Printing

The printing industry is very diverse, as can be seen in the multitude of different products that bear some form of printing—books, daily newspapers, periodicals, packaging, cartons, carrier bags, drink containers, signs, forms, brochures, advertisements, wallpaper, textiles, sheeting, metal foil, and so on.

Text, diagrams, pictures, and so on are designed and composed on, for example, a newspaper page. If pictures and/or text are to be printed in several colors, these must be separated. The pictures are also often screened, producing an image that consists of a large number of very small dots instead of a solid field. Photographic techniques are used for setting and working on pictures.

The page is then transferred to a printing form, a printing block (high-intensity, flexography), plate (offset), roller (rotogravure), or stencil (screen printing). This is done by means of exposure to a light-sensitive coating. In the case of offset and screen printing, the printing form is developed by washing away part of the coating; the form may then, in theory, be used immediately. The offset plate is coated with rubber to protect it from oxidation. The screen sheet's sides are masked with protective paint.

Other printing methods require further stages. The small grooves in the gravure roller are etched or, increasingly, engraved, and the surface is chromed for better durability. The rubber printing block for flexographic printing is cast or engraved by laser.

Printing is done on single sheets or paper web, using one or more printing units, depending on the number of colors required. The dyeing agent is, in most cases, a solvent that evaporates from the paper. (In some cases, it is necessary to hasten evaporation by feeding in warm air.) Clear varnish is sometimes added to the printed surface.

The printed matter is processed off-press, where it is cut, jointed, folded, sewn, bound, packaged, and so on.

Printing may also be a step in another manufacturing process—for example, laminating at package printing works, in which layers of paper, plastic and metal foil are joined.

Plastic surfaces are treated to facilitate printing using electrical discharges from an electrode system, the "corona treatment."

Waste Characteristics

Emissions into the air mainly consist of organic solvents and other organic compounds. Some substances may cause unpleasant odors or affect health and the environment.

Discharges to water bodies mainly consist of silver, copper, chromium, organic solvents, and other toxic organic compounds.

Noise comes principally from fans, printing presses, and transport.

Wastes consist of environmentally hazardous wastes such as photographic and residual chemicals, metal hydroxide sludge, dyestuff and solvent residues, wiping material containing dyes and solvents, and oil spills. There are also bulky wastes such as paper.

Pollution Prevention and Control

The recommended pollution prevention measures are as follows:

- Estimate and control, typically on an annual basis, the quantities of volatile organic solvents used, including the amount used in dyes, inks,

glues, and damping water. Estimate and control the proportion that is made up of chlorinated organic solvents.
- Replace solvent-based dyes and glues with solvent-free or water-based dyes and glues, where feasible. Water-based dyes are preferred for flexographic printing on paper and plastic and for screen printing and rotogravure.
- Give preference to the use of radiation-setting dyes.
- Engrave, rather than etch, gravure cylinders to reduce the quantity of heavy metals used.
- Enclose presses and ovens to avoid diffuse evaporation of organic substances entering the general ventilation system, where feasible. Use suction hoods to collect vapors and other fugitive emissions.
- Evacuate air from printing presses and drying ovens into a ventilation system.
- Where possible, replace chemicals used for form preparation and cleaning with more environmentally friendly alternatives. Maintain a record of chemicals and environmentally hazardous waste. Do not use halogenated solvents and degreasing agents in new plants. Replace them with nonhalogenated substances in existing facilities.
- Estimate the quantity of developing bath and fixing bath used per year and maintain these at acceptable levels.
- Minimize the rinse water flow in the developing machines by, for example, use of "stand-by."
- Collect fixing bath, developer, used film, photographic paper, and blackened ends of photosetting paper and manage them properly.
- Use countercurrent flow fixing processes.
- Aim for a closed washing system.
- Store chemicals and environmentally hazardous waste such as dyes, inks, and solvents so that the risk of spillage into the wastewater system is minimized. Examples of measures that should be considered are retaining dikes or areas with no outlet, as a means of absorbing spillage. Minimize noise disturbance from fans and presses.
- Use equipment washdown waters as makeup solutions for subsequent batches. Use countercurrent rinsing.
- Recover energy from combustion systems, when they are used.
- Return toxic materials packaging to the supplier for reuse.
- Recover plates by remelting.
- Label and store toxic and hazardous materials in secure, bunded areas.

