This sector (CORINAIR 94 SNAP source category 06 04 03) covers the main important printing processes. A subdivision has been made into four more specific source categories:

- flexography and rotogravure in the packaging sector: SNAP 06 04 03 01,
- heat set offset: SNAP 06 04 03 02,
- rotogravure in the publication sector: SNAP 06 04 03 03,
- screen printing: SNAP 06 04 03 04.

Printing involves the use of inks which may contain a proportion of organic solvents. These inks may then be subsequently diluted before use. Different inks have different proportions of organic solvents and require dilution to different extents. Printing can also require the use of cleaning solvents and organic dampeners. Inks, solvents, diluents, cleaners and dampeners may all make up a significant contribution to emissions from industrial printing involving the application of inks using presses. The largest plants may have as many as ten presses. [3]

### 7.4.4.2.1 Flexography and Rotogravure in the Packaging Sector

This source category (SNAP 94 extension 06 04 03 01) covers flexography and rotogravure printing in the packaging sector.

1 Technology Description

1.1 Flexography

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. [2, 3]

Steam set inks, employed in the "water flexo" or "steam set flexo" process, are low-viscosity inks of a paste consistency that are gelled by water or steam. Steam-set inks are used for paper bag printing, and they produce no significant emissions. Water-based inks, usually pigmented suspensions in water, are also available for some flexographic operations, such as the printing of multiwall bags. [2]

Figure 7.4.4.2.1-1 gives a schematic drawing of the flexographic printing process.
1.2 Rotogravure

In gravure printing, the image area is engraved, or "intaglio" relative to the surface of the image carrier, which is a copper-plated steel cylinder that is usually also chrome plated to enhance wear resistance. The gravure cylinder rotates in an ink trough or fountain. The ink is picked up in the engraved area, and ink is scraped off the non-image area with a steel "doctor blade". The image is transferred directly to the web when it is pressed against the cylinder by a rubber covered impression roll, and the product is then dried. Rotary gravure (web fed) systems are known as "rotogravure" presses. [2]

Water-based inks in rotogravure printing are in regular production use in some packaging and speciality applications, such as sugar bags [cf. 2].

The solvent part of the ink may be evaporated at ambient temperatures or through heating in an oven. Certain special inks, containing very little solvent, may be cured using ultra-violet or infra-red radiation. Solvents driven off through evaporation may be discharged untreated, recovered through carbon adsorption or destroyed via incineration. Cleaning techniques range from wiping over equipment with a solvent cloth to the use of an enclosed cleaning unit designed to recycle solvents. [3]

2 Emission Sources

Emissions to air arise primarily from the organic solvents contained in inks and for the dilution of inks. Solvents used in cleaning, and the storage and handling of solvents are also important sources of emissions of organic compounds. Emission points on flexography and rotogravure printing lines are: the ink fountain, the press, the dryer, and the chill rolls. The dryer is the major emission point. [2, 3]
3 Primary Emission Reduction Measures

Primary NMVOC-abatement measures consist of:

- good-housekeeping/solvent management plans,
- process modifications,
- low-solvent substitutes to conventional solvent-based printing inks.

The available primary measures may result in the following emission factors:

Table 7.4.4.2-1: Emission factors for primary measures

<table>
<thead>
<tr>
<th>Primary Measure</th>
<th>Emission Factor [g/kg non diluted ink]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncontrolled case</td>
<td>2,100</td>
</tr>
<tr>
<td>Low solvent-based inks (30 wt.-% solvent content)</td>
<td>730</td>
</tr>
<tr>
<td>Water-based inks (10 wt.-% solvent content)</td>
<td>210</td>
</tr>
</tbody>
</table>

Technical Aspects

Possibilities for solvent reduction may be identified through solvent management plans. Changes in work practises, particularly during the storage and handling of solvents, can lead to reduced fugitive losses. Less volatile cleaning agents may also be used, or when using cleaning agents with a high solvent content, enclosure of the installation may be a further NMVOC-abatement option. [3, 4]

Process modifications including reduced etching depth in rotogravure can also reduce solvent consumption [3].

