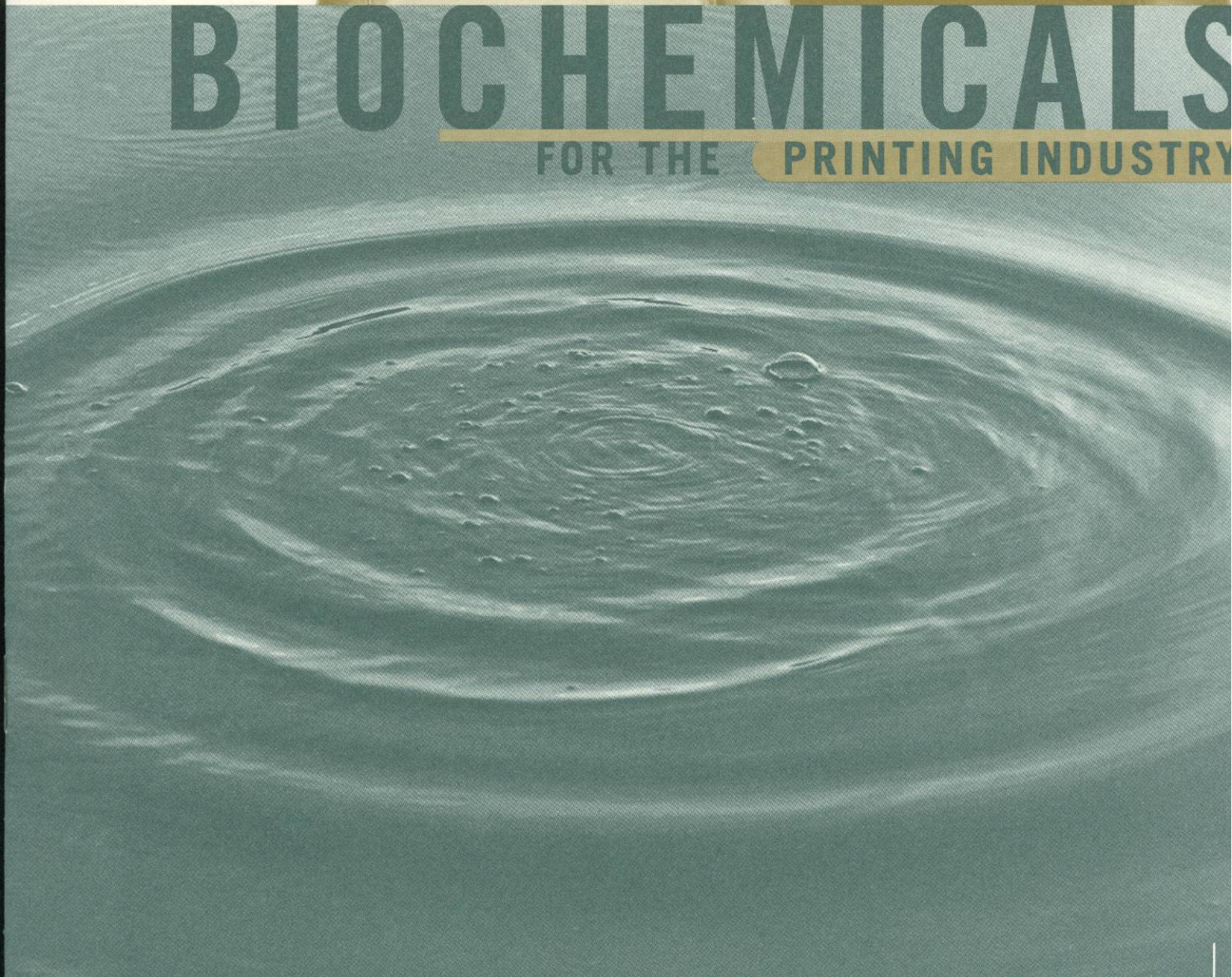
BIOCHEMICALS

FOR THE PRINTING INDUSTRY



THE CARBOHYDRATE ECONOMY

INDUSTRIAL PRODUCTS FROM THE SOIL

INTRODUCTION

The printing industry is one of the largest and most geographically diverse manufacturing industries in the U.S. In 1996, the industry consisted of more than 50,000 establishments with over one million employees and generated over $132 billion in sales.[1] More than 25 states had over 10,000 printing employees each. Most establishments are small. More than 80 percent employ fewer than 20 people; 50 percent employ fewer than five.[2]

Given the large size of the printing industry, it is not surprising that it also generates a significant amount of pollution. In 1995, more than 41 million pounds of toxic compounds were transferred or released into the environment by the printing industry.[3] Figure 1 shows the top ten polluting chemicals used by the printing industry. All ten are petroleum-derived. The vast majority of these chemicals are used in press cleaning operations, blanket washes, and as components of ink formulations. Toluene is by far the most-used chemical, accounting for 75 percent of all toxic chemicals used in printing.

Biological alternatives to these toxic petrochemicals exist. Plant matter-based materials for press cleaning, blanket washes, and inks can save businesses money, while reducing pollution and improving worker safety.

Environmental Advantages: The low toxicity and high biodegradability of biochemicals offers benefits to workers and the natural environment alike. The use of biochemicals also avoids a significant amount of the "upstream" pollution generated from the extraction and processing of crude oil into chemicals.

