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Environmental Aspects of Chemical Use in Printing Operations

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CURRENT STATUS OF WEB HEATSET EMISSION CONTROL TECHNOLOGY

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Abstract

The industry has tried many control methods to comply with Federal, State, and local air pollution regulations. This report outlines all known methods that were used or showed promise through the first half of 1975. Information is provided to identify the advantages and disadvantages of each method. Recommendations are also made to evaluate the costs of investing in the various control devices.

INTRODUCTION

The desire of every printer using heatset inks (web offset or letterpress) is for a pollution-free ink equivalent in price and performance to conventional heatset inks, one which allows him to continue operations without making any additions or changes in the present hardware. Thus for the printer, the least burdensome solution to his problem is ink reformulation.

Extensive research by ink manufacturers has shown progress in this direction; however, no heatset ink formulation (or reformulation) will meet all regulations in every part of every State. Several formulations have been developed through substitution of ink vehicles (solvent) and reduction of their quantity. Experience with reformulated inks (ref. 1) has shown that some reduction is achieved in smoke, odor, and the total quantity of hydrocarbons emitted (table 1).

Low-temperature drying inks with "exempt" (photochemically unreactive as defined in Los Angeles Rule 66) solvents usually cost 50 percent more but use only 60 percent of the heat required for conventional heatset inks and produce less odor. However, when tested under operating conditions, low-temperature drying inks produced more smoke.

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Table 1. Web offset inks for emission control

Ink Type	Percent solvent	Relative cost	Web temp. (° F)	Relative gas usage	Plume opacity (percent)	Relative odor
Heatset	40-45	100	300	100	15-20	100
Low-smoke	40-45	105	300	100	10-15	60
Low-solvent	25-30	120	270	85	5-10	40
Low-temp. dry[a*]	45-50	150	210	60	10-25	35
Low-temp. dry[b*]	25-30	125	230-250	60	15-20	slight
Low-temp. dry[c*]	25-30	105-110	220-250	87	none	slight
Heat-reactive	0-15	140-200	340	115	0-5	20
UV cure	0	200-300	120	0	0	trace

*a = ref. 1; b = ref. 2; c = ref. 3.

Low-solvent inks, e.g., 25-30 percent, appear to be the system that best satisfies the printer's needs, although the price generally runs 20 percent more than for conventional inks. The heat required is 15 percent less, and smoke and odor are significantly lower. Modification of dryer operation can further enhance this picture. Many printers have been using low-solvent inks where only smoke and odor regulations exist and the solvent is not photochemically reactive. Others have employed low-solvent inks as a temporary measure until a more permanent means of control is installed or available.

Attempts to reduce visible emissions by substituting different vehicles yielded no significant reduction in smoke. The heating requirements remain unchanged compared to conventional heatset inks. The price of the reformulated ink was 5 percent greater.

One novel approach to eliminating emissions from high-speed web operations is being used at Meredith Company (ref. 4). Instead of a heatset ink, an oxidative-drying ink is used, and a coating (a low concentration of a polymeric ester in ethanol and water) is applied and dried at 140°-150° F. The coating acts as a protective film to avoid setoff while the ink film dries underneath at its normal rate. No ink oil is emitted, as is the case in a conventional heatset ink, and the opportunity for visible emission and nuisance odor is virtually eliminated. The alcohol in the coating is recoverable and recyclable. Costs vary widely, depending on whether cover stocks or an entire magazine are printed this way. However, ultimate potential savings would include savings from paper as well as from drying operations.

The above control methods are the least burdensome for the printer, even though some changes in operating procedures and/or additional costs are involved. Unfortunately, however, more stringent control is necessary in some areas of the country, and more sophisticated, expensive, and extensive measures are required. These more extensive methods--unconventional or innovative inks and control equipment with conventional inks--are summarized in figure 1 and discussed in the sections that follow.

CONTROL TECHNOLOGIES

Heat-reactive Inks

Because the printer desires to maintain his present drying system, ink manufacturers investigated inks with different heat-drying mechanisms. Thermally catalyzed (heat-reactive) inks, an entirely different system chemically, require a 15 percent increase in gas and cost 40 to 100 percent more. However, a noticeable emission reduction was observed when the inks were submitted to analysis.

UV Inks

Ink manufacturers have recognized the need for a new ink-drying process for many years. Although they realized the complexity of the printer's immediate demands, they decided to concentrate some of their efforts on the longer-term development of a pollution-free ink (no solvent, no emission) using a different process to dry the ink film. Today their research efforts have produced a commercial success with UV (photoreactive) inks.

UV ink systems meet all the emission regulations and produce good print quality. UV inks appear to be the pollution control method presently closest to the ideal. The high costs of ink and hardware are a major consideration, but in certain circumstances are economically feasible. If