In some types of flexography, water-based inks may be used instead of organic solvent-based inks (solvent content of approximately 60 wt.-%). Water-based inks contain organic compounds such as alcohols and amines to improve conservation, adaptation and substrate moistening. The proportion of organic compounds varies widely from less than 5 % to as much as 20 %. Conversion of a press from solvent-based to water-based inks requires changes in driers, materials, and operation. Rotogravure presses also require differently engraved cylinders for operation with water-based inks. Since water has a higher boiling point, a higher heat of vaporisation, and a lower vapour pressure than the organic solvents traditionally used in rotogravure and flexographic inks, it dries more slowly and requires more energy. Water-based inks, in which the volatile portion contains up to 20 vol.-% water soluble organic compounds, are used extensively in rotogravure printing of multiwall bags, corrugated paperboard, and other packaging products, although water absorption into the paper limits the amount of water-based ink that can be printed on thin stock before the web is seriously weakened. [cf. 2] The trend for using water-based printing inks has been originally set by the packaging sector, since the implementation is not only dependent on the properties of the printed material, but above all on the packaging content (e. g. in the food industry). [cf. 3, 4, 5]

The composition of ink can also be changed allowing ultra-violet, infra-red or electron radiation for curing the ink. Many of these curing methods use inks containing almost no organic solvents, but only pigments and a non-volatile reactive binder or film former. Driers
Other Use of Solvents and Related Activities

for chemical reaction inks are usually very high energy UV lamps, electron-beam generators or thermal ovens. The absorption of this energy within the ink causes the film former to cure and harden. Very few, if any, NMVOC are evaporated. As radiation cure inks technology matures, its use is expected to increase steadily. Because these inks do not dry on the press and a skin does not form in open containers, less waste ink and cleaning wastes can be expected. Furthermore, their fast drying can induce increased press speeds. However, besides the environmental advantages of radiation-curing inks, it has to be mentioned that they tend to provoke various allergies. [cf. 5]

Table 7.4.4.2.1-2 gives a comparison of relevant properties between conventional solvent-based, water-based and radiation-curing inks.

Table 7.4.4.2.1-2: Comparison of relevant properties between conventional solvent-based, water-based and radiation-curing inks [4]

<table>
<thead>
<tr>
<th>Solvent-Based Inks</th>
<th>Water-Based Inks</th>
<th>Radiation-Curing Inks</th>
</tr>
</thead>
<tbody>
<tr>
<td>• pH-value is of no influence</td>
<td>• pH-value must be observed</td>
<td>• same quality than conventional inks</td>
</tr>
<tr>
<td>• wide variety of pigments</td>
<td>• limited variety of pigments</td>
<td>• short drying times, especially with UV</td>
</tr>
<tr>
<td>• drying time is optimisable</td>
<td>• drying lasts longer and is more energy consuming</td>
<td>• no de-inking possible</td>
</tr>
<tr>
<td>• good adaptation to subsequent process stages</td>
<td>• adaptation to subsequent process stages is delicate</td>
<td>• limited operating velocities</td>
</tr>
<tr>
<td>• waste water problems</td>
<td>• waste water problems</td>
<td></td>
</tr>
<tr>
<td>• corrosion problems</td>
<td>• corrosion problems</td>
<td></td>
</tr>
<tr>
<td>• no de-inking possible</td>
<td>• no de-inking possible</td>
<td></td>
</tr>
</tbody>
</table>

Economic Aspects

Information on economic aspects is given in the attached technical data sheet.

