

## ENVIRONMENTAL IMPACT OF PRINTING INKS

This Information Note has been prepared by EuPIA, based on an original publication by the British Coatings Federation. It provides an overview of the impacts that printing ink manufacture, printing and print can have on the environment, and has been prepared for manufacturers, printers and others in the print chain.

This Information Note will be regularly reviewed, as new knowledge or information becomes available.

If for any reason this Information Note does not provide an answer to a particular issue of interest, please contact EuPIA, so we can prepare appropriate additions to the note.

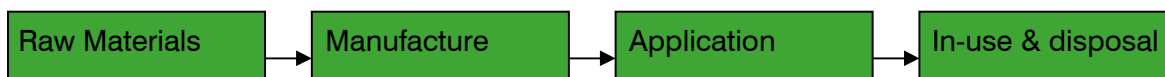


## Introduction

Managing and reducing the environmental impact of printing inks has been an important feature of EuPIA members' activities over many years, and continues to be an on-going element of product and process development.

In this Information Note, “printing ink” encompasses printing inks and other related products such as primers, sealers, overprint varnishes and wash-up materials, as typically applied on printing lines.

When considering inks from a cradle to grave perspective, they can have a potential impact on the environment at a number of points in their use cycle.



We will look at the impacts associated with each stage in the life-cycle shown above.

When assessing and comparing ink types it is essential that the ‘big picture’, i.e. the potential impact on the environment in the WHOLE use cycle, is considered before coming to any conclusions.

For example, the term “water based” suggests something environmentally friendly and likewise, “vegetable oil based systems” may be considered favourable because of their renewable source content. In some instances, however, these products may in fact need significantly more energy to dry than alternative materials and studying the ‘big picture’ may reveal that they have less of a beneficial environmental impact than first thought.

Furthermore, the type of substrate may also influence the overall impact: Significantly more energy is needed to dry water based inks on plastic or metal substrates, than on a substrate such as corrugated paper.

In reality, no single ink technology or printing process will provide a universal environmental solution. The determination of the most appropriate option can only be identified by all parties involved in the particular process or product, taking the relevant factors into account.

Studies carried out by bodies such as the UK's Carbon Trust, identify that the carbon footprint of an ink in either packaging or newsprint applications is less than 1% of the overall footprint of the product. It should be noted that this analysis takes into account only the manufacture of the ink and its transport to the customer.

The ink industry has undertaken a study to evaluate the carbon footprint of ink manufacture. The values obtained vary widely from site to site as electricity is the primary source of energy used in the manufacture of ink and materials; the actual carbon footprint of electricity varies widely across Europe depending on the percentage of low carbon footprint electricity production methods such as nuclear or hydroelectric power.

It is not feasible to manufacture ink in low footprint countries as the carbon cost of long distance transport to the final user would more than outweigh any benefit obtained. The ink industry is committed to further reducing its carbon footprint, wherever technically possible.

As a matter of course, optimisation of energy usage is an ongoing task in industrial processes.

## How do the technologies compare?

The following table has been produced to provide a very broad overview of the environmental impact of the different printing technologies. A traffic-light scheme is used to give a **relative** ranking of the impacts: red – yellow – green. Please note that the rankings cannot be used as absolute or definitive values, and some generalisations may be simplistic.

	Air/water quality			Energy		Sustainability		
	Low Level Ozone	Ground Water	Greenhouse Gas	Ink Manufacture	Application (drying)	Recyclability	Biodegradability	Raw Material Renewability
<b>Liquid inks</b>								
Solvent	Yellow	Green	Red	Green	Yellow	Green	Green	Yellow
Publication Gravure	Red	Green	Green	Green	Yellow	Green	Green	Green
Water based: paper	Green	Yellow	Green	Green	Green	Yellow	Green	Yellow
Water borne: film	Green	Yellow	Red	Green	Red	Green	Green	Red
<b>Energy Curing</b>								
UV	Yellow	Green	Green	Green	Yellow	Yellow	Green	Red
<b>Paste</b>								
Sheetfed	Green	Green	Green	Green	Green	Green	Green	Green
Coldset	Green	Green	Green	Green	Green	Green	Green	Red
Heatset	Green	Green	Red	Green	Red	Green	Green	Yellow
<b>Screen</b>								
Screen	Red	Green	Red	Green	Yellow	Red	Green	Red
<b>Metal Deco</b>								
Sheet fed	Green	Green	Red	Green	Red	Green	Green	Yellow