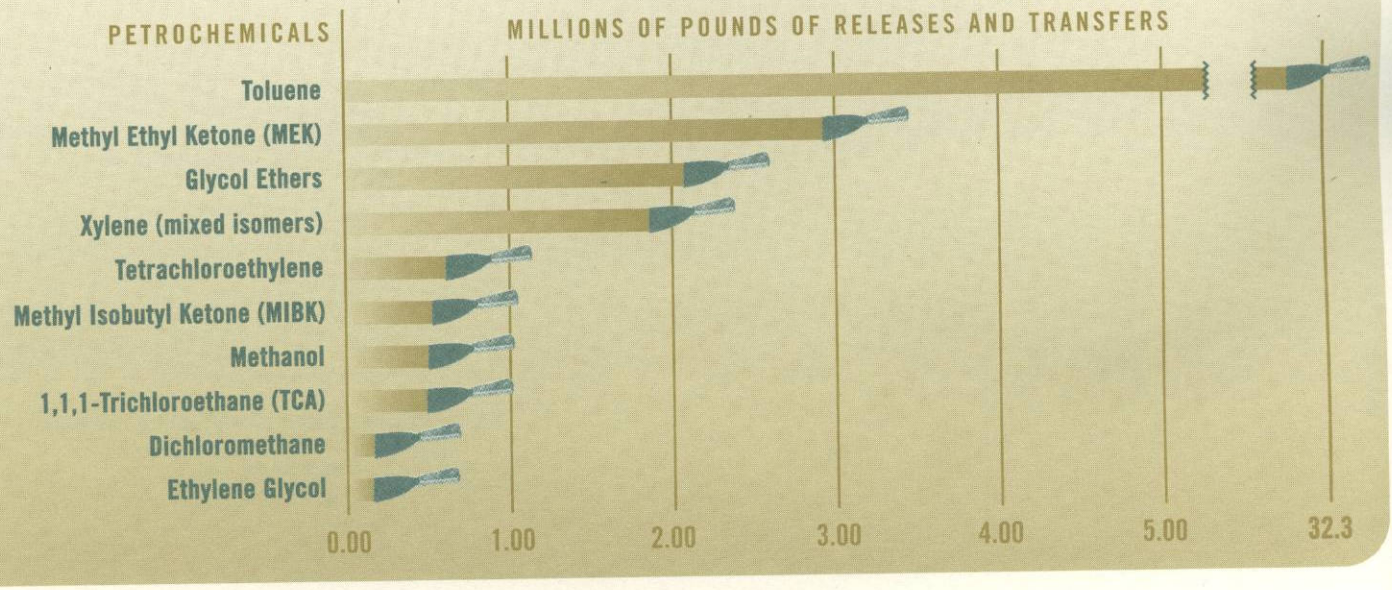
Manufacturing Advantages: Biochemicals save the private sector money in three ways:

- Reduced environmental compliance costs.
- Improved worker safety.
- Reduced disposal and liability costs.

Biochemicals can be price competitive with petrochemicals when all costs, including price, disposal, regulatory and administrative costs,

TOP TEN POLLUTING PETROCHEMICALS USED IN THE PRINTING INDUSTRY

FIGURE 1. This graph illustrates the top polluting chemicals from the EPA's 1995 Toxic Release Inventory (SIC 27). The totals include both transfers and releases. Transfers refer to chemicals in waste brought to off-site locations for further processing or disposal. Most of the releases were in the form of volatile organic compounds (VOCs). VOCs cause ground-level ozone, leading to the formation of smog and causing related health hazards.



What is a carbohydrate economy?

New technologies, new laws and an increasingly environmentally aware public are ushering in a new materials base for the 21st century—plant matter. Corn. Soybeans. Beets. Wheat. Alfalfa. Grasses. We call it a "carbohydrate economy."

One hundred years ago, most of our fuels, construction materials, clothes, inks, paints, and even synthetic fibers and chemicals were made from plant matter. Then petroleum flooded the economy and a new industrial era began. By the 1980s, less than 5 percent of our industrial products and fuels came from biological materials. Now industry may be moving away from the oil derrick and towards the silo for its supplies, as new technologies lower the cost of deriving products from plant matter and environmental regulations raise the cost of extracting, processing, using and disposing of fossil fuel derived products.

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are taken into account. Biochemicals offer manufacturers and printers another advantage: they allow for environmental marketing, popularly known as "green consumerism".

This report provides an overview of the use of biochemicals in the printing industry and identifies companies and products that use naturally-derived materials in press cleaning operations and as ink additives and vehicles. The companies highlighted offer economically competitive products for printers. ILSR believes this report identifies a significant portion of the companies manufacturing biological products for the printing industry, except for soybean-based ink manufacturers. Since over 45 percent of the nation's ink manufacturers produce at least one soy ink product, we have identified representative companies in this sector.

Each month brings news of another product or company entering the biologically-derived product market. Thus this report should be viewed simply as a snapshot of the industry in mid 1997. ■

In 1995, more than 41 million pounds of toxic compounds were transferred or released into the environment by the printing industry....The vast majority of these chemicals are used in press cleaning operations, blanket washes, and as components of ink formulations.

