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APPENDIX A
PRINTING INDUSTRY DESCRIPTION

Introduction

Due to the nature of the printing and packaging industry, printing facilities present unique challenges in the air permitting arena, and they have often been viewed as a complex source to permit. The diverse applications that exist within the industry, as well as within facilities, cause this complexity. Printing is a manufacturing process used to create such diverse items as decals, labels, books, pamphlets, potato chip bags, candy bar wrappers, soft drink cans, fleet markings, and imprinted textiles. Facilities engaged in the production of these products have chosen printing as their manufacturing technology and often do not consider themselves Aprinters,@ but converters, packagers, or manufacturers.

The following discussion provides background on the various printing processes including: 1) offset lithography; 2) flexography; 3) publication rotogravure and product rotogravure; and 4) screen printing. The manufacturing of printed matter and packaging can be broken into three distinct steps **B** prepress, press, and postpress activities. These steps, in relation to the various printing processes are explained in detail below.

Prepress Activities

There are several preparatory steps that have to be conducted prior to printing. The goal of the steps in the prepress area is to produce a plate or similar image carrier such as a screen. The steps involve the preparation of text and images by typesetting and scanning. The separate text and image(s) can then be output onto black and white film negatives. The separate negatives are then mounted together on a common material referred to as a stripping flat. This assembled image is then used to make another photographic black and white film negative. This negative is then used to make the plate or image carrier.

With the advent of computers and new software, many printers are now able to prepare the images and text together and expose the combined text and images directly onto a film negative. In some instances, the entire procedure of imaging to film and then to a plate or other image carrier is eliminated and the plate is directly exposed.

In commercial and other types of printing, it is common practice to produce a proof of the job to be printed prior to the actual printing. This proof is used to check image quality, placement of text and images, and color contrast. Proofs are generated from a variety of output devices and many of them now are digital or computer driven.

Film processors, used to make film negatives, are self-contained units that run at or slightly above room temperature. The VOC emissions from film processors are not significant. The principal reason why the VOC contained in film processing chemistry is not completely released is because these chemistries are water-based and are not designed to work by evaporation. The main source of chemical release from these processors is wastewater discharges.

Typically, the wastewater discharges are high in biological or chemical oxygen demand. This is a clear indicator that the effluent contains a large amount of organic material that is biodegradable. The

composition of the discharges from film processors include the dissolved unhardened emulsions, silver in the form of silver thiosulfate, and processing chemicals, some of which are considered VOC. Many printers utilize state of the art silver recovery technology to reduce silver discharges.

All of the organic-based chemicals in film processing chemistries have specific functions and must stay in solution in order for the chemistry to perform its intended function. It is important to note that the chemicals listed on an MSDS are not the ones that are always present in solution. For example, hydroquinone is used to initiate the development process and actually is consumed in the process. Sodium acetate is used as a buffer and is not lost to the atmosphere.

It is also interesting to note that all of these photo chemistries are available in a dry crystalline form. Many of the chemicals considered VOCs would be solids at room temperature.

The only releases of VOC containing material from the film processors would be the result of evaporation and the drying process in which the film is passed under to evaporate the wash water. This moist warm air would contain a trace amount of material. For this and the above reasons, it is assumed that a one percent or less emission factor for VOCs would be appropriate. The one percent emission factor translates into a 10,000-ppm concentration. Since most work place exposure monitoring usually shows employee exposures to chemicals like acetic acid to be below 10 ppm, the one percent emission factor actually overstates VOC emissions.

Likewise, the vast majority of lithographic plate developing systems are water-based and not solvent-based. In essence, they work by removing the unhardened image area from the plate surface. In the plate imaging process, the image area is hardened by exposure to UV light. Plate development systems, like photo processing units, are enclosed and the effluent is discharged to the sewer.

The VOCs contained in plate chemistry tend to occur in low concentrations ranging from about five to ten percent and are usually alcohols. Alcohols are completely miscible in water, and very little is lost to evaporation. There are no elevated temperatures used in plate developing. The same one percent or less emission factor as presented in the film chemistry section would also apply.

Some of the new direct-to-plate systems require a baking step to further harden the image area after development. This baking step is performed on the dry imaged plate and no solvents are used in this step.

In screen printing prepress, the screen, a porous polyester mesh that has been attached to a metal frame, is coated with a photochemically reactive emulsion. A film positive is adhered to the screen, and the screen is then placed on a vacuum table. While in the vacuum table, the screen is exposed to ultra violet light. The emulsion hardens, except in the image area. The screen is then placed in a washout tank, and water is used to rinse the screen. Similar to other print processes, the chemicals used in screen preparation contain negligible amounts of VOCs, and the wastewater discharges tend to contain a large amount of organic material that is biodegradable.