\*Does not include colourants

As this table demonstrates, no single technology is “the best” from an environmental impact perspective. Consideration of environmental impacts has to be taken into account along with all other factors on an individual basis, when selecting the most appropriate choice of printing process.

## Raw Materials and Packaging

### Renewable resources and recycled material

A proportion of materials from renewable resources are already used, e.g.:

- vegetable oil
- vegetable oil as components of alkyd resins or vegetable oil fatty acid esters
- rosin
- cellulose derivatives (e.g. nitrocellulose, CAB)
- ethanol and ethyl acetate produced from bio-sources

Significant progress is being made in the development of inks based on rape seed or soya bean oils, and alternative natural oils are being used as constituents of printing ink resins and additives. However, it should be noted that the use of natural materials may involve the use of genetically modified feedstocks and as demand increases this will become more likely.

The proportion of sustainable raw materials in any one printing ink will be dependent on the printing technology used, and the specific technical and performance properties required of the printed material or finished product.

There is, however, a limit to the amount of renewable materials that can be used in printing inks. For instance, only a few precursors of organic pigments, which make up a significant proportion of any printing ink, can be produced from renewable sources. This is also the case for certain highly specialised resins that are used to provide enhanced product performance and to meet applied costs specifications.

Opportunities to use raw materials derived from recycled processes are limited, given the demands for high performance, consistency and purity of printing inks and print, particularly in areas of printing inks used on food packaging.

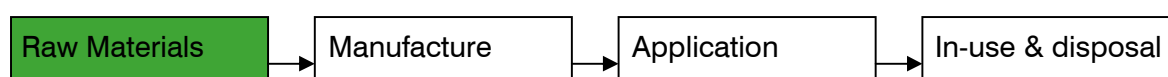
A specific example of reuse of solvents occurs in publication gravure, where the solvent is recovered and reused many times over.

Raw material suppliers endeavour to use multi-trip packaging, such as 1 tonne tote tanks or IBCs. In addition, every steel-based package (e.g. 25 litre cans, 205 litre drums) will contain a proportion of recovered and recycled steel.

### Environmental impacts

For many years EuPIA members have operated to an industry voluntary "Exclusion List for printing inks and related products". Initially focused on protection of the health and safety of printers in the work-place, it has now been extended to cover environmental protection issues.

The European REACH Regulation (EC) 1907/2006 requires that all substances on the EU market are assessed for their impact on human health and on the environment. Appropriate measures to ensure all uses are safe to human health and to the environment must be introduced.



Raw material selection can be influenced by the requirements of specific environmental protection legislation, which applies to printed materials and articles, such as the Packaging and Packaging Waste Directive, the Waste Electronic and Electrical Equipment Directive, and the Restrictions on Hazardous Substances Directive (RoHS).

Packaging used in the supply of products, has where possible been minimized through the use of lighter weight containers, larger pack sizes and reusable packaging. This can be limited by demands of other legislation, such as changes to transport regulations, which require use of more robust (and therefore heavier) packaging for higher levels of product containment.

## **Toxic heavy metals and other regulated elements**

The four toxic heavy metals

- cadmium
- hexavalent chromium,
- lead
- mercury

are recognised as hazardous to human health and are covered by the EuPIA Exclusion List. Such substances are not deliberately used in printing inks or related products supplied by EuPIA members. What cannot be excluded in raw materials, however, are trace levels of these metals, at concentrations below levels triggering hazardous classifications.