Photo courtesy of National Soy Ink Information Center

Biochemical-Based Cleaning Solvents

Press chemicals are by far the greatest contributors to the release of VOCs from printing establishments. Press washes outnumber fountain solutions three to one in a typical pressroom.

The main reason press washes are large generators of VOCs is that the vast majority are formulated with petroleum-derived solvents, resulting in products that adversely affect the environment and the pressroom workers.

Solvents used to clean printing equipment include toluene, xylene, methanol, and methyl ethyl ketone (MEK). In addition, blankets used to transfer the ink-filled image to sheets of paper are cleaned with washes that contain glycol ethers and 1,1,1-trichloroethane (TCA). The type of solvent used depends largely on the equipment to be cleaned. For example, a blanket wash must dissolve ink quickly and dry rapidly with minimal wiping. Conversely, a solvent that is intended to clean a chain of ink rollers must evaporate slowly, to insure that it does not flash off before it has worked its way through all the rollers.

Press operators often use "type wash"—a mix of acetone, toluene, MEK, and isopropyl alcohol—as a general, all-purpose solvent. This blend was not originally intended as an all-purpose solvent, but workers prefer it because it evaporates quickly, saving drying time. The faster drying time, however, comes with two drawbacks. As a result of the high volatility, about half of this type wash evaporates before it can be used. The higher volatility also causes environmental problems.

Biochemicals have proven themselves economically competitive with petrochemicals due to increased cleaning efficiencies..., lowered disposal costs..., and lowered regulatory costs....

In general, petroleum-based cleaners remove ink quickly and evaporate rapidly, requiring minimal down time for the press; however, they contain more than 60 percent VOCs.[4] The continued use of these press chemicals is becoming increasingly costly for printers due to both federal and state regulations.

Biochemical Alternatives

Companies evaluating a potential press or blanket wash are concerned with three factors: safety, performance and price.

Safety: With regard to safety, companies need to be concerned with the physical properties of the chemicals they use. Physical properties serve as indicators of the chemical's toxicity and reactivity. Key physical properties are low vapor pressures (allows for reduced VOC emissions), high flashpoints (reduces flammability) and little to no odor.

Performance: Performance of a cleaner is more difficult to evaluate due to variations in printing methods, equipment, and inks. However, printers generally want a cleaner that will cut ink effectively, require little manual effort, and not delay press runs. Vegetable-based washes have been criticized because they tend to handle differently than traditional washes. Press operators have found that a little extra effort might be required but, once that occurs, the vegetable-based washes perform as well as petroleum-based washes. A common concern is that vegetable-based washes leave an oily film or take longer to dry. These problems can be dealt with by modest changes in the cleaning technique. For example, a water-soaked wipe can remove oily films. A dry wipe can easily remove excess moisture.[5]

Price: Many bio-based cleaners have a higher price than petroleum-based cleaners. However, purchase price is only one of the factors that make up the overall "use cost" of a product. For a cleaning solvent, use cost includes compliance costs (potential permitting fees and compliance penalties), administrative costs (worker monitoring, liability claims, training), chemical costs, and disposal costs (including proper storage and handling). Biochemicals have proven themselves economically competitive with petrochemicals due to increased cleaning efficiencies (less

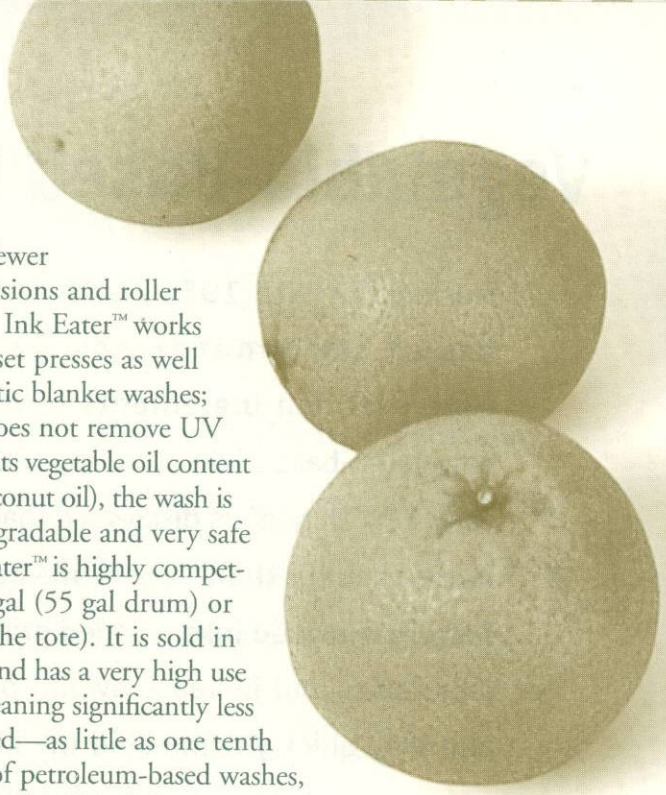
volume of solvent is needed per cleaning application), lowered disposal costs (solvents are not considered hazardous waste), and lowered regulatory costs (through lower VOC emissions).

