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What conclusions did the study reach?

The study compared environmental and health impacts, performance, and costs of the three primary flexo ink systems: solvent-based, water-based, and UV-cured inks. Environmental impacts included aquatic toxicity, emissions, energy use, resource consumption, and human health effects. The health impacts included estimated exposure and comparative risks to pressroom and prep-room workers and residents of surrounding communities, as well as safety hazards.

Some water-based and UV-cured ink formulations demonstrated improvements in worker safety, reduced concerns for health and environmental risk, and lower material costs.

Overall findings

No ink system was superior across performance, environmental, health, and cost criteria, although each system had advantages.

The study found a wide range of environmental, health, and safety (EH&S) characteristics of formulations in solvent-based, water-based, and UV-cured ink systems. This highlights the need for the flexo industry to work to identify and develop ink formulations that have superior EH&S profiles while still meeting performance needs.

Performance

Materials, equipment, and process need to be customized for each ink formulation, substrate, and printing situation.

All three ink systems performed acceptably, but each system showed a notable range of results on the 18 performance tests that were conducted. Results sometimes varied depending on the test site or the ink color. Substrate type also played a major role in performance, indicating that the ink-substrate relationship was very important to ink performance. The many variations in performance indicate the importance of customizing materials, equipment, and process for each ink formulation, substrate, and printing situation.

Health concerns

None of the ink systems was predicted to pose clear concerns for health risks to people in surrounding communities. However, all ink systems contained chemicals of clear concern for health risks to flexo pressroom and prep-room workers, as well as safety hazards.[1]

The study's health findings reinforce the need for adequate ventilation and for flexo workers to wear appropriate gloves and other personal protective equipment when working with inks. The findings also underscore the importance of developing improved formulations that reduce the EH&S concerns of ink chemicals.

About 25% of the chemicals studied showed clear concerns for systemic or develop-

[1]Pressroom workers were exposed via both inhalation and dermal routes; prep-room workers, however, were exposed via the dermal route only.

mental risks to workers under the conditions of the study. Chemicals showed risk concerns to workers via both inhalation (breathing) and dermal (skin) exposure routes. The study shows that it is *not* reasonable to assume an ink product is "safe" or "risk free" without knowing more about the chemicals in the product as well as the hazards associated with those chemicals and expected exposure to the product.

Aquatic toxicity

Over half of the ink chemicals studied showed a high or medium hazard to aquatic environments.

It is important to store and use chemicals properly, to avoid accidental releases that may end up in water systems. Inks and their wastes should never be put down the drain.

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Consumption of materials

The UV-cured systems consumed the least ink and press-side additions.

The solvent-based ink systems used, on average, about twice the materials (inks and press-side additions) as the water-based inks and four times the materials as the UV-cured inks.

Ink-related emissions

Even with oxidizers, the solvent-based ink systems had higher VOC emissions than the other two systems, on average.

As expected, water-based inks had a much lower VOC content than solvent-based inks. Interestingly, despite the fact that they used oxidizers, the solvent-based systems generated considerable uncaptured emissions, leading to much higher total ink-related emissions. The water-based systems were, however, the only ones in the study that contained listed hazardous air pollutants (HAPs). Because many inks and press-side additions (especially those in solvent-based and water-based inks) contain VOCs and HAPS, reducing the use of these materials may also lower the amounts of pollutants, both uncaptured (fugitive) emissions in the pressroom and stack emissions that are released outside the facility.

Energy consumption

The water-based systems consumed the least energy.

The solvent-based systems used the most energy to produce the same square footage of image, because they used energy-consuming oxidizers to destroy hazardous compounds. The water-based systems consumed the least energy, because they used neither oxidizers nor UV-curing equipment. The energy used by the UV-cured systems

was only slightly higher than that of the water-based inks and was approximately 22% less than that of solvent-based inks.

Energy-related air emissions

The water-based ink systems had the lowest releases of energy-related emissions.

Releases of polluting air emissions were associated with the facility's energy source. Emissions were highest for the UV-cured systems, because they depended entirely upon electricity, which releases more pollutants per unit of substrate printed than does natural gas. So, even though the UV-cured systems used only slightly more energy than the water-based systems, they contributed a larger share of pollutants based upon that energy use. By knowing more about the environmental impacts that can be attributed to the printing process a flexo facility uses, printers can plan ways to appropriately reduce energy use and related environmental releases. Employing more energy-efficient technologies may benefit a facility by reducing production costs, lowering energy-related emissions, and improving the facility's public image.

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Operating costs

Press speed was the most important driver of operating costs.

UV-cured inks in the study had the highest operating costs due to the higher cost of materials and energy, whereas water-based inks had the lowest costs. The UV-cured inks cost 29-46% more than the water-based inks, whereas the solvent-based inks cost 1% to 39% more than the water-based inks. Although the water-based systems had the lowest energy and capital costs, they did not use oxidizers, which would have added to these costs.

In addition to these specific findings, the study found press speed to be a critical driver of overall operating costs, because it affected all costs except inks and substrates.

The bottom line

The flexo ink study found that each of the ink systems studied had a range of different advantages, as well as health and environmental concerns. Considerable variation was noted even among different colors within a single ink product line. Thus, selecting the best formulations is just as important for a printer as selecting an ink system. To identify the "right mix" of ink products for a specific facility, flexo professionals need to consider many different EH&S aspects — environmental hazards, exposure to potentially harmful products, safety considerations, and the type of energy used — as well as performance, cost, substrate, press design, and operating conditions.

To be a good proactive decision-maker, it is critical to have the best information available. Developing and choosing product formulations with more positive environmental profiles may require extra care and scrutiny, especially when selecting raw materials.

Selecting the best formulations is just as important for a printer as selecting an ink system.

Acceptable performance is a critical characteristic of any environmentally preferable technology. Printers should work with their suppliers to select cleaner inks that deliver important performance characteristics.