Similar to other industry sectors, screen printing is moving towards the use of digital pre-press technology that will allow the screen to be pre-imaged with the use of little or no chemistry. Digital pre-

press technology is used quite a bit to produce the film positives.

Modern proofing systems have now moved away from using solvents to develop the images. Typically, output devices fall into three categories of dry toner, ink jet, and dye sublimation. In the case of dry toners and dye sublimation system, there are no solvents used in the process. Ink jet inks are usually water-based and use vegetable dyes. They are virtually identical to ink jet printers that are commonly found in offices and home.

Conventional proofing systems have moved away from solvent-based developers to water-based ones, dramatically reducing the amount of VOC emissions. Older proofing systems could use a developing solution of up to fifty percent solvent. New systems are water-based and contain very little solvent, about five percent. The solvents are usually alcohol based and, like plate and photo processors, do not work by evaporation. Their principal discharge is wastewater that is discharged to the local sewer.

Proof presses are usually small presses that are only set up and run to produce a limited number of proofs. Proofing systems are used to evaluate product quality and to show the customer what a final version of the product will look like. There may be VOC emissions associated with some of these operations, but they would be minor and insignificant.

While not necessarily all that common, another prepress technology used in printing is blueprint making systems. Blueprinting operations are occasionally performed at printing facilities. These systems are water-based and the principal air byproduct is a small amount of ammonia.

Press Activities

The pressroom accounts for the vast majority of emissions released from any printing operation. The pressroom is where most inks and coatings, as well as other input materials, are applied to the substrate. The differences between the various print processes is evident in the press area. The processes vary in the type of input materials and equipment used. It is important to understand that the differences are so distinct that the input materials and equipment, as well as the control approaches, are not interchangeable. For example, inks used for offset lithographic operations cannot be used in screen printing applications.

Offset lithography is a planographic printing system where the image and nonimage areas are chemically differentiated; the image area is oil receptive and nonimage area is water receptive. In printing, a thin film of aqueous solution (fountain or dampening solution) is applied to the plate and wets the nonimage area. Then ink is applied to the plate, where it adheres to the image area. On modern lithographic presses, the printing plate is attached to a cylinder and the ink on the plate is transferred, or offset, to a rubber-covered blanket, which in turn transfers the ink to the paper. Thus, the term "offset" is used to describe these types of presses. One revolution of the printing plate cylinder is referred to as an impression.

Offset lithographic ink drying is divided into two categories**B**heatset or non-heatset. Heatset ink, as the name implies, is dried by the evaporation of ink oil at an elevated temperature. The heatset process is a web (i.e., a continuous roll of substrate) printing process where heat is used to evaporate ink oils from

the printing ink. Heatset dryers (typically hot air) are used to deliver the heat to the printed web.

In non-heatset lithographic printing operations, the printing inks are set without the use of heat. Traditional non-heatset inks set and dry by absorption and/or oxidation of the ink oils. For the purposes of this document, ultraviolet-cured and electron beam-cured inks are considered non-heatset, although radiant energy is required to cure these inks. Both sheet fed (i.e., individual sheets printed sequentially) and web fed presses are utilized with non-heatset ink systems.

Flexography utilizes a flexible rubber or elastomeric image carrier in which the image area is raised relative to the nonimage area. The image is transferred to the substrate through first applying ink to a smooth roller, which in turn rolls the ink onto the raised pattern of a rubber or elastomeric pad fastened around a second roller, which then rolls the ink onto the substrate.

Inks and coatings can either be solvent or water based. Ink is metered through a series of rollers transferred to the plate from the anilox roller. The anilox roller is engraved or etched with micro cells and is scraped with a doctor blade to control ink and coating application. The inked image is transferred directly to the substrate from the plate. Most flexographic printing presses are web fed.

Rotogravure utilizes a chrome-plated cylinder where the image area is recessed relative to the nonimage area. Images are transferred onto a substrate through first applying ink to a cylinder into the surface of which small, shallow cells have been etched forming a pattern, then wiping the lands between the cells free of ink with a doctor blade, and finally rolling the substrate over the cylinder so that the surface of the substrate is pressed into the cells, transferring the ink to the substrate.

Inks and coatings can either be solvent or water-based. The inked image is transferred directly to the substrate from the cylinder.

Screen printing utilizes a web or fabric to which a refined form of stencil has been applied and the printing ink is forced through onto the substrate. The stencil openings determine the form and dimensions of the imprint. This method is known for its ability to impart relatively heavy deposits of ink onto practically any type of surface, in a controlled pattern.