Companies Marketing Biochemical Cleaning Solvents

Inland Technologies *(Tacoma, WA)* formulates alternative cleaning solvents tailored to its clients' cleaning needs. Inland's solvent line, based on the terpene d-limonene (derived from citrus fruits), has successfully replaced press cleaners containing TCA, MEK, acetone, toluene and methylene chloride. One such solvent, Citra-Safe,™ is an excellent cleaner of ink rollers and press blankets. Inland's Citra-Safe™ has a higher initial purchase cost ($32.95/gal) compared to other commercial press cleaners, such as Free-Glaze 600 ($29.95/gal). However, users of Citra-Safe™ claim that 75 percent less solvent (by volume) is required on a per application basis compared to traditional solvent cleaners.[6] The adjusted use cost for Citra-Safe™ is only $8.24/gal. In addition, Citra-Safe™ does not contain any components listed on the TRI or that are considered hazardous air pollutants (HAPs), whereas the components of Free-Glaze 600 (including toluene, acetone and methanol) require special permits to use, store, and dispose.

Concern has been raised about possible adverse effects of d-limonene on rubber. There are many different types of rubber and its composition does affect its chemical compatibility. Some of the vulnerable types of rubber, such as polycarbonate, can be attacked by d-limonene, however petroleum-derived solvents can have the same adverse effect. Other common types of rubber, including polypropylene and polyethylene, will not be affected by d-limonene. The best method for ruling out incompatibility is to perform an evaluation of the material with the alternative cleaning solvent.

Flint Ink *(Detroit, MI)* is marketing a vegetable oil-based press wash developed by Unichema International (The Netherlands), called Prifer 3303+ or The Ink Eater.™ This press wash contains no petrochemicals and has a very low VOC content, just 5% undiluted and 0.5% press-ready. Ink Eater™ can clean most inks, even metallics. It does not dilute the ink as petroleum-based washes do—it dissolves it. The wash is also said to "condition" the rollers, leading to a longer life, fewer deglazing sessions and roller adjustments. Ink Eater™ works on web heatset presses as well as in automatic blanket washes; however it does not remove UV inks. Due to its vegetable oil content (primarily coconut oil), the wash is highly biodegradable and very safe to use. Ink Eater™ is highly competitive at $25/gal (55 gal drum) or $20/gal (by the tote). It is sold in concentrate and has a very high use efficiency, meaning significantly less wash is needed—as little as one tenth the amount of petroleum-based washes, which average $9.00/gal. For example, a 20/80 mix of Ink Eater™ to water costs about $5.00/gal. Two cups of this mix cleans a roller unit, compared to four cups of a petroleum-based cleaner. Savings are also evident in lowered administrative and disposal costs.[7]



Franmar Chemical, Inc. *(Normal, IL)* markets a soybean-derived industrial solvent designed to remove plastisol ink (textile inks) from screens without damaging mesh or emulsion. This product, called BEAN-e-doo,™ is the first vegetable-based cleaning solvent designed specifically for the screen printing industry. This product offers significant advantages over traditional petroleum-based cleaners. BEAN-e-doo™ contains no petroleum distillates, is 100% biodegradable, has a high flashpoint (>325°F) and is non-toxic. It is also a non-evaporating solvent, thus it emits no harsh fumes or unpleasant odors. This product, of which 97% is made from soybeans, contains no hazardous components as specified by the EPA or OSHA.

BEAN-e-doo™ has a higher use efficiency than petroleum-based solvents, such as mineral spirits. For example, less than an ounce of BEAN-e-doo™ can be used for the same cleaning application that typically requires 8 to 10 ounces of mineral spirits. Although BEAN-e-doo™ is priced significantly higher ($13.79/gal, purchased by drum) than conventional solvents such as mineral spirits ($1.55-2.14/gal), its actual "use cost" is $1.38-1.72/gal.[8] ■

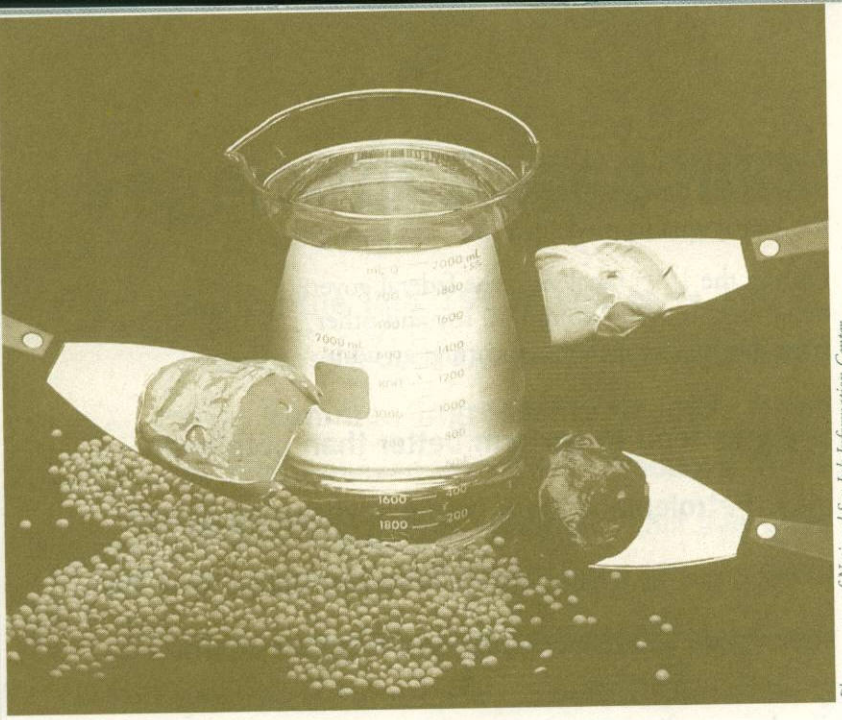


Photo courtesy of National Soy Ink Information Center

performed by the Hazardous Waste Research and Information Center (HWRIC), soy inks spread 17 percent further than petroleum inks on an identical press run.[14]

