Printers' National Environmental Assistance Center

Printing Environmental Technology
Fact Sheet

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MANAGEMENT OF AQUEOUS WASTE FROM WATER-BASED FLEXOGRAPHIC PRINTING PROCESSES

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As air regulations controlling volatile organic compounds (VOCs) become more strict, many flexographic printers are switching to water-based ink technology to reduce their emissions. With water-based ink production on the rise, the flexographic industry has begun exploring alternatives for handling the waste generated from working with these inks.

The assumption that these inks and their wash-up wastes can simply go down the drain is misleading. Different federal, state and local regulations apply to the wastewater generated by industrial facilities. Depending on where or from what system a facility discharges wastewater determines which regulations and limitations apply.

Wastewater associated with the use of water-based inks is contaminated with colorants (pigments and dyes), vehicles (alkali-soluble, emulsions or colloidal-dispersion chemistries), auxiliary solvents (alcohols, glycols and glycol ethers) and additives (waxes, plasticizers and defoamers). Colored wastewater may also be an aesthetic concern. It is often an issue of the quantity and/or quality of certain chemistries and pigments that can exceed maximum discharge allowances for particular regions and circumstances.

To discharge wastewater directly into the environment, a facility must have a permit specifying allowable pollutants and flow of discharge. This permit is known as a National Pollution Discharge Elimination System (NPDES) or in some cases a State Pollution Discharge Elimination System (SPDES) permit. These permits have very stringent limits on the allowable level of pollutants that can be discharged and require monitoring of effluent, periodic testing of the receiving body of water and extensive record keeping and reporting.

Septic systems are designed to treat sanitary wastewater only. Industrial wastewater is not permitted to be discharged to septic tanks or septic systems. Discharging industrial wastewater into a septic system can result in groundwater contamination requiring costly cleanup. For those operations in regions that rely solely on septic systems as a means to process their wastes, wastewater treatment is not as much an option as a requirement. In some very restricted areas, no treated industrial waste waster may be discharged to a septic system. This can be verified with local authorities.

Discharge into a Publicly Owned Treatment Works (POTW – sewage treatment plant) is the most common means of wastewater discharge for printers. Some POTWs require all businesses that discharge a process waste to obtain a local discharge permit while others have an agreement based on local ordinances that the POTW will accept the printing wastewater. The waste discharged to the POTW should always be consistent with what is specified in the local ordinances or facility specific permit limits.

The most efficient method of determining if a discharge permit is required or specific discharge limits apply due to your industrial activities is to send a letter that identifies the operation and type of discharges being sent to the POTW. The POTW may required laboratory analyses of the waste stream before allowing a facility to discharge into the system. As with any environmental compliance requirement, written return correspondence from the POTW needs to be maintained in the form of a letter, permit or other response. This serves as the basis for demonstrating compliance. Fees are commonly associated with the discharge permit. The appropriate person can be located by inquiring with the utility that issues the water bill, or by contacting the local public works office at your local government agency.

While many large flexo shops are located in metropolitan areas with generous water and waste allowances, those in rural areas typically do not have these allowances. Industrialization has been stretching the treatment limitations and abilities of POTWs in many metropolitan areas. However, no matter what type of system a printer discharges to, it is to their benefit to reduce the amount of wastewater which needs to be disposed of in the first place.

WASTEWATER TREATMENT

Some of the most practical methods for processing post-production water wastes from water-based flexographic printers include:

- Chemical splitting in continuous or batch process. After adjustment of the pH, the solids (pigments and resins) are precipitated via flocculation into an encapsulated sludge. The sludge is then separated from the water through paper filtration for dewatering and easy disposal. A filter press further removes water and the “cake” is disposed. Typically, a band filter can process 0.1 to 2 m^3/day, while a chamber filter press can process 0.5 to 20 m^3/day.

- Continuous effluent treatment. A process similar to chemical splitting described above, continuous effluent treatment systems are designed to handle wastewater flows from 15 to 200 m^3/day.

- Microfiltration, ultrafiltration, nanofiltration and reverse osmosis.* This process works like kidneys in mammals. By passing wastewater through organic and inorganic membranes, 0.1 to 5000 liters per hour can be processed. The process basically takes the water (or anything else with the same or smaller molecular weight) out of the process solution. Post membrane carbon filters remove ammonia. There are no secondary disposal costs of the spent membranes with this type of filtration. The clean water can be used in other areas (e.g. as part of the adhesive in corrugated manufacturing).
  **Although these process terms are sometimes used interchangeably, they differ in membrane size. Microfiltration (0.7 to 2.0 micrometers) separates out paint pigment and bacteria, ultrafiltration (0.007 to 0.2 micrometers) will separate carbon black and viruses), nanofiltration (0.0009 to 0.009 micrometers) will separate sugar and synthetic dyes) and reverse osmosis (0.00009 to 0.002 micrometers) will separate aqueous salt and metal ions.*

- Biologically-absorptive treatment using activated brown carbon; recycling with part or full stream desalination and reactivation of the carbon – (mixed slope-reactors, flotation, filtration, softening, reverse osmosis, revolving cylindrical furnace).

- Oxidation technology through modular systems offering oxidation, ozone/UV oxidation, UV/H_2O_2 oxidation.