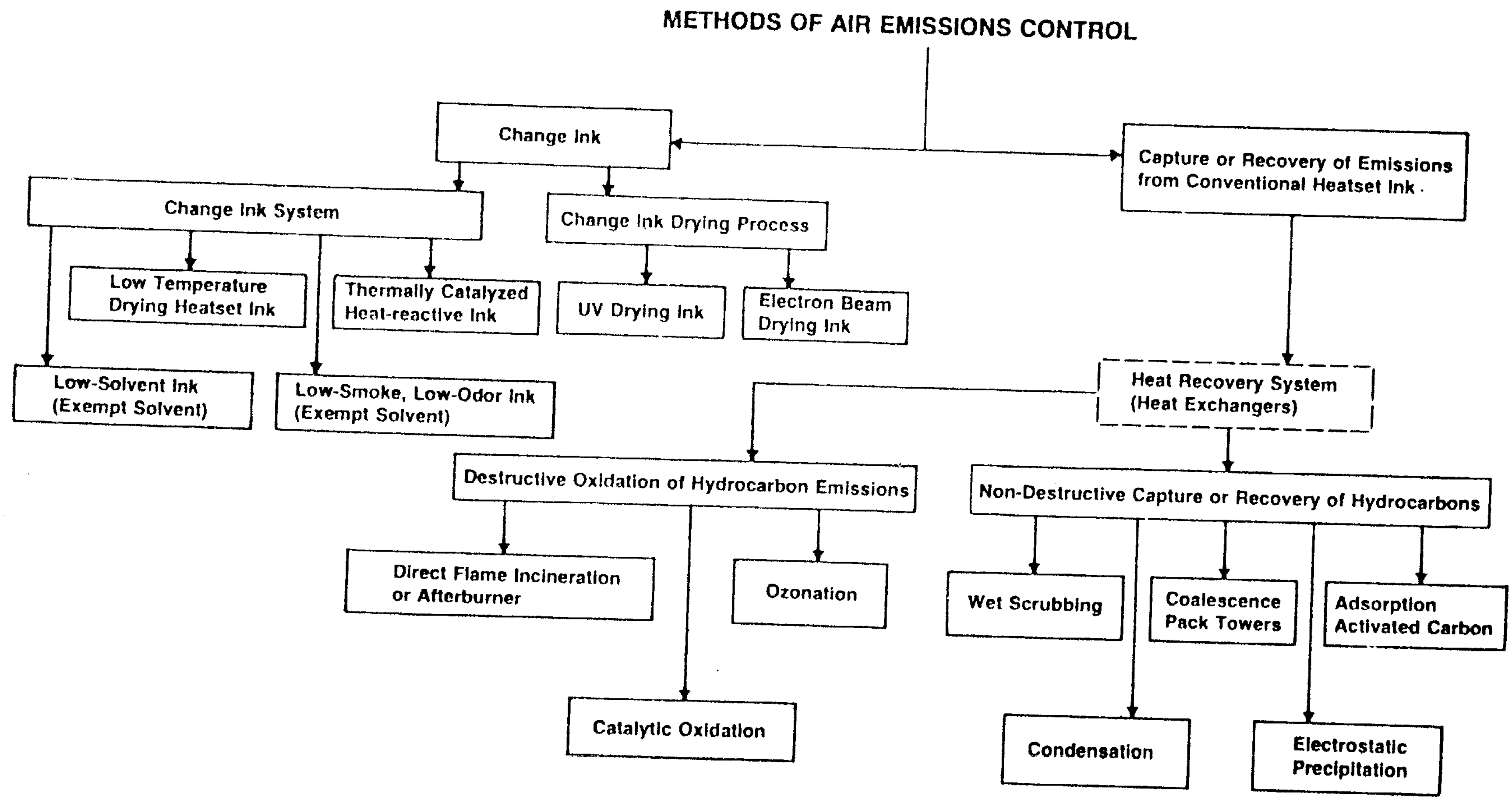

Figure 1. Pollution control techniques applicable to web offset.

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...s can be justified and some performance problems eliminated, the UV ...tem, considered revolutionary by some in the industry, may become a ... widely used drying process.

...tron Beam Drying (EBD)

Electron beam drying is another of the new drying systems. Although ...as not yet achieved commercial acceptance, this process has no pollu-...n potential and can dry (cure) ink films which are too thick to be cured by ... Tests are anticipated for both gravure and offset in 1975. This sys-...ay be most practical for screen printing (ref. 5). Some developers ...BD systems feel that its potential is fairly unlimited in all areas ...printing.

...tructive Oxidation

Within the past 4 years thermal and catalytic oxidation of hydrocar-...s has been used successfully to control emissions in the printing in-...try. Incineration techniques now available can control the emission of ...ost every known hydrocarbon by converting it into carbon dioxide and ...ter (ref. 6). The various incineration processes differ only in reaction ...anisms and temperatures. Process designs differ primarily in control ...temperature, turbulent mixing of gases, and kinetic reaction contact ...es (ref. 7).

Optimum operational design of equipment is extremely important in in-...eration processes. Insufficient temperature: nonhomogenous mixing of ...rocarbons, gas, and air: and/or insufficient time in the reaction zone ...tribute to incomplete combustion, which yields carbon and carbon monox-...e. These unwanted reaction products can be generated in sufficient con-...trations to cause smoke, hydrocarbons, and/or carbon monoxide to be ...tted. Some companies, in a false economy move, reduce the fuel feed to ...e afterburner, leading to incomplete combustion, visible emissions, and ...ations.

A problem common to all combustion systems is the possibility of oxi-...zing atmospheric nitrogen at high temperatures into nitrogen oxides, ...ch also are an air pollutant.

Direct flame incineration (afterburners): Many direct flame incineration processes differ only in the design of fuel burners, baffling, and constriction devices employed to optimize turbulent mixing of gases before combustion. Automatic fuel and air flow controls are available to maintain stoichiometric flow rates to achieve complete combustion. Incineration requires oxidation temperatures in the 1,100°-1,200° F range (ref. 8) and sufficient time in the reaction zone. Proper contact time is dependent upon the kinetic rate of reaction (oxidation) for that organic component in the effluent having the slowest reaction rate.

Within the past year, printers have been extremely cautious about installing afterburners because of fuel shortages. Fuel requirements for afterburners depend on the air-handling rates of press dryers. Theoretically, a typical afterburner for a press dryer operating at STP would use about 105 cfm of natural gas (100 percent methane) per 1,000 scfm of spent dryer gases. Based on September 1974 rates in Pittsburgh (ref. 9), the natural gas costs for this afterburner would be about 14 cents per 1,000 scfm of spent dryer gases.

Some printers using afterburners are now considering replacing them with other control devices requiring less energy. Over the last year, as many as 20 afterburners have been installed and equipped with heat exchangers that can reclaim as much as 40 to 60 percent of dryer and afterburner heat.

The prime advantages of direct flame incineration are essentially complete oxidation of all organics, no smoke or odor, moderately priced hardware, and minimum maintenance. The major disadvantage has become recently apparent with short fuel supplies and soaring costs. Current domestic production of natural gas is predicted to be 75 percent lower by 1985 with prices increasing twofold to fourfold (ref. 1). Economists have been projecting shortages in domestic supply and imports of expensive liquid natural gas--unless industry reduces consumption, new gas reserves are found, and/or synthetic gas processes are developed. Gas suppliers have already reduced allocations to some companies by 15 to 60 percent while others require 1- to 2-year waiting periods for either new customers or for increased allocation.