Soy inks also can be removed from paper more easily, making paper printed with soy ink easier to recycle. Chemicals used to de-ink paper tend to break down the fibers that give paper its strength. Soy ink gives up its bond to paper more easily than petroleum ink, requiring less harsh chemicals, and reducing the breakdown of paper fibers. This results in a higher quality recycled paper.

Colored soy inks are competitively priced with petroleum-based colored inks.... The slightly higher cost of the soybean oil vehicle is offset by a reduced amount of hard resin needed in the colored ink formulation.

Soy inks are more biodegradable than petroleum inks. As the percentage of soybean oil increases in an ink formulation, biodegradability increases.[15]

Economics of Soy Inks Soy inks are priced higher than petroleum inks. The average price for black offset lithography news ink is $0.60/lb (petroleum-based), while the soybean-based alternative costs $0.80/lb.[16] Black ink consists primarily of two components, oil and pigment. The oil accounts for over 80 percent of the formulation; therefore the price of black ink is driven mostly by the cost of the oil.

This tends to keep soy inks priced at a 25 percent premium over petroleum-based black inks, due to the higher cost for refined soybean oil vehicles. So far, the higher costs for black soy inks have limited its use in the black ink market, but if the price of naphthenic oils continue to rise (there has been a 30 percent increase in cost from 1996)[17], black soy inks should become increasingly competitive.

In colored inks, pigments are by far the most expensive component. Colored soy inks are competitively priced with petroleum-based colored inks. For example, a recent price quote for both petroleum and soybean-based colored offset lithographic news inks was $2.98-3.57/lb, dependent on color (bulk delivered).[18] The slightly higher cost of the soybean oil vehicle is offset by a reduced amount of hard resin needed in the colored ink formulation.[19]

Printing with soy ink generates less paper waste during press runs, reducing overall disposal volumes and lowering disposal costs. Reducing the waste stream is a key factor for printers, considering the continued increases in the cost of paper.

A Call for Standardization

The term "soy-ink" does not necessarily mean that the ink is 100% soybean oil. In fact, inks may contain only minimal amounts of soybean oil and still be marketed as a "soy-ink". An attempt at some standardization came in 1993, when the American Soybean Association (ASA) established informal standards that would allow printing ink manufacturers to use a SoySeal® logo. Use of this logo requires inks to have the following percentages of soybean oil: black news ink, 40%; sheetfed ink, 20%; coldset ink, 30%; color news ink, 30%; heatset ink, 7%; and business forms ink, 20%.[20]

All-Soy Inks On The Way

Almost all printing inks that claim to be vegetable oil-based still contain some petroleum-derived components. These components were necessary because, until now, no ink had been developed that had acceptable performance properties and contained a 100 percent vegetable oil-based vehicle. In fact, the current maximum soybean oil content in a black news ink is 75%; followed by colored news ink at 50%, sheetfed ink at 30%, heat-set ink at less than 20%, cold-set ink at 30%, and business forms ink at 50%.[21]

A patent has been issued for a 100 percent soy news ink. This new soy ink contains no petroleum or mineral oil, has a high biodegradability, and has excellent de-inking properties. ARS predicts that it will also be priced lower than the soy inks currently on the market.

The Agricultural Research Service (ARS) in Peoria, IL, a division of the USDA, has developed a printing ink comprised of 100 percent soybean oil and pigment. A patent has been issued for a 100 percent soy news ink. This new soy ink contains no petroleum or mineral oil, has a high biodegradability, and has excellent de-inking properties. ARS predicts that it will also be priced lower than the soy inks currently on the market. This lower pricing is possible due to the fact that using more soybean oil in the vehicle means that less pigment (black, cyan, magenta and yellow) is needed because the soy oil provides a lighter vehicle.

The ARS is also developing a patent on an all-soy ink for sheetfed and heatset printing. This ink would contain 60 percent soybean oil, eliminating all the petroleum oil and resin, with the remaining 40 percent consisting of pigments and other ink additives. Not yet ready for licensing, preliminary tests indicate excellent performance characteristics and an enhanced drying time.[22]

Representative Companies That Offer Vegetable-Oil Based Inks

Flint Ink *(Detroit, MI)* markets its Agri-Tek® line of vegetable-based inks. The inks contain 40 percent vegetable oil, a blend of soybean and corn oils. A synergistic blend of corn and soybean oil is used to achieve fast-set drying properties, while maintaining press stability and decorative properties. Pricing for Agri-Tek® black ink is approximately $4.37/lb and color inks range from $5.51-5.71/lb.