4 Secondary Emission Reduction Measures

Applicable secondary measures and related emission factors are listed in the following table:

Table 7.4.4.2.1-3: Emission factors for secondary measures

<table>
<thead>
<tr>
<th>Secondary Measure</th>
<th>Emission Factor [g/kg non diluted ink]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncontrolled case</td>
<td>2,100</td>
</tr>
<tr>
<td>Thermal or catalytic incineration</td>
<td>525</td>
</tr>
<tr>
<td>Activated carbon adsorption</td>
<td>525</td>
</tr>
</tbody>
</table>

Technical Aspects

Within packaging flexography and rotogravure printing, often mixtures of solvents are in use; they may be recovered by activated carbon or another adsorption medium, however, their immediate reuse is often not practical, and the recovered solvents are generally sent away for reprocessing or destruction. [3]
A demonstration project aiming at recovering a large variety of solvents and mixtures of solvents has been realised in the Netherlands and has been reported to have operated successfully. The recovery of solvents used in the packaging sector has been quoted to be a technical and economical possibility for large printing installations with an annual solvent consumption of at least 500 Mg. For smaller printing facilities consuming less than 500 Mg solvent a year, the recovery of solvent proves to be a rather uneconomical technique; in that case, incineration remains the preferred option. Detailed information on this demonstration project is given in [6].

In practice, thermal incineration is the most widely used method for destroying organic compounds emitted from printing processes. Destruction techniques are often more than 90 % efficient, however, this may not necessarily mean a 90 %-reduction in emissions as solvents are also lost from i. a. storage, transportation and cleaning activities. [3]

Some smaller rotogravure operations, such as those that print and coat packaging materials, use complex solvent mixtures in which many of the solvents are water soluble. Thermal incineration with heat recovery is usually the most feasible emission control for such operations. With adequate primary and secondary heat recovery, the amount of fuel required to operate both the incinerator and the dryer system can be reduced to less than that normally required to operate the dryer alone. [cf. 2]

In addition to thermal and catalytic incinerators, pebble bed incinerators are also available. Pebble bed incinerators combine the functions of a heat exchanger and a combustion device, and can achieve a heat recovery efficiency of 85 %. [cf. 2]

Vapour capture systems are necessary to minimise fugitive solvent vapour loss around the ink fountain and at the chill rolls. Fume incinerators are the only devices proven to be highly efficient in controlling vapours from flexography operations. [2]

Detailed information on costs is given in the attached technical data sheet.

5 Side Effects

- Water-based inks reduce occupational health problems caused by solvent containing inks. However, a switch of emissions from air towards water should be avoided.
- UV-curing inks are nearly solvent-free, but can lead to health problems such as skin allergies.
- The incineration of solvent containing waste gas will result in additional combustion emissions, such as CO₂, NOₓ, etc.
- Also adsorption will result in increased energy demand and thus emissions. Furthermore, the spent carbon requires disposal.
6 References


7.4.4.2.2 Heat Set Offset

This source category (SNAP 94 extension 06 04 03 01) covers heat set offset printing.

1 Technology Description

This printing technique is used for printing magazines, catalogues and books with non-absorbent papers, i.e. for multi-colour printing in large quantities. Offset means a printing process using an image carrier in which the printing and non-printing area are on the same plane. The non-printing area is treated to attract water and thus reject ink. The printing area is treated to receive and transmit ink to the surface to be printed. Heat set means a printing process where evaporation takes place in an oven where hot air is used to heat the printed material. [cf. 3]

Figure 7.4.4.2.2-1 gives a schematic drawing of the offset printing process.

![Schematic drawing of the offset printing process.]

2 Emission Sources

Emissions to air arise primarily from the organic solvents contained in inks and for the dilution of inks. Solvents used in cleaning, the storage and handling of solvents and the use of organic solvents as dampeners (commonly isopropanol in offset printing) are also important sources of emissions of organic compounds. Solvents driven off through evaporation may be discharged untreated or destroyed via incineration. Cleaning techniques range from wiping over equipment with a solvent cloth to the use of enclosed cleaning units designed to recycle solvents. [cf. 3]

The inks used within heat set offset printing consist of high boiling mineral oils as solvents (about 45 wt.-%). About 12 to 19 % of the solvent remains in the paper, and the rest evaporates during the drying stage, which occurs at high temperatures (200 to 300 °C). [4]
3 Primary Emission Reduction Measures

Technical Aspects

Possibilities for the reduction of solvent emissions are:

- **Good housekeeping/solvent management plans**: Changes in work practises, particularly during the storage and handling of solvents, and the cleaning of equipment, can lead to reduced fugitive losses [3].