Quality and quantity of wastewater to be treated are generally the determining criteria for choosing which method is best for a particular production scenario. For nearly all flexo producers of wastewater, chemical splitting is appropriate and the least expensive short and long-term solution for reducing or eliminating wastewater problems. The step up from a band filter process to filter press process is called for based on both quantity and quality of treated wastewater. The quality of treated water is determined by the local discharge limits and/or if the printer plans to reuse the water for cleaning or other purposes.

While many printers elect to process only their wastewater and handle waste ink disposal as a separate component of waste management, some opt to add waste inks directly to their wastewater. This will generally increase the amount of suspended solids in the waste stream requiring a more effective and costly way to process the sludge resulting from the chemical treatment. In the end, more wastewater may need to be processed.

Although many companies are being offered simple filtration as a means to handle their wastewaters and remove solids and some coloration, the following should be understood: Most wastewaters resulting from flexographic printing and wash-up create an emulsion through the addition of inks, water and cleaning solutions. Processing this wastewater effectively can only be accomplished by first breaking the emulsion through chemical splitting, then physically filtering the resulting material.

Different chemistries are available for breaking this emulsion, and will accomplish the following:

1) Neutralization - adjustment of pH level back to neutral range;

2) Absorption – absorbing selected chemicals and suspended solids from the water;

3) Coagulation – continued chemical additions resulting in flocculants – filterable material;

4) Encapsulization – permanent entrapment of selected chemicals in solid form – suitable for disposal in a non-hazardous industrial landfill;

5) Physical filtration – through band filter or filter press operation.

Most commercially available splitting agents operate best in a pH range of 6.5 to 9, and pretreatment monitoring and adjustment of pH is recommended when wastes are outside of that range to afford a more effective performance of the agent. The pH of the discharge water may need to be adjusted prior to discharge to meet effluent limits.

WASTEWATER MINIMIZATION

The use of water is so widespread that it is taken for granted -- it is seemingly inexpensive to obtain and use. When the entire cost of its acquisition, use and disposal are fully taken into account, it is often surprising how expensive water can be. The cost of water from a municipal system ranges from $125 per million gallons to well over $1,000 per million gallons. Water disposal (or effluent discharge) costs range from $600 per million gallons to over $4,000 per million gallons. By minimizing water use, a facility can minimize both the cost of acquiring water as well as its disposal. Waste minimization consists of source reducing and recycling. Of the two approaches, source reduction is usually considered preferable to recycling from an environmental perspective.

It is useful to determine where and how much water is being used. Develop a plant water diagram (flow chart of water usage) and water balance (how much in/out) that is periodically reviewed, updated and used to develop further conservation methods. Use the diagram to develop a written water conservation program that utilizes elements given below that apply to your facility. Ideally, install water meters at key usage points in the plant and take readings at regular intervals to account for all water used. Form a multi-disciplinary water conservation team to review all facets of plant operation to develop a plant water budget that is tracked and followed.

Train plant personnel in ways that minimize water use. The amount of water used in the cleaning process can be reduced by training press operators to:

- Drain as much ink as possible into containers.
- Thoroughly scrape press parts before any water is used for cleaning.
- Increase cleaning efficiency by cleaning ink stations promptly (before the ink begins to dry).
- Use low flow spray nozzles.
- Use water flow restricters.

Press cleaning can be modified to an organized three-stage cleaning process to reuse wastewater:

Stage 1: The majority of ink is removed using dirty water.

Stage 2: Ink, left after the first stage, is removed using partially dirty water.

Stage 3: Any remaining ink is removed by clean water.

When the water in Stage 1 becomes too dirty to be effective, it is processed or disposed of appropriately. Stage 2 becomes Stage 1, Stage 3 becomes Stage 2 and fresh water is used for Stage 3.

Some companies have found that filtered wastewater, depending on its degree of contamination, may be used to dilute inks when necessary.

EFFLUENT TRADING

Another concept to be considered in addressing the bottom line through waste management is to explore effluent trading. Under effluent trading, a cost-effective source that achieves greater pollutant reductions than required under its wastewater discharge permit may be able to barter or sell credits for this excess to another discharger. Buyers purchase pollution reduction credits at a cost lower than what they would otherwise spend to achieve reductions. In the printing industry, effluent trading is most likely to occur as pretreatment trades. Additionally, large facilities with two or more water discharge points may conduct intra-plant trading. Contact your local POTW to determine if they offer this type of program.

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Additional Sources of Information

There are numerous excellent resources available today, such as the U.S. Environmental Protection Agency, state small business programs, trade associations and environmental equipment distributors, that can direct printers to the best sources for additional information on making environmentally informed waste management decisions effectively and efficiently. For additional information on flexographic wastewater management and environmental issues impacting flexographic printers, contact the Flexographic Technical Association at environment@flexography.org or call (631) 737-6020.

For information on silver recovery from photoprocessing wastewater, see the PNEAC fact sheet *Silver Recovery Systems and Waste Reduction in Photoprocessing* which can be downloaded from PNEAC's website at www.pneac.org/sheets/all/silver.html.

Care and handling of flexographic waters. 1998. P. Nolan. FLEXO® Magazine, April.