Sun Chemical *(Northlake, IL)* manufactures a line of vegetable-based inks under the Naturalith Plus® trade name. These inks are more than 50 percent vegetable oil, and offer a variety of beneficial features such as reduced VOC content and increased press mileage. Naturalith® inks are designed as sheetfed-offset inks, which can be used on a variety of stock including coated stock and folding cartons. Pricing for Naturalith® inks range from $5.04-5.37/lb for colors and approximately $4.10/lb for black.

Gans Ink & Supply Co. *(Los Angeles, CA)* is well known for its Soy Plus® ink, which contains less than 1 percent VOC. SoyPlus® contains predominantly soybean oil; however nut oils are added to enhance setting speed. Pricing for SoyPlus® inks range from $6.10-6.45/lb for colors and approximately $4.20/lb for black (all are 4-color process inks). Gans also manufacturers Dri-Soy® inks, the first soy-based inks designed for waterless printing methods. ■

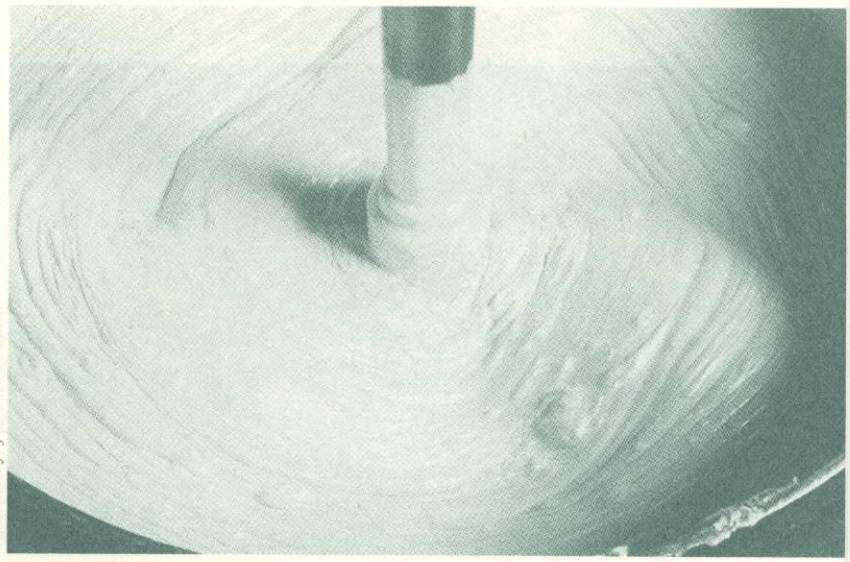


Photo courtesy of Fleishman Hillard

petroleum-based competitors, such as petrolatum, cost $0.45-0.54/lb. Although Natralith™ 125 is twice as expensive as petrolatum, Fanning claims its superior performance will result in a higher quality print job.

Natralith™ 440 is a metallic pigment wetting agent that is derived from meadowfoam oil. This plant matter-based compound is an all natural pigment wetting, transfer agent and color enhancement product for offset printing inks. Natralith™ 440 is claimed to work well with many pigments and inks to enhance color, however its properties specifically enable metallic and fluorescent offset inks to achieve superior color enhancement and transfer. This product, which sells for $7.84-7.99/lb, can actually reduce the amount of pigment needed in ink formulations. This can dramatically offset ink costs, as metallic pigments can cost upwards of $20.00/lb.

Natralith™ 520 is a soybean oil-derived pigment wetting and transfer agent for sheetfed and heatset printing inks. It is primarily used with black printing inks, where the ink manufacturer needs to reduce the amount of costly toners. It can also be used with color, metallic and fluorescent printing inks for improved pigment wetting and transfer. Using Natralith™ 520 as a wetting agent is said to improve ink mileage in offset printing inks for coated papers, as well as enhancing gloss and increasing printing density. It sells for $0.50-0.93/lb (depending on quantity purchased), which is competitive with petroleum-based products.[26] ■

BIOCHEMICALS ENHANCE WORKER SAFETY

Biochemicals offer a number of advantages for workers. Most importantly, they significantly reduce the health risks related to petrochemicals. Lower levels of health risk mean that less safety training and protective equipment may be required. Working with less hazardous chemicals reduces the stress associated with accidental spills and contaminations that could lead to uncontrolled reactions. A safer work environment also benefits the manufacturer by reducing work-related injuries or illness related to hazardous chemical exposures. This translates into fewer liability claims and increased productivity.

The following table compares the National Fire Protection Association (NFPA) ratings for components of common petrochemical-based products to components of biochemical-based products. Biochemicals exhibit far less health and safety hazards.

PETROCHEMICALS	HEALTH RATING	FLAMMABILITY RATING
Methyl Isobutyl Ketone (MIBK)	2	3
Methyl Ethyl Ketone (MEK)	1	3
Xylene	2	3
Toluene	2	3
Styrene	2	3

BIOCHEMICALS	HEALTH RATING	FLAMMABILITY RATING
Soybean Oil	0	1
Coconut Oil	0	1
Grain-derived alcohol	0	0
Rapeseed Oil	0	1
Terpene (pinene)	1	0

Note: Ratings from the NFPA and chemical manufacturers.