- **Reduced consumption, or even suppression of isopropanol used for impregnation**: Over the last years, the isopropanol concentration of 12 – 14 vol.-% has been reduced to 5 – 8 vol.-% either through substitution with non-volatile organic compounds or via optimisation of the dampening system; in the future, a total suppression of isopropanol seems realisable [4, 5].

- **Low-solvent substitutes**: Solvent-free radiation-curing inks are already commonly used for the printing of mailings; the application of water-based printing inks is technically not feasible [4];

- **Process changes**: For some application fields, a change to the water and alcohol-free dry offset process is possible [4, 5]. Conventional offset printing makes use of a mixture of water, approximately 8 to10 % vol.-% isopropanol and about 2 to 3 vol.-% additives, in order to moisture the parts of the paper, which remain un-printed. Within the dry offset technique, the parts of the printing surface which must not be printed are kept white by using a printing surface with a layer of silicon rubber at those parts, which must remain un-printed. Dry offset has been and may certainly also in the future be implemented mainly because it allows a higher quality of printing than the conventional offset printing. Further advantages of the dry offset process over the conventional offset technique are reduced paper consumption, reduced printing time, and avoidance of substantial materials and costs related to the conventional offset process. Nowadays, already 10 % of the Japanese printing facilities are equipped with dry offset, as well as some installations in the USA, Germany and the Netherlands. It is assumed that for the year 2000, dry offset will be implemented at about 5 % of the European printing facilities and at about 30 % in the Japanese printing industry. [6]

- **Vegetal oil-based cleaning agents**: For the cleaning of the installation, vegetal oils, especially soya bean, rape and coconut oils, can be seen as alternatives to solvent-based cleaning agents.

Economic Aspects

Economic aspects are dealt with in the attached technical data sheet.

4 Secondary Emission Reduction Measures

Technical Aspects

Applicable secondary measures and related emission factors are:
Table 7.4.2.2-1: Emission factors for secondary measures

<table>
<thead>
<tr>
<th>Secondary Measure</th>
<th>Emission Factor [g/kg ink]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncontrolled case</td>
<td>720</td>
</tr>
<tr>
<td>Controlled (thermal or catalytic incineration)</td>
<td>180</td>
</tr>
<tr>
<td>Controlled (thermal or catalytic incineration), less isopropanol</td>
<td>100</td>
</tr>
</tbody>
</table>

In practice, thermal incineration is the most widely used method for destroying organic compounds emitted from heat set offset printing processes, in particular since this technique is characterised by malodorous emissions to be removed. Destruction techniques are often more than 90 % efficient, however, this may not necessarily mean a 90 %-reduction in emissions as solvents are also lost from storage, transport, cleaning, etc. [3, 4]

In the special case of heat set offset, enclosure of single installation parts is difficult to realise, since the produced heat must be evacuated [4].

**Economic Aspects**

Information on costs is given in the attached technical data sheet.

5 Side Effects

- As regards UV-curing inks, health problems have been reported for some products (e. g. allergies on skin).
- The incineration of solvent containing waste gases results in additional energy consumption and related combustion emissions, such as CO<sub>2</sub>, NO<sub>x</sub>, etc.

6 References


7.4.4.2.3 Rotogravure in the Publication Sector

This source category (SNAP 94 extension 06 04 03 01) covers rotogravure printing in the publication sector.