Treatment Technologies

Air Emissions

- Control emissions of gases from web offset with heat-setting thermic or catalytic incineration. Recover toluene from rotogravure by absorption, using active carbon. Carry out adsorption of solvents, using zeolites, and recover organic solvents.
- Treat organic solvents by using trickling filters. Use biological scrubbers to treat discharges of water-soluble solvents.
- Treat metal-containing effluents from the manufacture of gravure cylinders and printing blocks by applying the established methods of chemical precipitation, sedimentation, and filtration. Collect fixing baths for recovery or destruction. Evaporate solvents from regeneration of active carbon filters. Perform closed-screen chase washing; recirculate solvents and separate sludge. Fit developing machines with counterflow fixing or connect them to an organic ion exchanger. Collect film-developing agents for destruction. Carry out high-pressure water jet cleaning. Use ultrafiltration to treat washing water.

Solid Wastes

Because of the relatively small volumes of solid wastes, it is difficult to find acceptable and affordable methods of disposal. Ideally, solid wastes should be sent for incineration in a facility where combustion conditions (1,100° C and at least 0.5 second residence time) that ensure effective destruction of toxics are maintained.

Emissions Guidelines

Emissions levels for the design and operation of each project must be established through the environmental assessment (EA) process on the basis of country legislation and the *Pollution Prevention*

and Abatement Handbook, as applied to local conditions. The emissions levels selected must be justified in the EA and acceptable to the World Bank Group.

The following guidelines present emissions levels normally acceptable to the World Bank Group in making decisions regarding provision of World Bank Group assistance. Any deviations from these levels must be described in the World Bank Group project documentation. The emissions levels given here can be consistently achieved by well-designed, well-operated, and well-maintained pollution control systems.

The guidelines are expressed as concentrations to facilitate monitoring. Dilution of air emissions or effluents to achieve these guidelines is unacceptable.

All of the maximum levels should be achieved for at least 95% of the time that the plant or unit is operating, to be calculated as a proportion of annual operating hours.

Air Emissions

The maximum value for emissions of volatile organic compounds (VOCs) should be below 20 milligrams per normal cubic meter (mg/Nm^3), calculated as total carbon. Chlorine (chloride/chlorinated hydrocarbons) emissions should be below 10 mg/Nm^3.

Liquid Effluents

The effluent levels presented in Table 1 should be achieved.

Solid Wastes

Toxic solid wastes should be treated to destroy toxic organics to levels below 0.05 milligrams per kilograms (mg/kg). Wastes containing toxic metals should be stabilized to achieve levels in the leachate below those indicated in Table 1.

Ambient Noise

Noise abatement measures should achieve either the levels given below or a maximum increase in background levels of 3 decibels (measured on the A scale) [dB(A)]. Measurements are to be taken at noise receptors located outside the project property boundary.

Table 1. Effluents from Printing Plants
(milligrams per liter, except for pH)

Parameter	*Maximum value*
pH	6.5–10
BOD	30
COD	150
TSS	50
Oil and grease	10
Cadmium	0.1
Chromium	
Hexavalent	0.1
Total	0.5
Copper	0.5
Silver	0.5
Zinc	2

Note: Effluent requirements are for direct discharge to surface waters.

	Maximum allowable log equivalent (hourly measurements), in dB(A)	
Receptor	*Day (07:00–22:00)*	*Night (22:00–07:00)*
Residential, institutional, educational	55	45
Industrial, commercial	70	70

Monitoring and Reporting

Frequent sampling may be required during start-up and upset conditions. Once a record of consistent performance has been established, sampling for the parameters listed in this document should be as described below:

- Continuously monitor air emissions exiting the air pollution control system where toxic organics are being emitted at rates greater than 0.1 kilogram/hour.
- Analyze liquid effluents generated from the process at least monthly, and analyze solid waste before sending it for disposal.

Monitoring data should be analyzed and reviewed at regular intervals and compared with

the operating standards so that any necessary corrective actions can be taken. Records of monitoring results should be kept in an acceptable format. The results should be reported to the responsible authorities and relevant parties, as required.

Key Issues

The key production and control practices that will lead to compliance with emissions guidelines can be summarized as follows:

- Put in place and use good management practices, especially cleanliness and materials control.
- Collect spent fixing solution. Reuse it, or manage it as hazardous waste.
- Recirculate liquid effluents.
- Do not use halogenated solvents.
- Use organic, solvent-free dyes and glues, where feasible.
- Minimize air emissions and generation of toxic wastes, especially organics.
- Incinerate all toxic organic wastes except those containing toxic volatile metals.
- Collect solvent vapors, including toluene. Recover solvents or incinerate them in a combustion unit.
- Manage as hazardous waste spent photographic chemicals, plate developer, dye residues, and other wastes containing toxic organics or metals.

Sources

Swedish Environmental Protection Agency. 1991. "The Graphic Industry, Industry Fact Sheet." SNV 91-620-9305-3 / 91-03 / 500ex. Solna.

USEPA (United States Environmental Protection Agency). 1995. "Printing and Publishing: Sector Notebook, EPA Envirosense Bulletin Board." EPA / 310-R-95-014. Office of Compliance, Washington, D.C.