HEALTH RATING

0 = no hazard
1 = caution (may irritate)
2 = warning (if inhaled/absorbed)
3 = corrosive/toxic
4 = danger (possibly fatal)

FLAMMABILITY RATING

0 = not combustible
1 = combustible if heated
2 = combustible liquid
3 = warning (flammable liquid)
4 = danger (extremely flammable liquid/gas)

Bolger Publications Switches To A Biochemical Press Wash

Bolger Publications is one of the Twin Cities' leading combined printer and creative agencies. Established in 1952, the lithographic printer employs 125 people. Bolger has five presses (two 6-colors, a 5-color, a 4-color, and a 2-color) and an annual sales volume of approximately $16 million.

Four years ago, Bolger became one of the first in the United States to rid its pressroom of hazardous press chemicals. This change stemmed from a concern for the safety of Bolger's workforce. Employees were concerned with possible adverse health effects associated with the continued use of toxic, petroleum-based press chemicals. Hazardous chemicals were coming in contact with the worker's skin and the foul odor from the evaporating solvents was a serious problem.

The company committed itself to finding a viable and economical alternative chemistry to replace traditional cleaners. Bolger chose a bio-based cleaning solvent. The new press wash, called Prifer 3303+ (or Ink Eater™), was developed by Unichema International and is distributed in the U.S. by Flint Ink. Prifer 3303+ contains no petrochemicals and has a very low VOC content, just 5% undiluted and 0.5% press-ready. More importantly, its vegetable oil content (primarily coconut oil), makes the wash highly biodegradable and very safe to use (See the Flint Ink section on page 3 for more information on Prifer 3303+). No protective equipment or special storage is required. Even the shop towels used with this wash are considered non-hazardous.

Bolger succeeded in finding a safer chemistry and its press operators quickly discovered that the new bio-based press wash out-performed petrochemical competitors.

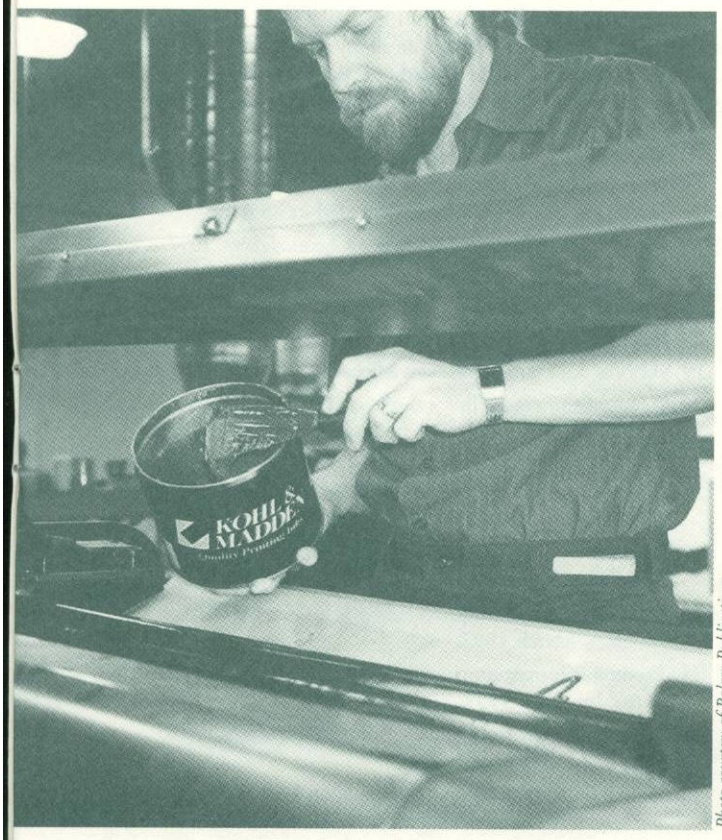
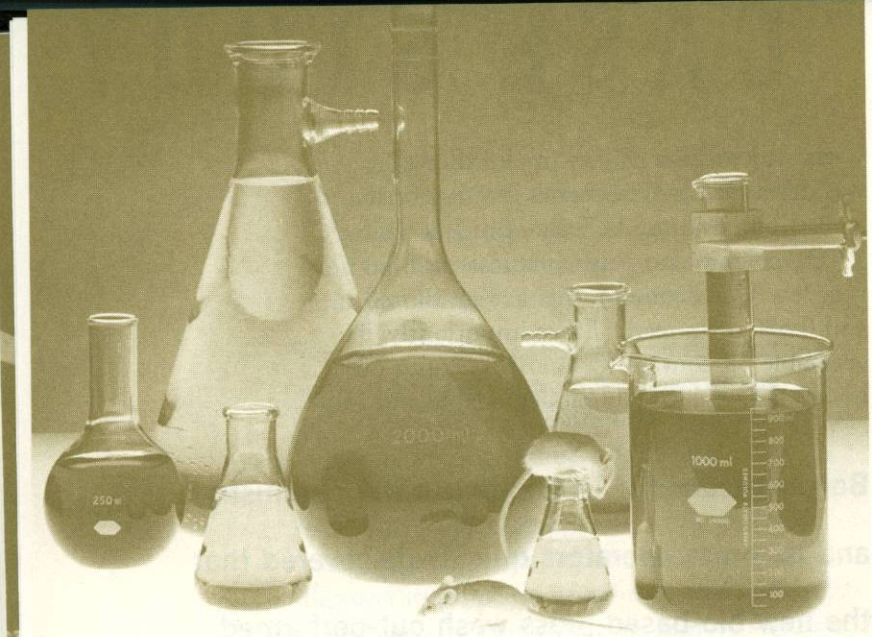