The use of regenerative heat exchangers may recover as much as 70 percent of the waste heat, but the severity of temperature and ink solvents, resins, dust, etc., all detract from the life and performance of this type heat exchanger (ref. 11). The use of heat exchangers and/or the replacement of inefficient gas dryers, however, can save as much as a 76 percent (ref. 12) in natural gas costs.

Given unlimited fuel supplies, the overall air quality performance of direct flame incineration would have to be rated as excellent.

<u>Catalytic oxidation processes</u>: Like direct flame incinerators, the catalytic oxidizer also converts hydrocarbons into carbon dioxide and water but uses a different reaction mechanism and at a lower reaction temperature (ref. 13). The oxidation rate accelerates in the presence of an appropriate catalyst, and the temperature required is lower, the optimum depending upon the catalyst used. Reports have been made that optimum hydrocarbon oxidation could be accomplished at reaction temperatures as low as 650°-700° F (ref. 14).

Typical catalysts are the transition metals or their oxides: iron, cobalt, nickel, platinum, palladium, copper, and silver. Catalysts are usually manufactured by coating an inert support material with a finely divided metal or metal oxide. The catalyst usually used in the industry is a platinum and/or palladium coating on a ceramic cylindrical pellet. The catalyst bed is usually located in a temperature-controlled heating zone where premixed stoichiometric quantities of atmospheric oxygen, fuel, and hydrocarbon (organics) react to form carbon dioxide and water. Control of temperatures and contact time with the catalyst bed are especially important to insure complete oxidation.

Improper temperature or contact time can cause incomplete oxidation, yielding carbon, carbon monoxide, and side reactions such as resin polymerization. Polymerized resins condensed on the catalyst surface can deactivate the catalyst or plug the catalyst bed.

Catalysts are susceptible to substances that inhibit or destroy (poison) their activity, even in minute amounts or very low concentrations. Certain heavy metals, halogenated hydrocarbons, and organosilicon compounds in trace quantities will poison many catalysts. In practice, catalyst cost, life, physical strength, resistance to thermal shock, and resistance to poisoning are factors that must be considered in addition to activity and specificity. All catalysts are expensive, especially those using precious metals: platinum, palladium, and silver. In considering a catalyzed system, evaluations of catalyst replacement or regeneration must be made.

A distinct advantage of this process is that less natural gas is consumed than in the direct-flame afterburner incinerators because of the lower reaction temperatures. However, catalytic systems can waste fuel and energy, just as the afterburner, unless heat recovery is employed with heat exchangers.

Ozonation: Ozonators produce ozone by applying a high voltage alternating current to an air space between two insulated electrodes. Permeating the air space is a charge which converts atmospheric oxygen to ozone. The spent dryer gases are mixed with the ozone, creating oxidation products frequently soluble in water or in a slightly basic, aqueous solution. Ozone generators produce 0.1 pounds of ozone per kilowatt hour of electricity consumed.

Ozonators have been equipped with catalysis beds and with wet scrubbers to optimize oxidation and to remove water-soluble carboxylated hydrocarbons from the stack effluent (ref. 15). But the use of afterburners with ozonators cannot reduce afterburner gas consumption significantly because reaction temperatures must be maintained at 1,100° to 1,200° F (ref. 8) to oxidize all those molecular sites not oxidized by the ozone.

The major use of an ozonator is only to oxidize the most odorous hydrocarbons into a less objectionable form, though without any change in the rate of hydrocarbon emissions (pounds of carbon per hour). The process has not gained wide acceptance because ozone reacts very slowly or not at all with saturated hydrocarbons. (Ozone readily oxidizes unsaturated hydrocarbons.) Ozonators have been used successfully with other incineration processes to speed up oxidative reactions. Pilot tests in our industry, however, indicate that ozonation will not effectively eliminate odorous emissions from web dryers (ref. 13).

Nondestructive Control Processes

Petroleum derivatives make up about 80 percent of conventional heatset inks (55 percent solvent). Last year, the price of ink solvents increased by 340 percent (ref. 16). This year, ink vehicles are expected to increase in price an average of 25 percent. No relief is foreseen from these spiraling costs (ref. 17).

Clearly, incineration destroys a prime raw material--one expected to continue to increase in value into the foreseeable future. Even in incinerators equipped with heat exchangers, the market value of the solvent lost exceeds the market value of the heat recovered. (Ninety-five gallons of solvent is equivalent in heating value to about 0.5 tons of coal or 10,000 cubic feet of natural gas. See table 2.)

Nondestructive recovery control devices may not only offer an acceptable means of emissions control, but also help conserve these ever more-expensive petroleum derivatives. Ink solvents have been successfully recovered from these types of devices and substituted for No. 2 fuel oil in diesel engines and oil heaters. Last year, recovered ink solvents were sold for 20 to 50 cents per gallon. The use of recovered solvents in ink manufacture, however, has not yet been proven successful.

Many nondestructive recovery control processes have been developed or are under development. As yet, most have had limited success in meeting

Table 2. Value of ink solvent loss in incineration

Fuels	Market price	Heat of combustion	Quantity to produce 1.1×10^7 Btu	Cost of equipment heat
Ink solvent	0.50/gal	11,250 Btu/lb	95 gal	47.50
Natural gas	$1.40/10^3 ft^3$	$1,100\ Btu/ft^3$	$10^4 ft^3$	14.00
Propane	0.32/gal	91,500 Btu/gal	120 gal	38.40
No. 2 fuel oil	0.37/gal	140,000 Btu/gal	80 gal	29.60
Kerosene	0.385/gal	135,000 Btu/gal	81 gal	31.37
Coal (bituminous)	35.50/ton	13,000 Btu/lb	0.445 tons	15.60
Equivalent electrical energy	0.06/kWh	* 3,413 Btu/kWh	3223 kWh	193.34

*Heat conversion factor.

air quality standards and in recovering ink constituents. Even so, there can be little question that the philosophy behind the approach is fundamentally sound. Solvent emissions into the atmosphere should be viewed as a "misplaced resource," a resource to be conserved in a time of shortages and increasing prices.

