7.32 Printing processes

7.32.1 Coverage

The most important techniques in the printing sector are heatset offset, flexography and rotogravure in the packaging sector, publication gravure and rotary screen printing.

According to Intergraf [10], sheetfed and coldset have very limited VOC emissions. These emissions are also difficult to measure since there is no forced drying process producing waste gasses. There is a trend towards the use of low volatility cleaning agents and the avoidance of isopropanol in dampening solutions. The applicability of these emission reduction measures however depends very much on locally determined circumstances and cannot be translated in any kind of emission limit value. For this reason, these processes cannot be covered in the system used for the other printing processes and should be left out of this document.

7.32.2 Emission sources

a/ Heatset offset

Offset means a printing process using an image carrier in which the printing and non-printing areas are on the same plane. The non-printing area is treated to attract water and thus reject the greasy ink. The printing area is treated to receive and transmit ink to a rubber coated cylinder and from there the surface to be printed.

Heatset means an offset printing process where evaporation takes place in an oven where hot air is used to heat the printed material (most offset inks do not dry by evaporation, but by oxidation or absorption in the paper. Heat set inks are the exception. They are the only offset ink drying largely through evaporation [1]).

Emissions to air arise primarily from the organic solvents contained in inks. Inks used within consist of high boiling mineral oils as solvents (between 40 and 45 wt.-%). About 20% of the mineral oil remains in the paper, where once cooled to room temperature, no longer fall within the definition of NMVOC, and the rest evaporates during the drying stage, which occurs at high temperatures (200 to 300 °C).

Solvents used in cleaning, the storage and handling of solvents and the use of organic solvents as part of the dampening solutions (commonly isopropanol) are also important sources of emissions of organic compounds.

b/ Publication gravure

Rotogravure means a printing process using a cylindrical image carrier, in which the printing area is below the non-printing area, using liquid inks that dry through evaporation. The cells are filled with ink and the surplus is cleaned off the non-printing area before the surface to be printed contacts the cylinder and lifts the ink from the cells. Only toluene based inks are used [1]. Ink contains 50% of toluene when leaving the ink factory. A dilution is made in the printing plant to obtain the proper concentration in toluene: machine ready ink contains up to 80% toluene [2]. This dilution is made with toluene recovered inside the plant.

c/ Flexography and rotogravure in packaging

Flexography means a printing process using an image carrier of rubber or elastic photopolymers on which the printing areas are above the non-printing areas, using liquid inks that dry through the evaporation of organic solvents. The process is usually web fed and is employed for medium or long multicolour runs on a variety of substrates, including heavy paper, fibreboard, and metal and plastic foil. The major categories of the flexography market are flexible packaging and laminates, multiwall bags, milk cartons, gift wrap, folding cartons, corrugated paperboard (which is sheet fed), paper cups and plates, labels, tapes, and envelopes. Almost all milk cartons and multiwall bags and half of all flexible packaging are printed by this process.

Solvent based inks can have different solvent contents when bought but ready to use inks contain about 80 to 90% of solvents (these figures take into account cleaning agents). Substitution can be implemented with water-based products (containing about 5% of solvent), UV curing inks and 2-

components adhesives. Water-based inks in flexography printing are in regular production use in some packaging applications such as paper bags and plastic carrier bags [1].

7.32.3 BAT, Associated Emissions Levels (AEL)

BAT AEL and techniques are based on the STS BREF [3] when information is available (for large installations consuming more than 200 tones of solvents a year) and on the SED Directive [4] or EGTEI data for smaller installations. For screen printing, data are based on a study from 1999 [5] as this sector has not been treated specifically by EGTEI.

a/ Heatset Offset

NMVOC emissions from *heatset printing* consist of isopropanol (IPA) emitted from the dampening solutions, from cleaning agents and the stack emissions from dryers. BAT is to reduce the sum of fugitive emissions and to treat stack VOC emissions with thermal, catalytic or regenerative oxidation.

It is then BAT to reduce:

- The emission of IPA by using low IPA or free-IP dampening solution,
- Fugitive emissions from the cleaning process by a combination of the following techniques: substitution and control of NMVOC used in cleaning, automatic cleaning systems for printing and blanket cylinders.

Table 1: BAT associated emission levels for heatset offset

Type of press	BAT associated emission levels for VOC [Defined for the following averaging periods: daily for AELc and yearly for AELf and total AEL]
IPPC installations [1]	
For new and upgraded presses	2.5 to 10% VOC expressed as % of the ink consumption by weight
For existing presses	5 to 15% VOC expressed as % of the ink consumption by weight
Smaller installations	
For all presses	Fugitive emissions lower than 30% of solvent input can be reached [1] with concentration in the stack not greater than 20 mg C / Nm^3

b/ Publication gravure

In the *publication rotogravure* sector, more than 90% of the organic solvent consumption can be recovered, if activated carbon adsorption is used, due to the small number of components in the organic solvent (mainly toluene). The recycling of these organic solvents is possible and has long been practiced.