EU environmental protection legislation now restricts the levels of these four metals in road vehicles, packaging, and electronic and electrical equipment. In all cases, where traces of the metals are present in printing inks supplied by EuPIA members, they are well below the threshold levels applicable to these end uses. In addition, other metallic elements, such as (tri-organo) tin compounds, are subject to specific environmental protection controls.

## ***Aquatic effects***

For technical and/or economic reasons, some raw materials, which are classified as hazardous to the aquatic environment, may be used in products. Such inks are classified and labelled in accordance with the relevant EU legislation. When used in accordance with environmental regulatory requirements and industry guidelines, these compounds will not be released into the aquatic environment.

## ***Atmospheric effects***

In the atmosphere, nitrogen oxides, from road transport, power plants etc., react in the presence of sunlight to form ground-level (troposphere) photochemical smogs. Organic solvent vapours can accelerate these effects. Experimental data suggests that the solvents typically used in printing inks will photo-degrade rapidly in the atmosphere into water and carbon dioxide, and are not significant contributors to lower atmosphere ozone, independent of the fact that the amount of solvents emitted into the atmosphere during printing is strictly controlled. Although the carbon dioxide generated does have a greenhouse gas effect, emission of solvents from the sector are such that our contribution is extremely small compared to that from road transport and energy generation.

Organic solvents used in the formulation of printing inks do not contribute to ozone depletion in the stratosphere (upper atmosphere).

A wide range of measures and actions have been taken over many years to reduce the effects of printing inks and the printing process on the environment, including:

- solvents such as chlorinated hydrocarbons, which are known to be harmful to various organisms and can also bio-accumulate, have long been eliminated from ink formulations.
- aromatic fractions of many hydrocarbon solvents have been minimised, or have been substituted by low aromatic-content solvents where possible. This applies not only to heatset inks solvents and mineral oils, but also to mineral oils in coldset inks, and hydrocarbon solvents used in packaging inks.



# Manufacture

## Emissions

Printing ink manufacture is not a significant polluting process, reflected by its categorisation in a number of EU and national environmental protection regulations and control regimes as low polluting.

## Soil

There are no emissions from the ink manufacturing process to soil. The various process steps are carried out in purpose-built buildings with impervious floors.

## Air

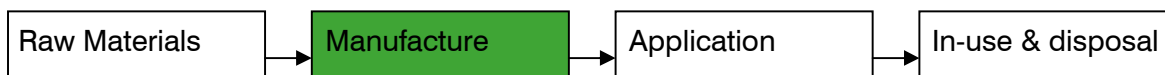
Printing ink manufacture results in the potential emissions of VOCs and pigment/extender dusts to atmosphere. Manufacturing processes are subject to control under the national Environmental Permitting Regulations for such emissions. Emissions of volatile solvents used in the manufacture of flexographic and gravure inks are kept to a minimum by use of fully enclosed or covered systems. Any pigment dust is captured by filters and sent for specialist disposal. Odour traps are fitted on high temperature varnish manufacturing vessels.

## Water

There are no direct discharges to water of any raw materials used in the manufacture of organic solvent borne and solvent-free printing inks.

Any discharges of water-borne wastes to sewers, arising from the manufacture of water-borne inks, are subject to closely monitored discharge consents, with specific restrictions on contaminant content set by sewage companies. More usually, such wastes are removed from site by specialist waste companies through established waste handling processes, which are subject to permitting under national or local waste management regulations.

Water is used as a processing aid, e.g. to cool manufacturing equipment. Cooling water is only used in closed-loop systems and no large volumes of cleaning water are used. Any effluent water produced is treated on site or disposed of by specialist waste management companies. Companies adopt water-efficiency measures wherever possible.



## Energy Usage

Ink manufacture is not regarded as an energy-intensive sector, and therefore is not included in national or EU energy management initiatives focused on high energy using industry processes. Nevertheless, ink manufacturers constantly monitor energy consumption and seek to minimise usage.