Wet-scrubbing processes: Wet-scrubbing systems are used successfully in the chemical industry to clean and purify gas streams from manufacturing processes. Vapors are removed from the gas stream by a series of steps in which the stream is sufficiently cooled to condense and form microscopic colloidal particles. These particles enlarge through impingement on droplets of water or wetted surfaces. The liquified chemical particles either diffuse into the water droplets or agglomerate and become large enough to separate out of the gas stream by gravity.

Some wet scrubbers use only water or aqueous solutions of water-soluble organic chemicals or inorganic salts to improve efficiencies and insure dissolution or emulsification of the hydrocarbons into an aqueous phase. The aqueous scrubbing liquor readily absorbs heat from the spent dryer gases and saturates the air with water vapor (steam). Wet scrubbers that do not adequately precool spent dryer gases (such as those with a heat exchanger) produce a characteristic white steam plume, which eventually dissipates.

The disposal of the aqueous scrubbing liquor may be a problem because the dissolved water-soluble hydrocarbon or organic material will contribute to the pollutants in the aqueous effluent.

Aerosols' wet scrubber: The pollution control device manufactured by Aerosols Control Corporation (figure 2) is a combination of two basic processes where hydrocarbon vapors are scrubbed with an aqueous solution. A fiberglass filter bed backs up the system by coalescing liquid chemical particles that have not enlarged enough to separate from the gas stream by gravity.

The scrubbing liquor contains sodium hydroxide and dioctylphtalate (DOP) to dissolve and emulsify the hydrocarbon vapors, and surfactants to prevent the buildup of foam in the system. A sump tank containing 100 to 150 gallons of the scrubbing liquor traps about 8 pounds of emulsified hydrocarbons per hour. The liquor is dumped and replenished weekly.

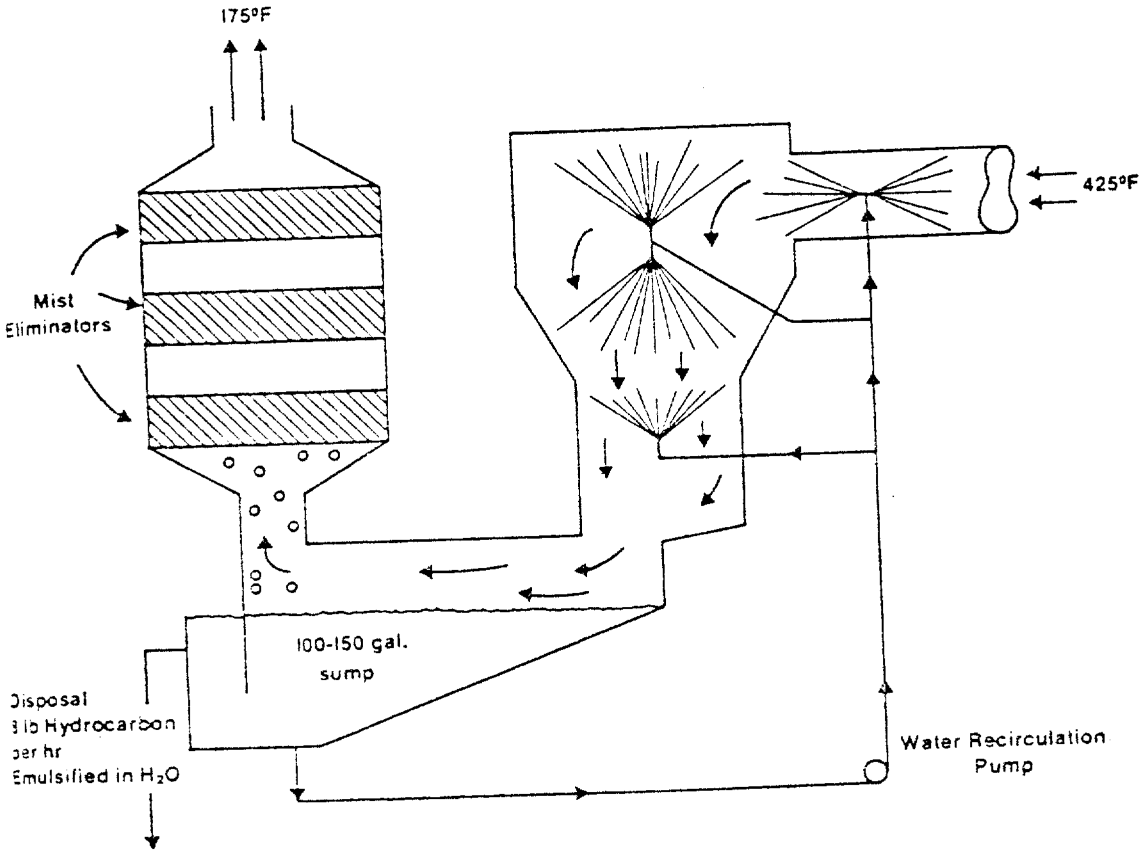

Figure 2. Aerosols Control Corporation web scrubber.

When this unit was in operation in the industry, it processed 2,500 cfm of exhaust gases from a Ross combination dryer on a M-1000 web offset press.

The manufacturer claims the unit can remove as much as 99 percent of the hydrocarbon emissions and reduce the visible emissions to 0-5 percent opacity. A State air inspector reported that, although the total hydrocarbon emission was held below the 0.8 lb/hr State requirement, the maximum efficiency of the Aerosols scrubber was only 83 percent. The manufacturer also reports a normal 90 percent efficiency with normal ink coverage. If isopropanol is present in the fountain solution, the efficiency drops to 87 percent.

The State inspector said the scrubber permits as much as 30 percent visible emissions and does not meet the State requirement of 0 percent opacity. Operational problems could cause this discrepancy. The inspector suggested that adequate precooling would normally control visible emissions. We believe a heat exchanger before the scrubbing unit would meet this need.

But because the Aerosols wet scrubber was not complying with the local visible emissions standard, the printing plant where it was installed was pressured by the local regulatory agency to replace the Aerosols unit with a device such as an electrostatic precipitator (which is known to provide compliance only with the visible emissions standard).