1 Technology Description

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 recesses 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 recesses. [3]

Rotogravure can produce illustrations with excellent colour control, and it may be used on coated or uncoated paper, film, foil, and almost every other type of substrate. Its use is concentrated on publications and advertising such as newspaper supplements, magazines, and mail order catalogues, folding cartons and other flexible packaging materials, and specialty products such as wall and floor coverings, decorated household paper products, and vinyl upholstery. Multiple units are required for printing multiple colours. [2]

In the rotogravure printing process, a web or substrate from a continuous roll is passed over the image surface of a revolving gravure cylinder. For publication printing, only paper webs are used. The printing images are formed by many tiny recesses or cells etched or engraved into the surface of the gravure cylinder. The cylinder is about one-fourth submerged in a fountain of low-viscosity mixed ink. Raw ink is solvent-diluted at the press and is sometimes mixed with related coatings, usually referred to as extenders or varnishes. The ink, as applied, is a mixture of pigments, binders, varnish, and solvent. The mixed ink is picked up by the cells on the revolving cylinder surface and is continuously applied to the paper web. After impression is made, the web travels through an enclosed heated air dryer to evaporate the volatile solvent. The web is then guided along a series of rollers to the next printing unit. [cf. 2]

Figure 7.4.4.2.3-1 gives a schematic drawing of the rotogravure printing process.

![Schematic drawing of the rotogravure printing process](image-url)
The rotogravure press is designed to operate as a continuous printing facility, and normal operation may be either continuous or nearly so. Normal press operation experiences numerous shutdowns caused by web breaks or mechanical problems. Each rotogravure press generally consists of 8 to 16 individual printing units, with an 8-unit press the most common. In publication printing, only four colours of ink are used: yellow, red, blue, and black. Each unit prints one ink colour on one side of the web, and colours other than these four are produced by printing one colour over another to yield the desired product. [cf. 2]

Rotogravure is similar to letterpress printing in that the web is printed on one side at a time and must be dried after application of the last colour [5]. Thus, for 4-color, 2-sided publication printing, eight presses are employed, each including a pass over a steam drum or through a hot air dryer at temperatures from ambient up to 120 °C where nearly all of the solvent is removed. [cf. 2]

The inks used in rotogravure publication printing contain from 55 to 95 vol.-% low boiling solvent (average is 75 vol.-%), and they must have low viscosity. Typical gravure solvents include alcohols, aliphatic naphthas, aromatic hydrocarbons, esters, glycol ethers, ketones, and nitroparaffins. [cf. 2]

Solvents driven off through evaporation may be discharged untreated, recovered through carbon adsorption or destroyed via incineration. Cleaning techniques range from wiping over equipment with a solvent cloth to the use of enclosed cleaning units designed to recycle solvents. [3]

2 Emission Sources

Emissions to air arise primarily from the organic solvents contained in inks and for the dilution of inks. Solvents used in cleaning, and the storage and handling of solvents are also important sources of emissions of organic compounds. The use of glues and adhesives, particularly in publication, is also a potential source of emissions. Emissions from rotogravure printing occur at the ink fountain, the press, the dryer, and the chill rolls. Most of the fugitive vapours result from solvent evaporation in the ink fountain, exposed parts of the gravure cylinder, the paper path at the dryer inlet, and from the paper web after exiting the dryers between printing units. The quantity of fugitive vapours depends on the solvent volatility, the temperature of the ink and solvent in the ink fountain, the amount of exposed area around the press, dryer design and efficiency, and the frequency of press shutdowns. The dryer is the major emission point, because most of the NMVOC in the low boiling ink is removed during drying. At present, only solvent-based inks are used on a large scale for publication printing. Pigments, binders, and varnishes are the non-volatile solid components of the mixed ink. For publication printing, only aliphatic and aromatic organic liquids are used as solvents. Presently, two basic types of solvents, toluene and a toluene-xylene-naphtha mixture, are used. The naphtha-based solvent is the more common. Benzene is present in both solvent types as an impurity, in concentrations up to about 0.3 vol.-%. Raw inks, as purchased, have 40 to 60 vol.-% solvent, and the related coatings typically contain about 60 to 80 vol.-% solvent. The applied mixed ink consists of 75 to 80 vol.-% solvent, required to achieve the proper fluidity for rotogravure printing. [cf. 2, 3]
3 Primary Emission Reduction Measures

Technical Aspects

Possibilities for solvent reduction may be identified through solvent management plans. Changes in work practices, particularly during the storage and handling of solvents, can lead to reduced fugitive losses. Less volatile cleaning agents may also be used, or when using cleaning agents with a high solvent content, enclosure of the installation may be a further NMVOC-abatement option. Process modifications including reduced etching depth in rotogravure can also reduce consumption. For publication rotogravure, water-based inks are still in research and development stages, but some are now being used in a few limited cases, among them the printing of wall and floor coverings. However, there is still a secondary control measure necessary. The resulting emission factor is given as 210 g/kg ink. [2, 3, 4, 5]

Economic Aspects

Economic aspects are dealt with in the attached technical data sheet.