## Waste

EuPIA members conform to the EU waste hierarchy:

- Minimize
- “3Rs”: reduce, re-use, recover
- energy recovery
- Landfill (if permissible by national law)

A number of waste streams are generated from ink manufacturing processes, but these represent only a small proportion of the raw material inputs, due to the high process efficiencies, with conversion rates up to 99%.

Whenever possible, excess or otherwise unsold printing ink is recycled. Cleaning solvents and wipes are either recovered and re-used, or are disposed of through accredited waste disposal companies. Use of reclaimed solvent for equipment cleaning purposes is an established practice.

Water effluent is either treated on site or disposed of by specialist companies.

EU waste management legislation prevents the disposal of liquid wastes whether or not hazardous, in landfill sites. Non-liquid hazardous wastes can only be disposed of to landfill in very few sites; and all non-hazardous wastes that are to be disposed of in this way have to be treated before sending to landfill.

Many waste inks have a calorific value greater than traditional fuels such as coal and wood. When incinerated, they represent a valuable source of energy which can be exploited.

Where possible any excess raw material are returned to the supplier, sold elsewhere inside the ink-maker groups, and only as a last resort, disposed of. Some types of raw material and process packaging are designed to be re-used and/or recycled. Any residual non-hazardous packaging waste, which cannot be recovered, is compacted and sent for incineration or landfill.



## Application

**More detailed and focused information on the environmental impact of printing processes is available from print industry organizations.\***

**This section of the brochure is intended only to highlight a number of general aspects.**

Use of electronic colour control systems allows for greater efficiency of use of such materials. In certain circumstances, ink dispensing systems can be effective in reducing excess mixed ink.

## Emissions

### *Air*

Volatile Organic Compounds (VOCs) contribute to atmospheric photochemical reactions. In practice this means the organic solvents and diluents used in printing inks, which are emitted to atmosphere during the printing process. Organic solvent-borne heatset, flexographic, gravure, non-impact (digital) and screen printing inks, which contain organic solvents, are all possible sources of VOCs. Further potential sources of VOC emissions to atmosphere include:

- organic solvent-containing founts in offset printing processes
- organic solvent press cleaning materials in offset printing processes
- pre-press production of flexographic plates.

Under the current requirements of the Solvent Emissions Directive, and national regulations, emissions of VOCs to atmosphere have to be controlled within specified limits by the printer/converter, as part of the Environmental Pollution Permit, issued by the relevant regulating authority.

Emission control in general is by recovery or destruction and can be achieved in a number of ways.

**Recovery:**            Adsorption (scrubbing)  
                              Adsorption/desorption  
                              Condensation

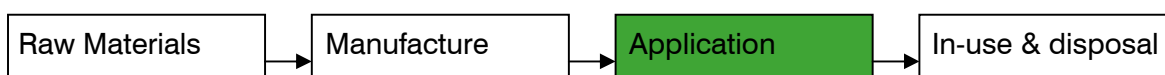
**Destruction:**     Catalytic thermal oxidation  
                              Thermal oxidation  
                              Biological scrubbing

In large-scale flexographic and gravure printing processes, thermal oxidation is the most common. The heat produced may be used in the operating plant in place of primary fuels. Any carbon dioxide produced in thermal oxidisers simply substitutes that from primary fuel production.

There is considerable debate over the relative environmental merits of each of these processes.

In publication gravure inks, where the solvent is primarily toluene, the solvent is subject to recovery levels in excess of 98%, with the recovered solvent being returned to the ink-maker for re-use in future batches.

\*(see for instance the BPIF/Envirowise publication "How to become a greener printer").



## ***Soil and water***

Under normal application conditions there is no release of printing inks or related products to soil or to ground water.

Product storage areas are bunded, to contain spillages and prevent soil and water contamination. Should a liquid spillage occur, or for any areas where washing of equipment takes place, then any waste should be collected for removal and processing. For waterbased materials, disposal into a foul water drain may be allowed by local authorities.