The capital costs and installation costs of the Aerosols unit are comparable with incineration. The only "real savings," perhaps, lies in lower operational costs in water consumption, chemicals in the scrubbing liquor, and the use of electrical energy as opposed to natural gas.

CVM Fume Eliminator: The Fume Eliminator manufactured by the CVM Corporation (figure 3) does not significantly differ in principle from the

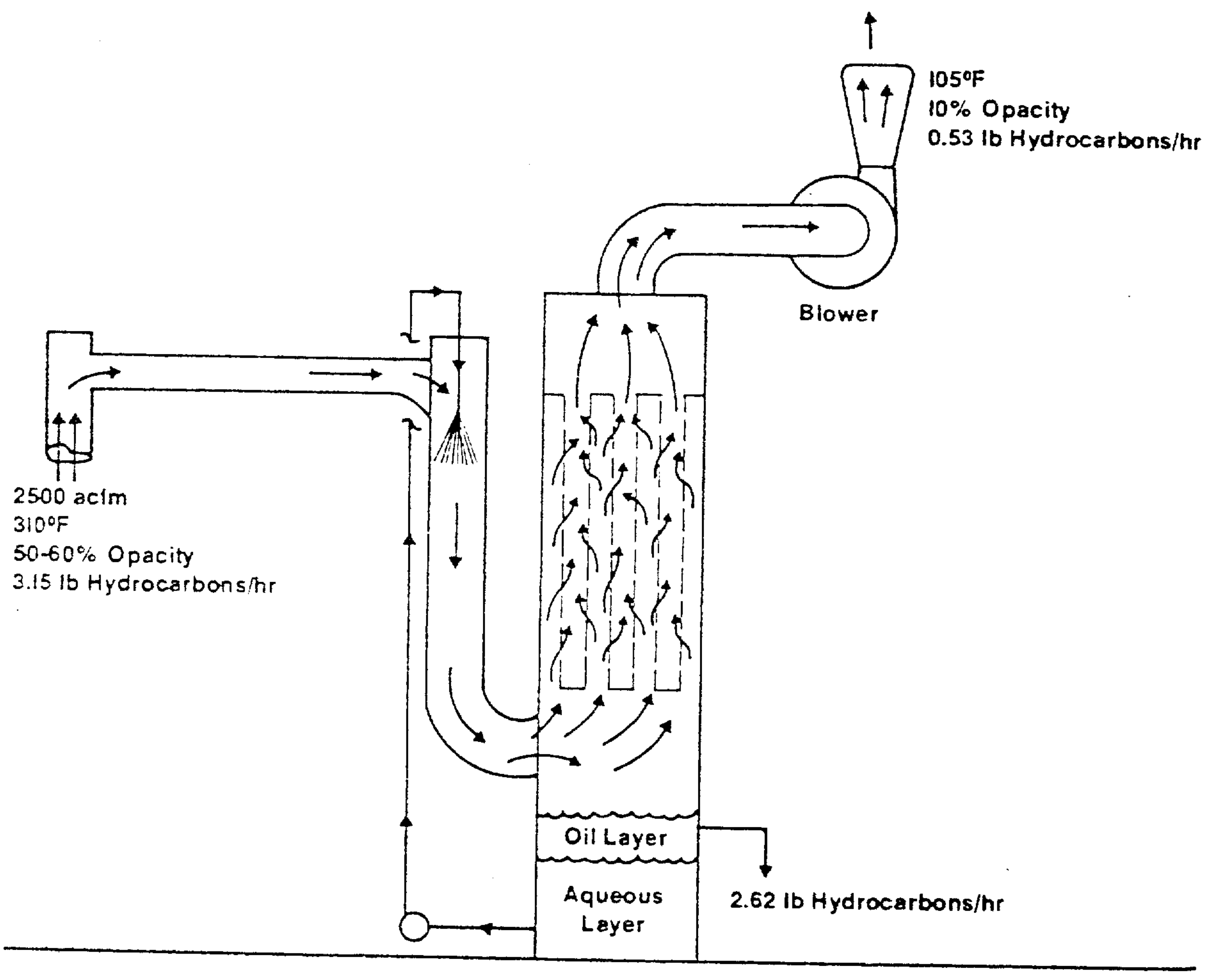

Figure 3. CVM Corporation fume eliminator.

Aerosols wet scrubber but shows significant differences in hardware design and power requirements. The system is equipped with a water scrubber tower that cools the hydrocarbon vapors to below their boiling point to facilitate the enlargement of colloidal droplets. Suspended droplets are passed through a bed of fine fibrous material (fiber glass wool) sandwiched between supporting grids. As the droplets pass through the fibrous bed, they coalesce by the impingement of larger droplets and the bed packing. As the droplets grow larger, they collect on the bed packing and drain off into a sump for removal from the system. (There are no reports of the recovered ink solvents being sold. However, they have been used successfully and experimentally as a heating fuel oil.)

The power requirements of the exhaust blower and the water recycle pump are about 4 to 5 horsepower for every 1,000 cubic feet of spent dryer gas processed per minute.

Periodically, the fiber glass bed elements may require replacement. There is no reported evidence of element fouling if used in continuous service for 6 months. Expected element life can exceed a year with a minimum service of 18 turns per week. Element replacement cost and labor would be about $400 per 1,000 scfm capacity.

The manufacturer claims 83 percent removal of hydrocarbons, and the opacity of the plume has been consistently less than 10 percent. The State air quality inspector quoted earlier reports that with medium to heavy ink coverages, the CVM device will reduce emissions by 83 percent and occasionally perform in compliance (85 percent). According to him, visible emission (20 to 5 percent opacity) is the only serious problem and appears to be attributable to inadequate cooling in the first stage of the unit.

The plant in which the CVM unit was installed has since terminated the unit's operation. Consideration was given to transferring the device to a plant in another State within the corporation. After extensive studies comparing its performance with other pollution control devices, it was decided that the CVM unit could not provide compliance with either the hydrocarbon or visible emissions regulations.

