to chemicals in the packing rooms, i.e. loose ammonia fumes, water vapors, etc. Inks have to be resistant to these influences.

Overcoming these barriers has posed the major challenges facing package printers electing to use waterborne inks and coatings.

BASIC REQUIREMENTS FOR CONVERTING TO WATERBORNE INKS

At the outset, machine and personnel problems arose with regard to the use of waster technology. This required new perspectives and modification of the flexographic printing press and its functional components.

1. The **ink transfer system** requires attention to ensure the metering capabilities of the components and the structural nature of the rollers. Changes in the rollers are required because of the nature of the water ink (it tends to be somewhat like a high solids ink), as well as the need to use less solvent (water) to facilitate drying. Potential corrosion and abrasion necessitates a close look at the materials from which the anilox roller is made.

It is imperative that the **metering rollers are in continuous motion** when the water inks are in the printing station. Re-wetting of all surfaces is critical as dried water ink is like cement. This is most important during press stoppages. Older press configurations and in-line units do not always have this feature and must be modified. At the same time, provisions must be made to automatically move the plate cylinder away from the anilox roll when the press stops.

Fountain(Ink) and anilox rollers in the ink transfer systems have to be replaced with new rollers that have properties that will facilitate the use of the water formulated inks.

The **fountain roller** carries the ink from the ink reservoir (pan) to the metering roller (anilox). The harder the **durometer** of the rubber covering on the roll, the less ink the roller will transfer. Where the standard rubber covering for solvents is between 65-75 Durometer, Shore A, the hardness required for water inks is in the 85-90 Durometer range.

The **anilox roller** is engraved with cells that meter and transfer the inks. The finer the **screen** (cells per inch) and the shallower the etch, the less ink that will be transferred. For example, a 360 screen would deliver a much finer layer and lesser quantity of ink and solvents than would a 200 screen. A similar screen but lower **volume** will effectively reduce the amount of ink transferred. Water-based inks have higher pigment concentrations by volume than solvent-based inks. Therefore, less water-based ink volume is required on the printing plate. Anilox roll cells should be adjusted accordingly. The net result is less ink volume used.

2. **Drying systems** that were more than adequate with hydrocarbon solvents can be totally inadequate for water. The typical flexo dryer box had air flowing into the constrained area, bouncing off the walls and through slots or holes onto the web. This was adequate with a solvent that evaporated quickly and could be removed by a slightly higher exhaust air flow.

Water inks posed two problems. One was the volume of the vapors from the water - essentially 10 times the volume of- solvent given the same liquid volume as a starting point. Second, amines required in the formulations to hold the resins and pigments in suspension. If the amines are not completely removed by a scrubbing action, they can remain in the ink layer and soften subsequent layers of inks that may be printed in succession.

Drying systems have to be rebuilt or equipped with better air movement and much higher exhaust rates.

Drying speed is also a factor. A slow press will not require as much air flow. Production on a high-speed press will be limited if the air flow is not adequate. A general finding with water inks on existing high-speed presses is the loss of 25% to 30% of the production speed when run with drying systems designed for solvent-based inks.

Dryers designed for water-based inks feature different airflows. The best designs have sought to generate a scrubbing action to remove the amines and water, and high velocity to evacuate the vapors.

3. **Film surfaces** must be **post-treated** at the press to raise the surface tension during printing. Post-treating units (**Corona or Flame**) are required to bombard the surface of the film and make it more receptive to the waterborne inks.

The corona treatment not only raises the surface tension of the film surface, making it more receptive to ink wetting out and adhesion; it either causes the slip compound to retreat into the film surface temporarily or moves the slip around enough to "wet" out the inks.

4. A new development in flexo press design has become a major consideration for the printer using water, namely the replacement of the fountain roller with an **enclosed doctor blade system**. More recently a further refinement of the chamber doctor blade system enables the flexo printer to do an automatic cleanup of the ink train.

Instead of having the ink fed from an open fountain to the anilox roller by a rubber roller, the doctor blade system has its ink injected into a reservoir that consists of the cavity formed by the anilox roller, a retaining blade and a cutting blade. The cutting blade shears off all unwanted ink from the rotating surface of the roller as the ink is transferred to the printing plate.

Not only does this system improve the quality of the printing, it eliminates a major area of both captured and fugitive emissions by removing the open fountain. By enclosing the layer of ink (and water) being transferred, the system reduces the amount of diluent that will vaporize in the press operation.

The latest innovation provides for an air-powered wash cycle that cleans out the unit and the anilox roller, and minimizes both waste ink and washwater (or solvent).

5. Coupled with the above major mechanical changes in equipment are those necessitated in auxiliary systems:

- a. **Ink pumps** that were used with solvent inks are not compatible with water. The fast impeller speed promotes foaming of the water inks. New pumps must be obtained.

- b. **Printing plates** may have to be changed to different rubber or photopolymer base material having surface tensions that will accept and transfer inks more adequately.

- c. **Solvent recovery equipment**, normally distillation units, which were used for solvents, are not feasible for reclamation of water inks. New technology, i.e. evaporation or ultrafiltration, or the off-site removal of this waste, may be required.

6. Films and paper/paperboard that have coatings will require compatibility with water inks. Too often, a solvent or UV curable ink system will not anchor to coatings that have been developed for solvent inks. Consult your ink/coating company for assistance.

7. **Personnel must be trained** to utilize new methods in the setting up and cleaning of presses to ensure that inks do not dry on the rollers, on plates, or other parts of the machinery.

A major effort has to be made in the methods used in setting up, operating and breaking down presses. The transfer characteristics of waterborne inks are such that the work force has to be completely trained in the use and troubleshooting of the new inks. Solvents were very forgiving; water inks are not.

The drying of waterborne inks results in a solid that is difficult to remove. To avoid loss of rollers and gears, as well as damage to cylinders and impression drums (cylinders), the pressroom personnel have to be convinced of the need to clean any spills, as well as all rollers and plates when the press is down for changes or any extended downtime.

8. Obtain a complete technical profile of the **substrate** to be printed. Various polymers, coatings and additives (for example, slip agents), may be more or less receptive to water inks. Knowing the limitations can help you to use the appropriate substrates or treat the materials in a manner that will facilitate wetting and adhesion of the inks.

Research and development efforts are most needed in this area. Little has been done or published with regard to the ramifications of using various slip agents and anti-block additives on films printed with waterborne inks. The same can be said of coatings used to promote adhesion to films and foils.

Supporting Documentation

To give a more complete picture of the status of waterborne inks and the technology required to make them work, I refer you to articles and papers delivered at programs and printed in the various trade journals and magazines such as *American Inkmaker*, *Converting*, and *Paper, Film and Foil Converter*. These papers were delivered by some of the leading experts in the field, and should help to foster a better understanding of why water can work and what it takes to make that effort successful.

Fred Shapiro authored this fact sheet.

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