Inks and coatings can either be solvent or water-based. The inked image is transferred directly to the substrate through the screen.

After printing on one particular job is completed, the press needs to be set up for the next one. This preparatory phase is often referred to as “make ready@ and during this phase, the plates are removed and replaced with new ones, the press cleaned, inks changed, and new substrate is loaded into the equipment.

Postpress Activities

The postpress activities is a term used to describe those activities associated with the final stage of the manufacturing process where the printed sheet or other printed substrate is subjected to one or more binding and/or finishing steps. These steps include, but are not limited to, cutting, folding, trimming, die

cutting, embossing, foil stamping, drilling, saddle stitching, sewing, perfect binding, vacuum forming, and gluing. The gluing steps range from the application of a hot melt adhesive to the back of a book or magazine, to layering of a laminate to the printed substrate.

In the cutting, folding, trimming, die cutting, embossing, foil stamping, drilling, saddle stitching, vacuum forming, and sewing operations, no VOC-containing materials are utilized. The only emission would be particulate matter from the paper dust. Most of these pieces of equipment do not have any direct exhaust associated with them. They are Avented@ into the facility. Some of the larger printing operations use cyclones and/or vacuum pumps to create a vacuum for a centralized trim collection system. Occasionally, a bag house can be attached to the exhaust of cyclones. These systems can either be vented outside or back into the building.

In perfect binding lines, the cut and gathered printed pages are Asanded@ with rotary sanding discs to increase the surface area of the portion to be bound. After sanding or roughing, hot melt adhesive is applied in a thin strip and the cover is attached. The particulate matter generated by this operation is typically vented to a baghouse, which is in turn vented inside the facility.

In lithographic printing, adhesives are used in the production of products ranging from books, magazines, direct mail pieces, advertisements, business forms, folding paper boxes such as food packaging, inserts, to letterhead and envelopes. Substrate, function, application methods and other production drive the specific type of adhesive that is used. As each of these products is unique, the physical and chemical characteristics of the adhesives used in their manufacture are also different. For example, some adhesive application activities occur after the actual printing process with separate equipment or integrated lines that can fold, cut, trim, emboss, foil stamp, coat, laminate, and glue.

The other common type of adhesive application is performed in-line during the actual printing production step, where the adhesive is generally applied after the desired images and text has been applied or Aprinted@ to the substrate. Generally, in-line application of adhesives will occur on web presses and not sheet fed presses. An adhesive used in-line must have properties compatible with the line speeds that are common on today=s modern printing presses. They need to be able to be both applied and dried quickly.

The specific adhesives that are used for a given application depend upon the product=s end use and substrate characteristics. The critical substrate characteristics include surface area, surface structure, and surface energy. For example, an adhesive used to bind the spine of a book, magazine, or telephone directory must be flexible and pliable as these products will be opened and closed multiple times. The adhesive must be capable of withstanding multiple flexing without allowing the pages to fall out. Conversely, applying a glassine or other similar clear window to an envelope requires an adhesive that can wet the surface of the window material allowing the adhesive to spread and eventually bind to the envelope=s substrate. The ability to wet the substrate is very important when the substrate is nonporous and only certain technologies can be used to accomplish this goal.

Likewise, the selection of adhesives in the flexographic, rotogravure, and screen printing industries are driven by the unique demands of their processes, substrates, and end use. For example, some flexible food packages are composed of multiple layers of foil, polymer, and paper substrates. The demands of

adhesives for these types of substrates are vastly different than those for products produced via the lithographic process. The adhesive properties required for these products are not the same as those produced via the lithographic printing operations.

The range of adhesives used in printing operations fall into three broad categories: hot melts, water-based, and solvent-based adhesives. Many of the adhesives used in the gluing steps contain little or no VOCs. For example, hot melt adhesives are solid at room temperature and must be heated to allow them to become AfluidA enough so they can be applied. Attempts at measuring the VOC content of these adhesives using Method 24 have been challenging. Nevertheless, the data indicate they have an extremely minimal VOC content.

Many water-based glues also contain little or no VOCs. Such glues are derived from animal rendering operations and are comparable to Elmers Glue**7** commonly found in homes and schools. They routinely test, via Method 24, as having no VOC content.

The third type of adhesive is a more traditional solvent-based one. Some of these adhesives are used to prepare pads and multi-part business forms. Some laminates can also be solvent-based. In some applications, newer low (or no) VOC adhesives have been introduced that allow for a reduction in VOC emissions.