Elbair wet scrubber. The Elbair wet scrubber (figure 4), marketed by Peninsula Lithograph Company (PenLitho), is a simple water-scrubbing system in which the spent dryer gases pass horizontally through two high-pressure

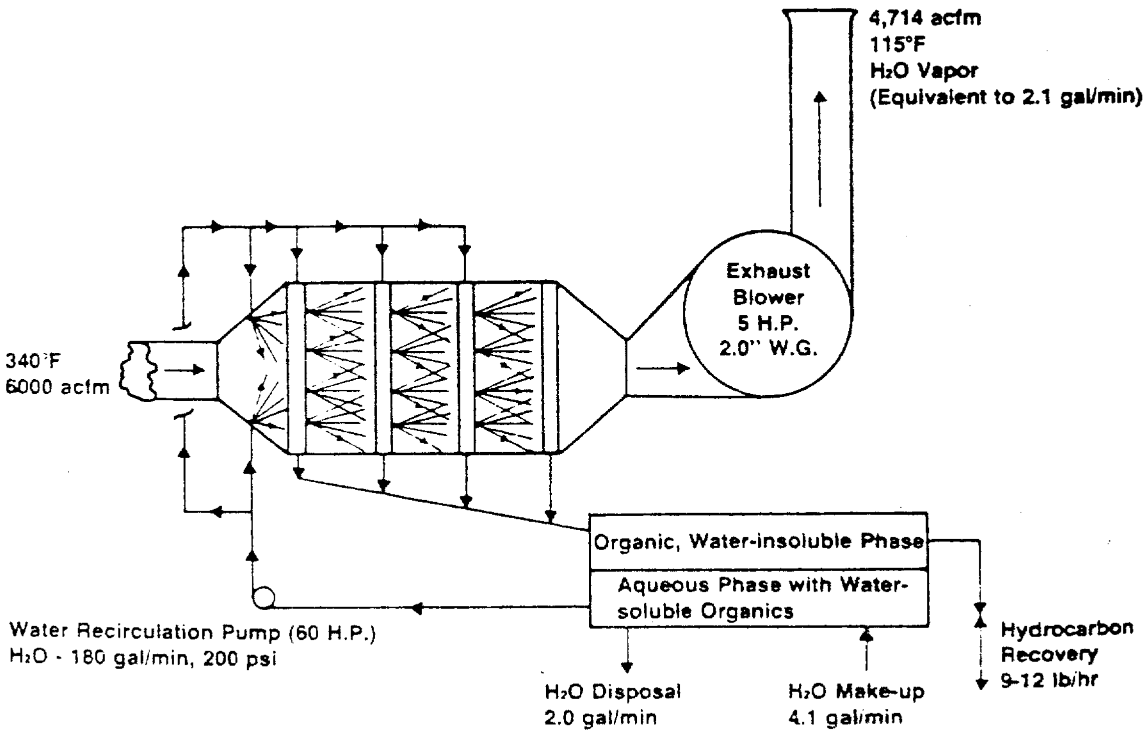

Figure 4. Elbair wet scrubber (Peninsula Lithograph Co.).

jet streams of water that precool the vapors. The precooled vapors condense and then pass through a series of three horizontal, 10-gallon housings, each of which is equipped with four high-pressure spray nozzles. The spray nozzles are directed to patented vertical impinging plates. The recovered ink solvent and scrubbing water liquor is collected from a drain in each housing and transported to a phase separation tank. The aqueous phase is recycled and the water-soluble ink solvent periodically drawn off.

The Elbair wet scrubber has been accepted by the San Francisco Bay Area Air Pollution Control Agency. PenLitho claims their scrubber recovers as much as 95 percent of the hydrocarbon emissions. Although a white steam plume is always visible, the plume opacity (5 to 15 percent) is acceptable to the regulatory agency.

The maximum energy requirement for this system is 65 horsepower for the exhaust blower and the water spray pump.

PenLitho claims they can operate this pollution control device for only 50 cents an hour and recover 1.5 gallons of ink solvent per hour for resale. They claim that they will pay off this scrubber in only 22 months.

The only disadvantage we could perceive is the heat losses that might be salvaged with heat exchangers. The evaporation rate of water lost (2.1 gal/min) alone accounts for a heat loss of 17,900 Btu per minute which is equivalent to heat from 978 cubic feet of natural gas per hour ($1.39/hr).

To our knowledge, there are only two printers using the Elbair wet scrubber to control hydrocarbon emissions. One of the two replaced after-burners with the Elbair unit because of reduced natural gas allocation in the area. Using limited gas supplies for incineration became a luxury the company could not afford.

Electrostatic precipitation. United Air Specialists, Inc., has been manufacturing an electrostatic precipitation control device called a "Smog-Hog" (figure 5). The "Smog-Hog" is a rather simple operating system. A heat exchanger or heat wheel is used to cool and condense spent dryer gases into liquid droplets. The airborne droplets then pass through an electro-