4 Secondary Emission Reduction Measures

Technical Aspects

The complete air pollution control system for a modern publication rotogravure printing facility consists of two sections: the solvent vapour capture system and the emission control device. The capture system collects NMVOC vapours emitted from the presses and directs them to a control device where they are either recovered or destroyed. [cf. 2]

Vapour capture systems are necessary to minimise fugitive solvent vapour loss around the ink fountain and at the chill rolls. Fume incinerators and carbon adsorbers are the only devices that have a high efficiency in controlling vapours from rotogravure operations. [cf. 2]

If a single solvent is used, e.g. toluene in rotogravure printing of newspapers and magazines, the solvent may be economically recovered for reuse, by means of activated carbon or other adsorption medium. Solvent recovery by carbon adsorption systems has been quite successful at a number of large publication rotogravure plants. These presses use a single water, immiscible solvent (toluene) or a simple mixture that can be recovered in approximately the proportions used in the ink. In the Netherlands, the four existing rotogravure installations in the publication sector are already equipped with toluene recovery devices [5]. Mixtures of solvents may also be recovered in this way, however, their immediate reuse is often not practical, and the recovered solvents are generally sent away for reprocessing or destruction. [cf. 3]

All new publication gravure plants are being designed to include solvent recovery. Fixed-bed carbon adsorption by multiple vessels operating in parallel configuration, regenerated by steaming, represents the most used control device. A new adsorption technique using a fluidised bed of carbon might be employed in the future. The recovered solvent can be directly recycled to the presses. [cf. 2]

Presently, only the concentrated dryer exhausts are captured at most facilities. The dryer exhausts contain the majority of the NMVOC vapours emitted. The capture efficiency of
dryers is limited by their operating temperatures and other factors that affect the release of the solvent vapours from the print and web to the dryer air. Excessively high temperatures impair product quality. The capture efficiency of older design dryer exhaust systems is about 84 %, modern dryer systems can achieve 85 to 89 % capture. For a typical press, this type of capture system consists of ductwork from each printing unit's dryer exhaust joined in a large header. One or more large fans are employed to pull the solvent-laden air from the dryers and to direct it to the control device. [cf. 2]

A few facilities have increased capture efficiency by gathering fugitive solvent vapours along with the dryer exhausts. Fugitive vapours can be captured by a hood above the press, by a partial enclosure around the press, by a system of multiple spot pickup vents, by multiple floor sweep vents, by total pressroom ventilation capture, or by various combinations of these. The design of any fugitive vapour capture system needs to be versatile enough to allow safe and adequate access to the press in shutdowns. The efficiencies of these combined dryer exhaust and fugitive capture systems can be as high as 93 to 97 % at times, but the demonstrated achievable long term average when printing several types of products is only about 90 %. [cf. 2]

The overall emission reduction efficiency for NMVOC control systems is equal to the capture efficiency times the control device efficiency. The 75 % control level represents 84 % capture with a 90 % efficient control device. The 85 % control level represents 90 % capture with a 95 % efficient control device. This corresponds to the application of best demonstrated control technology for new publication presses. [cf. 2]

Applicable secondary measures and related emission factors are summarised in the table below.