Photo courtesy of Bolger Publications

Bolger succeeded in finding a safer chemistry and its press operators quickly discovered that the new bio-based press wash out-performed petrochemical competitors. Prifer 3303+ cleans most inks, even metallics. However, it does not dilute the ink as petroleum-based washes do — it dissolves it. This enables the presswash to clean more efficiently, requiring less volume per cleaning application. For example, Bolger estimates that only 4 ounces of Prifer 3303+ can clean an entire color unit, compared to a traditional press wash which requires 16-45 ounces to clean a color unit, depending on the color.

The switch to Prifer 3303+ as the primary press wash saved the company money. Previously, Bolger had been purchasing approximately 30 fifty-five gallon drums of petroleum-based presswash per year, at $2.50/gallon. After switching to Prifer 3303+, the company needed 1 to 2 fifty-five gallon drums per year, at $18.00/gallon. Thus, Bolger saved $2,150 to $3,150 a year in purchase costs for their presswash! The company also found that with the new bio-based wash, they generated only one tenth the amount of waste as with the petrochemical wash. Bolger was unable to estimate savings in disposal costs due to a recent facility expansion.



Some modifications in cleaning technique were necessary. Press operators were trained in the proper use of the new cleaner in order to maximize its performance advantages. Prifer 3303+ leaves an oily residue on the rollers which has to be wiped off with a water-soaked rag after cleaning, a change from the previous presswash. Bolger does not view any of these cleaning modifications as a disadvantage. The economic, environmental and worker safety benefits from using biochemicals far outweigh minor changes in cleaning technique.

Prifer 3303+ does have some limitations. Bolger's press operators found that the bio-based cleaner could not remove hardened ink that had remained on the press for two weeks. To solve this problem, Bolger did not revert to using hazardous petrochemical washes for this limited application. Instead they sought another bio-based press wash formulated specifically for the removal of severely hardened ink. They found such a chemical, an orange oil-based product called Triple O, distributed by State Manufacturing Company.

Switching to biochemical-based press washes allowed Bolger to eliminate hazardous press cleaners. Prifer 3303+ not only out-performed the tradition petrochemical washes, it also saved Bolger money and enabled them to provide a safer work environment for employees. ■

Special thanks to Bolger Publications' Charlie Bolger and Andy Barbeau for working with ILSR to bring this case study to light.

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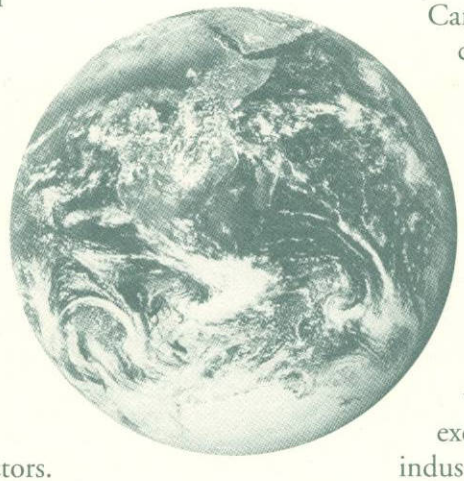
THE INSTITUTE

Biochemicals in the Printing Industry is the latest addition to ILSR's growing family of studies on the Carbohydrate Economy. When we first coined that term more than a decade ago, it described a vision of a future economy based on carbohydrates rather than hydrocarbons, on agricultural fibers rather than tree fibers, on sustainable rather than unsustainable industries.



That vision is slowly becoming a reality. Pushed by environmental regulations and aided by technological advances, entrepreneurs are developing an array of plant matter-derived products that compete with petroleum-derived products in many sectors. This report focuses on one such sector: printing. The printing industry is one of the largest and most geographically diverse in the United States. Virtually every town boasts at least one and often several printers.

Three factors are driving the printing industry to seek alternatives to petrochemicals: ever-more-stringent environment regulations; concern for worker safety; customer demand. The industry has discovered that biochemicals can be just as effective as petrochemicals and, when the full use cost of the chemical is taken into account, including the purchase price as well as the regulatory, liability and disposal costs, that biochemicals can even be cheaper.

The author of this report, Michelle Carstensen, was trained as a chemist, toxicologist and agricultural scientist. In order to find out the state-of-the-art in printing-related biochemicals, she worked with manufacturers and printers around the country. She discovered what works, what doesn't work, and why there is a growing excitement in the printing industry about the potential for that industry to take a lead role in moving us into a carbohydrate economy.

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Dr. David Morris
Vice President

The Institute for Local Self-Reliance (ILSR) is a nonprofit research and educational organization that provides technical assistance and information on environmentally sound economic development strategies. Since 1974, ILSR has worked with citizen groups, governments and private businesses to develop and promote strong local economies and the efficient use of our natural resources.

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