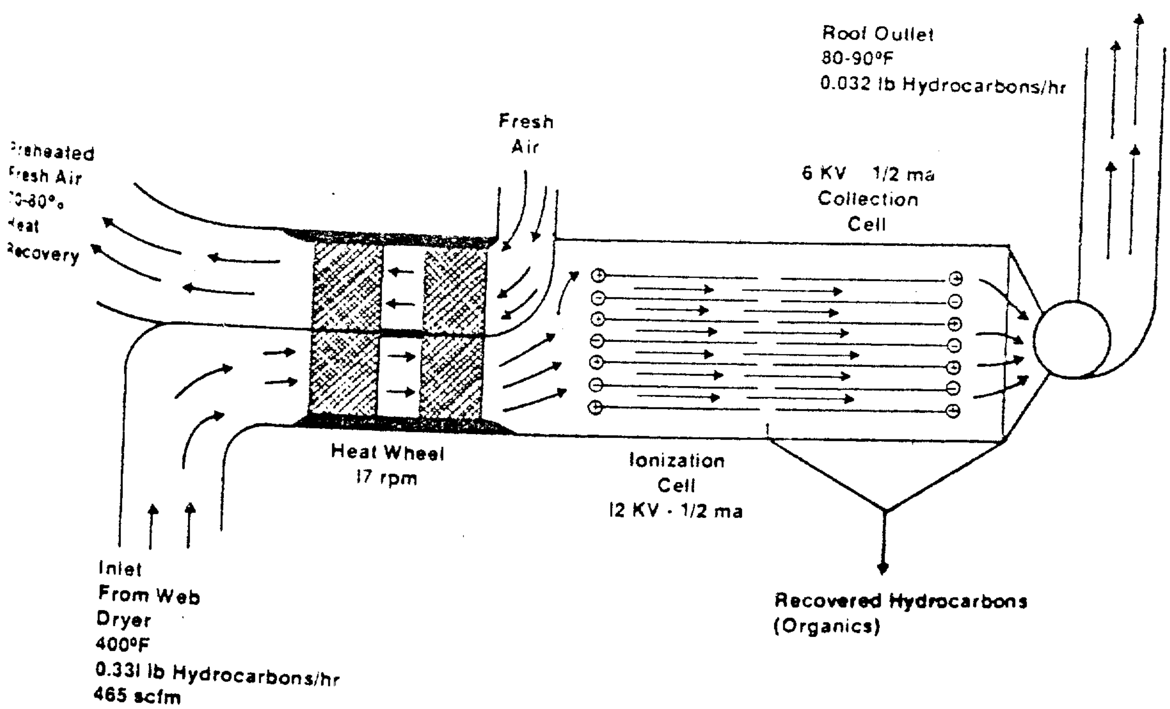

Figure 5. United Air Specialists "Smog Hog."

static ionizing cell that places an electric charge on each droplet. The charged droplets are then collected in the next electrostatic cell where the droplets agglomerate on the vertical cell plates, draining off by gravity.

The manufacturer claims at least an 85 percent removal of all hydrocarbon emissions with no smoke and odor.

No evidence has come to light refuting the recovery efficiency of the "Smog-Hog." Reports of many observers indicate no visible emissions and only slight traces of odor.

The only electrical power demands are for the motor drive of the heat wheel, electrostatic cells, and the exhaust blower. The precipitation power is only 20 to 50 watts per 1,000 cfm of exhaust.

The manufacturer claims operating costs rarely exceed 0.1 cent per 1,000 cfm. They also claim that the heat wheel recovers 70 to 80 percent of the heat loss. According to reports, no printer has taken advantage of this recovered heat.

The Betran electrostatic precipitator differs from the UAS "Smop-Hog" only in design, and eliminates visible emissions equally well. However, in a recent GATF performance study during a Beltran pilot test, this device demonstrated that the hydrocarbon emissions were not significantly reduced. Its major performance problems appear to be temperature control of the incoming gases and the residence time in the electrostatic cell. Thus, its application for compliance appears limited to areas where high reductions in organic emissions are not required.

<u>Activated carbon adsorption</u>: The power of activated charcoal to remove or adsorb many different hydrocarbon gases, vapors, and odors has been known for over 100 years. The adsorbing power of activated charcoal differs for each adsorbate and depends on the physical and chemical properties of the adsorbate.

The Los Angeles Lithograph Co., Inc. (L.A. Litho), is currently marketing a patented activated-carbon pollution control device (figure 6), which they have demonstrated at their plant as an efficient means of complying with the Los Angeles air quality standards.

In the L.A. Litho system, spent dryer gases pass through a manifold plenum, which evenly distributes the gas flow into three of the four

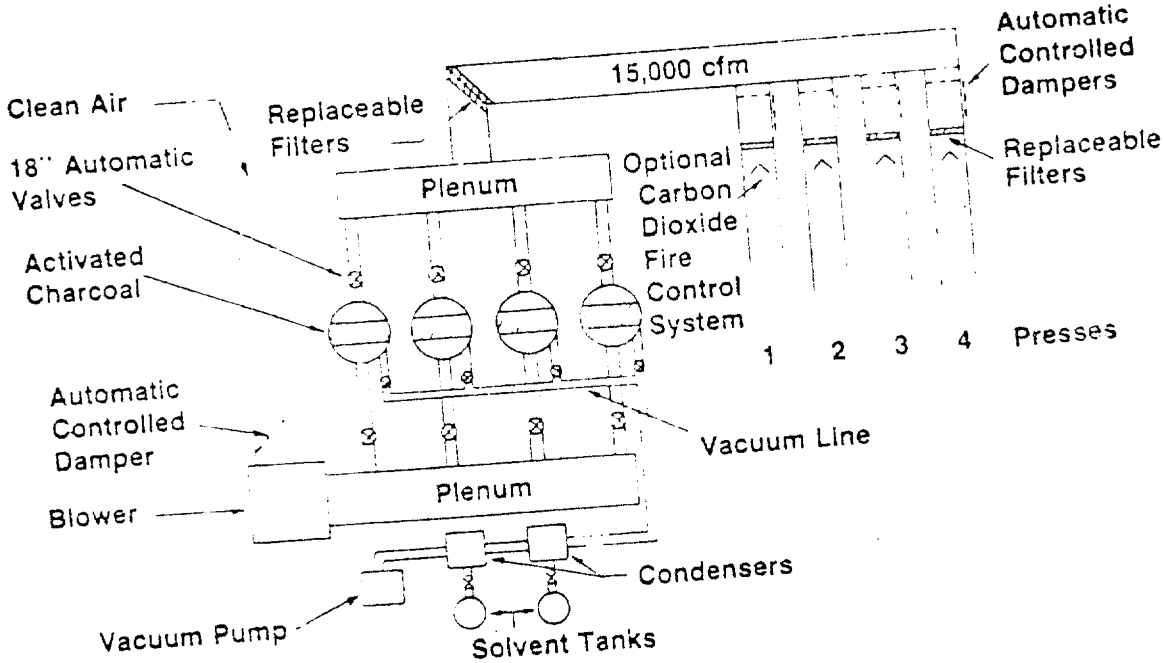

Figure 6. L.A. Litho activated carbon adsorber.

activated charcoal beds. While three beds are adsorbing hydrocarbons, the fourth is being regenerated. It remains on automatic standby until one of the other three beds reaches its maximum loading capacity of adsorbed hydrocarbons.