**Table 7.4.4.2.3-1:** Emission factors for secondary measures [1]

<table>
<thead>
<tr>
<th>Secondary Measure</th>
<th>Emission Factor [g/kg non diluted ink]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Uncontrolled case</td>
<td>1,500</td>
</tr>
<tr>
<td>Controlled (mainly adsorption)</td>
<td>375</td>
</tr>
<tr>
<td>Controlled (mainly adsorption), low-solvent inks</td>
<td>183</td>
</tr>
</tbody>
</table>

**Economic Aspects**

Information on costs is given in the attached technical data sheet.

5 Side Effects

- Water-based inks reduce occupational health problems caused by solvent containing paints. However, a switch of emissions from air towards water should be avoided.
- The incineration of solvent containing waste gas will result in additional combustion emissions, such as CO₂, NOₓ, etc.
- Also adsorption will result in increased energy demand and thus emissions. Furthermore, the spent carbon requires disposal.
6 References


### 7.4.4.2.4 Screen Printing

This source category (SNAP 94 extension 06 04 03 01) covers screen printing.

**1 Technology Description**

Screen printing means a printing process in which the ink is passed onto the surface to be printed by forcing it through a porous image carrier, in which the printing area is open and the non-printing area is sealed off, using liquid inks, that dry through the evaporation of organic solvents. [cf. 3]

Application fields of this technique are the printing of prospects, calendars, large advertisements, as well as printing on plastic, PVC, textiles and glass [4].

**2 Emission Sources**

Emissions to air arise primarily from the organic solvents used in inks (conventional high-solvent inks contain about 40 wt.-% solvent); for screen printing inks, no dilution is required. Solvents used in cleaning, and the storage and handling of solvents are also important sources of emissions of organic compounds. The use of glues and adhesives, particularly in publication, is as well a potential source of emissions. [cf. 3]

The solvent part of the ink may be evaporated at ambient temperatures or through heating in an oven. Solvents driven off through evaporation may be discharged untreated, recovered through carbon adsorption or destroyed via incineration. Cleaning techniques range from wiping over equipment with a solvent cloth to the use of enclosed cleaning units designed to recycle solvents. [3]

**3 Primary Emission Reduction Measures**

*Technical Aspects*

Primary NMVOC-abatement measures include:

- **Good-housekeeping/solvent management plans**: Possibilities for solvent reduction may be identified through solvent management plans. Changes in work practises, particularly during the storage and handling of solvents, can lead to reduced fugitive losses. Less volatile cleaning agents may also be used, or when using cleaning agents with a high solvent content, enclosure of the installation may be a further NMVOC-abatement option. [3, 4],

- **Low-solvent substitutes**: Water-based inks, as well as radiation-curing inks can be used instead of organic solvent-based inks within screen printing. Water-based inks contain organic compounds such as alcohols and amines to improve conservation, adaptation and substrate moistening. The proportion of organic compounds varies widely from less than 5 % to as much as 20 %. Nearly solvent-free inks allowing ultra-violet, infra-red or electron radiation for curing can be used as well. [cf. also section 3 of chapter 7.4.4.2.1]
• Process changes: Currently, so-called ‘thinprint’ techniques do already exist. These techniques allow to reduce ink and solvent consumption by approximately one third, and can be applied to existing screen printing installations [4].

Economic Aspects

Economic aspects are dealt with in the attached technical data sheet.

4 Secondary Emission Reduction Measures

Technical Aspects

Within screen printing, catalytic incineration and biofiltration may be applied in the case of larger facilities. In [1], an emission factor of 370 g/kg ink has been reported for such facilities. However, due to the existence of a large number of small screen printing facilities, this may not be feasible to a large extent due to technological and economic restrictions.

Economic Aspects

As already mentioned above, for the large number of small plants, secondary measures will be too expensive. Thus, they may be taken in consideration only for few large plants. Detailed information on costs is given in the attached technical data sheet.

5 Side Effects

• Water-based inks reduce occupational health problems caused by solvent containing paints. However, a switch of emissions from air towards water should be avoided.
• As regards UV-curing inks, health problems have been reported for some products (e. g. allergies on skin).
• The incineration of solvent containing waste gas will result in additional energy consumption and related combustion emissions, such as CO₂, NOₓ, etc.

6 References

Technical Data Sheets