## **Energy**

The energy requirements in application processes represent only part of the overall energy usage, and are both ink technology and process dependent.

## **Process wastes**

### ***Surplus ink***

A number of printers now re-use excess product and press returns. Use of electronic colour control systems allows for greater efficiency of use of such materials.

### ***Organic solvents and water***

Best practice for organic solvent-based cleaning fluids is for these to be sent for recovery and reuse. Alternatively, wastes should be disposed of in accordance with the waste management hierarchy.

### ***Ink containers***

Empty, dry ink containers are not hazardous waste and, for those not designed for return and reuse, recycling via specialist waste management companies is the best available disposal option.

The incineration of plastics is an effective alternative. Their high calorific values (42 KJ/kg for polyethylene – greater than high grade coal) make them a valuable fuel source.

Facilities for cleaning and recycling of containers, particularly large drums, are widely available and are used whenever possible.

# In-use and Disposal

## In-use impact

During the intended use of any printed article or material, there will be no environmental impact from the print.

## Management of article waste

Recycling of paper is now common and the associated de-inking processes well-established. The difficulties with UV and waterbased ink technologies have been well documented and are the subject of continuing research. As a result of the introduction of new de-inking methods, print is now routinely recycled for newspaper, magazine and corrugated board use, the typical small proportion of UV print in the mix not being an obstacle\*.

## Biodegradability and composting

Biodegradation is the process where microbes break down the material to water, carbon dioxide and some biomass.

Composting is usually carried out in industrial facilities and similar breakdown products are produced.

Compliance with the composting system has to be achieved and this is done by meeting the conditions specified in EN13432 (in other areas of the world ASTM D6400 may be used). Certification bodies can issue certificates confirming the biodegradability of a printed article. Where the print is above the threshold level on the article, the inks used on the packaging must not contain excessive levels of specified materials, and the printed article must bio-degrade within the relevant timeframe. Inks will meet the chemical specification and ecotoxicology standards, and can be certificated as such. As supplied, however, they do not meet biodegradation requirements, This is due to the presence of water insoluble pigments and resins in the ink, which are carefully selected to ensure the quality of print for the life of the printed product. Water soluble colourants that would meet the biodegradability specification would fade before the end of the product life and are therefore unsuitable for quality reasons.

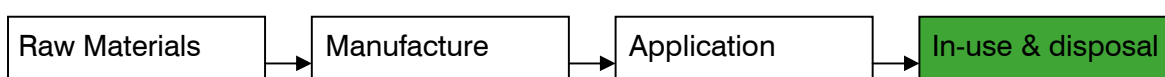
However, as a general rule, the presence of print on a printed article will not prevent the article from complying with the biodegradation requirements. Any residues of print, which may remain after biodegradation are inert and would not be considered as being harmful to the environment.

## Re-use

The ink on printed material is classed as a contaminant, along with labels, adhesives etc. In practice, the amount of dried ink is so small that it constitutes only a minor contaminant. Equally, in UV printing, the original components are reacted in the final cured print to form a polymer matrix, which no longer presents an environmental hazard. However, re-use of the majority of printed articles is not technically viable.

In addition, ink manufacturers do not recommend that printed material is recycled for use in packaging, which will be in contact with food. The raw materials in the wide range of print that will be found on recycled paper cannot be guaranteed to meet the regulatory standards required to ensure the safety of food packaging.

\* European Recovered Paper Council (ERPC)



## Disposal

### Energy recovery

A major inhibiting factor in terms of reuse of printed packaging, particularly for plastic based packaging, is collection and sorting. Printed matter, however, represents a potential source of energy, due to its intrinsic calorific content. Printed matter can be incinerated in plants with energy recovery, leading to overall environmental benefit.

### Incineration

Printing ink films do not contain any materials that would inhibit the suitability of printed matter for incineration and are not a concern to human health.

### Biodegradation

Due to the biologically neutral nature of raw materials used in printing inks, any print on waste material sent to landfill will not have any major effect on the anaerobic degradability of printed matter in a landfill.