During the regeneration cycle the adsorption bed is sealed off from the intake and exhaust manifolds. An electrical heating element in the bed heats the adsorbates on the charcoal, while a vacuum pump produces a vacuum of 1 Torr (1 mm Hg). This reduced pressure allows the adsorbed hydrocarbons to be flashed off at a temperature much lower than the boiling point of the hydrocarbons at atmospheric pressure. The distillate hydrocarbon is recovered, and the adsorption bed is reactivated. The hydrocarbon vapors condense in a water-cooled condenser and a refrigerated trap. The water-cooled condenser separates the high-boiling hydrocarbons (ink solvent), and the freeze trap recovers the low-boiling and low molecular weight hydrocarbons.

The regeneration process of the adsorption bed is unique because flash evaporation processes have not been developed commercially to desorb high-boiling hydrocarbons from activated charcoal. L.A. Litho reports hydrocarbon recoveries of 90 to 95 percent with no visible emissions and only very slight traces of odor.

The Los Angeles Air Pollution Control Department has monitored the emissions from L.A. Litho, and no objections have been reported.

The only electrical demand is the 75 horsepower blower and the 2-hours-per-day use of the regeneration equipment such as bed-heating element, vacuum pump, and the refrigeration unit. L.A. Litho claims that this system processes 15,000 scfm of spent dryer gas for less than 15 cents per hour. The estimated initial cost of this system is in the neighborhood of $7.00 per cfm.

The high-boiling hydrocarbon is recovered as a dark "tarry" liquid, which after suitable filtering may be used as a diesel fuel oil. Ink manufacturers attempted unsuccessfully to utilize this recovered solvent as an ink vehicle or press wash-up solvent. Last year, L.A. Litho marketed the recovered hydrocarbon as a fuel oil. (However, during the oil embargo they discovered they could use this oil more economically in their own diesel trucks!)

Although this activated charcoal adsorption process appears to be a viable system to combat hydrocarbon, smoke, and odor emissions, L.A. Litho has been troubled with many operational and equipment malfunctions. A redesign of hardware and addition of adequate process control devices may be necessary to eliminate the temperature and pressure control problems encountered.

DISCUSSION

Equipment Costs

Estimates of the initial costs of pollution control hardware are difficult to correlate because prices vary with the size of the unit, volume of air-handling capacity, and the date of the price quote. The estimates presented in table 3 do not include the cost of installation.

Operating expenses include the consumption of gas, water, and electrical utilities; and these have been calculated from a common rate for all three utilities. The operating expenses of labor and replacement parts are unavailable.

The table also designates the major source of energy (natural gas or electricity) for each process. The processes that recover potentially saleable hydrocarbons and the processes which may present a water pollution problem also are indicated.

Table 3. Comparison of pollution control processes

	TEC After-burners A[1]	B[2]	Incin-erator	Cata-lytic	Aero-sol	Pen-Litho	CVM	L.A. Litho	UAS
Costs:									
Hardware ($/cfm)	6-13	8-18	3-6	3-8	5	4-7	4	7-10	4-6
Operation ($/Mcfm)			2.42	0.53	1.20	0.001	0.001	0.01	0.001
Major energy consumed:									
Natural gas	x	x	x	x					
Electricity					x	x	x	x	x
Systems with:									
H_2O disposal					x	x	x		
Recovery of hydrocarbon						x	x	x	x

[1]With 40 percent heat recovery.

[2]With 60 percent heat recovery.

Performance and Compliance

With the exception of afterburner incinerators, most newly installed pollution control devices have had some difficulty being totally accepted by the local regulatory agencies. Regulatory agencies have been cautious in accepting any unproven control device that might establish a precedent.

Recovery of Heat Losses

The use of heat exchangers to cool spent dryer gases will improve recovery efficiencies of all pollution control devices with the exception of the UV and electron beam systems. Fuel reduction can also be accomplished with these systems to reduce the operating costs of gas dryers and afterburner incinerators.

The use of afterburners, even with heat exchangers, does not appear to be an economical means to control emissions. Afterburners incinerate $47.50 worth of ink solvent to produce the same quantity of heat as $14 worth of natural gas.

The value of natural gas saved through heat exchangers and the resale value of recovered ink solvent suggest that each printer should consider some of the advantages of recovering heat and/or ink solvents to help meet future needs.

New Ink Systems

The UV inks and drying systems appear to be one of the most promising methods of eliminating hydrocarbon emissions. The deterrent for most printers is absorbing the high costs of ink and hardware. The low-smoke, low-solvent, and low-temperature drying inks show some reduction in emissions and fuel consumption; however, all show some increase in cost over conventional heatset inks.

Recommended Approach to Pollution Control

Before a printer invests in a method of pollution control, he must evaluate the immediate and long-range economic factors that will affect the initial capital outlay, operational overhead, and the advantages of payback features.

When considering the various alternative control methods, the effects of inflation on the cost of equipment and the cost of labor to install that equipment may make it necessary to determine a time-price relationship.

Overhead expenses must also be approached with caution. Energy, manpower, raw material consumption, and parts replacement must all be given equal weight. The printer will have to ask himself some critical questions. Will the addition of this control technique reduce or add to present overhead costs? Can the printer withstand possible reductions in future fuel allocations and increased costs of natural gas and critical raw materials?

The printer must consider whether heat and hydrocarbon recovery have real payback features. With the high cost and the availability of natural gas and petrochemicals such critical factors, loss of heat and ink solvents must be considered as "misplaced resources."

In many regions of the country there are tax incentives available where pollution control equipment must be installed. The printer should investigate this. Some offer exemptions from sales taxes, others increased rates of depreciation or other "tax-breaks" on new control equipment. The cost of pollution control is, of course, passed on to the consumer ultimately.

Some companies in other industries have investigated all the above economic factors associated with pollution control and discovered that besides complying with the air quality regulations, the control equipment can offer a reduction of energy requirements, a "tax break," and an eventual payoff of the investment with a recovered, saleable product.

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<u>NOTE</u>. - A joint discussion with Zborovsky and Fremgen follows Fremgen's paper.