It is BAT to reduce fugitive emissions remaining after gas treatment:

Table 2: BAT associated emission levels for publication rotogravure

For new installations [3] **[Defined for the following averaging periods: yearly for total AEL]**
Total emissions of 4 to 5% of solvent input
For existing installations [3], [4] **[Defined for the following averaging periods: yearly for total AEL]**
Total emissions of 5 to 7% of solvent input

c/ Packaging rotogravure and flexography

In the *packaging rotogravure and flexography* sector, the following control measures for VOC emissions can be used:

Substitution with low solvent or solvent-free inks, and adhesives where practicable;

Activated carbon adsorption: the efficiency of the capturing system is an important parameter for the overall efficiency. Due to the numerous organic solvents in the inks, recycling on-site is difficult. This option may be technically and economically feasible for large printing installations with an annual solvent consumption of at least 500 Mg. The optimisation of the captured air flow at the different parts of an installation is always advisable when designing an installation. Minimizing the overall air flow rate and thus increasing the inlet concentration results in considerable savings in investments and operating costs;

Thermal or catalytic oxidation: the efficiency of the capturing system is an important parameter for the overall efficiency. At present, this measure is the most commonly used to reduce VOC emissions in this part of the printing sector, and it is expected to remain the most favourable option from an economic point of view for printing facilities with a solvent consumption of less than 500 Mg/year. The optimization of the captured air flow at the different parts of an installation is always advisable when designing an installation. Minimizing the overall air flow rate and thus increasing the inlet concentration results in considerable savings in investments and operating costs.

Table 3: Emission sources and selected VOC control measures with associated emission levels for packaging rotogravure and flexography

Type of installation	**Combination of control measures**	**BAT associated emission levels for VOC** **[Defined for the following averaging periods: daily for AELc and yearly for AELf and total AEL]**
IPPC installations	For plants with all machines connected to oxidation	7.5 to 12.5% of the reference emission[a/] [3]
	For plants with all machines connected to carbon adsorption	10 to 15% of the reference emission[a/] [3]
	For existing mixed plants: where some existing machines may not be attached to an incinerator or solvent recovery	Emissions from the machines connected to oxidisers or carbon adsorption are below the emission limits of 7.5 to 12.5% or 10 to 15% respectively For machines not connected to gas treatment: use of low solvent or solvent free products, connection to waste gas treatment when there is spare capacity and preferentially run high solvent content work on machines connected to waste gas treatment. Total emissions below 25% of reference emission *(requirement reduction scheme SED)*
Smaller installations	AELc = 100 mg C/Nm^3 and AELf = 20 wt-% **Or** total AEL = 25% of reference emission[a/] which can be reached with the following measures	
	Switch to water-based inks (5 wt.-% solvent content)	50 g/kg of product ready to use (Abatement efficiency ~ 94%) [6]
	Solvent based products and treatment of stack emissions by oxidation	Abatement efficiency ~ 76% [5]
	60% of products with no-solvents and treatment of stack emissions for the remaining 40%	~ 80 g/kg of product ready to use (Abatement efficiency ~ 90%) [6]

[a/] Using the reference emission defined in annex IIb to the SED [4]

7.32.4 Cost data for emission reduction techniques

The detailed methodologies developed to estimate costs are defined in the EGTEI synopsis sheets concerning “heatset offset” [6], “packaging” [7], and “publication gravure” [8].

Caution: these documents are susceptible to evolve if new updated data are available.

For *heatset offset*, abatement costs for the implementation of an oxidiser vary between about 1 and 5 k€ according to the size of installations.

For the *packaging industry*, abatement costs are very dependant of the installation's size: for small installations, the use of an oxidiser costs around 22 k€/t NMVOC abated versus less than 1 k€/t NMVOC for the biggest installations. For all types of installations, when the use of water-based inks is technically feasible, this option will lead to costs around 0.15 k€/t NMVOC abated. The last option, technically and economically available only for large installations, is the implementation of carbon adsorption leading to abatement costs below 1 k€/t NMVOC.

For the *publication gravure*, abatement costs to reduce emissions by carbon adsorption are about 1 k€. Abatement costs are reduced because a large amount of toluene can be recycled.

7.32.5 Emerging techniques

It is likely that UV curing flexo printing, for purposes other than beverage cartons, will be developed in the future [3].

7.32.6 References used for chapter 7.32

[1] P. VERSPOOR for INTERGRAF – Communications for EGTEI and IIASA – 2002 to 2004

[2] J. BERNARD for ERA. – 2003

[3] STS BREF – August 2007

[4] Directive 1999/13/EC of 11 March 1999. on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations

[5] Task Force on the Assessment of Abatement Options/Techniques for VOC from Stationary Sources – 1999

[6] EGTEI synopsis sheets: Heatset offset – 2005

[7] EGTEI synopsis sheets: Packaging – 2005

[8] EGTEI synopsis sheets: Publication gravure – 2005

[9] Compilation of the answers-to-questions-and proposal of EGTEI secretariat.doc – EGTEI - 02/2009

[10] Comments from Intergraf – 25/03/2009 and 25/05/2009