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International Confederation for Printing and Allied Industries

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Publication Gravure

Process description

Gravure is an intaglio process, that is, the image is recessed into the surface of the plate or cylinder. It tends to be a more specialised process than either relief or litho printing, being mainly used for long runs as the origination (cylinder making) costs are relatively high.

In this process, the cylinder is flooded with ink, and the surface scraped clean to leave ink only in the recessed, image areas. It is then printed on to fairly absorbent substrates.

Today, gravure is almost totally a web-fed process, although sheet-fed presses are available. The high costs of making a cylinder will continue to make it a mainly web process, until cheaper origination methods are developed.

Gravure, like flexo, uses low-viscosity inks, nearly all of them being solvent based. The inks used do, however, vary depending on whether they are being used to print publications or packaging. Publication inks rely totally on toluene, whereas packaging inks, like flexo inks, use a variety of, mainly, aliphatics. Water-based gravure inks have not yet proved very successful. Because of the solvent inks used, all gravure presses are fitted with dryers.

Gravure is best known for being capable of producing very high-quality colour printing on lower-quality, cheaper grades of paper. Large publication gravure presses go up to a web width of 3,600mm, with 8 units printing 4 colours on each side. Flexible packaging presses tend to be narrower, and print 8 or more colours on one side. The process is best suited for long-run magazines, periodicals, colour supplements, mail-order catalogues, along with labels, cartons, packaging, decorative products such as wallpapers and gift wrappings, postage stamps and security work.

Introduction to the recommendations

Printing in publication gravure is the most industrial of all printing processes. A 'normal' four press printing plant may annually use between 50 and 100 kTon of paper and up to 10 kTons of press ready ink and will consequently have a solvent input of some 8,000 tons of solvent. Of this amount some 7000 tons are recovered and either reused or sold back to the ink manufacturer.

Please note that 'input' is used in the sense as defined in the VOC directive. This includes all solvents bought, including those in inks and all solvents that are recovered and reused. ('Throughput' might have been a better word.)

Trend

Presses are becoming wider and faster. Web widths are increasing from 2 meters to 3.60 meters or even wider. New presses have speed of up to 60,000 revolutions per hour, where older presses were limited to some 30,000. Although the number of presses is not increasing, the capacity of the industry certainly is.

Introduction

All publication gravure plants nowadays have solvent recovery installations. The inks are generally toluene-based. Toluene is easy to recover. It adsorbs well to activated carbon and is retrieved by heating the carbon with steam. The steam and solvent vapours are condensed and separate almost completely. The toluene is in part re-used and in part sold back to the ink manufacturers.

In spite of the toluene recovery, a part of the toluene input is emitted. The abatement equipment has a limited efficiency, air from press room or other department where toluene is used may be ventilated to the outside, the printed product will contain some residual toluene, and other fugitive emissions may occur.

Where no care is taken to limit these emissions, toluene losses may be up to 20% of the solvent input. Considering the amount of solvent used, this may account for over 1000 tons for large plants.

Unabated situation

In the truly unabated situation, all the solvent would be emitted without abatement. The total unabated emission, if no toluene recovery were used at all, would be some 200 kTons per year. To our knowledge, the truly unabated situation does not exist anymore in Europe.

The situation where up to 20% of the toluene input is emitted will be found more often. A present average loss of between 15 and 20% would account EU wide for an emission of some 35 kTons per year.

Abated situation

In the abated situation, new plants will emit less than 10% of their solvent input and existing plants less than 15%. The average loss will probably be some 10% and the total abated emissions will be some 20 kTons.

Recommendations	**Applicable to**
1: Regular solvent balances	All plants
2: Apply solvent recovery and reduce fugitive emissions (See benchmark figures)	All plants. For extremely small plants see 'Provisions'
Not recommended	
3: Closed air loop ventilation	Not recommended
4: Use water-based inks	Not recommended
5: reduce end of pipe emissions to no more than xx mg/Nm³.	Not recommended

1. Regular solvent balances

Description

Where solvents are recovered as in publication gravure, it is possible to make precise solvent balances.

In order to reduce the toluene losses to a minimum, it is necessary to know these losses both in quantity and origin.

Once a low level of losses has been achieved, they need to be kept there. Publication gravure plants are large and complicated: keeping toluene losses low needs permanent attention. A periodic check is needed to warn at an early stage for disruption in the total system of avoiding toluene losses.

Solvent balances whose function it is to prove compliance to regulations or environmental permits should be drawn up annually. This frequency is however not good enough to prevent plants from not complying. For that purpose, they need to keep track of solvent input and emissions more frequently. Monthly solvent balances are a minimum requirement.

The annual balance should not be the mere sum of all the monthly balances. It should be made separately, from original data, as far as possible. This annual balance should than be compared to the sum of the monthly balances. The causes of discrepancies should be found.

Remarks

Annex III of the VOC directive provides guidance on the possible content of solvent management plans.

Emission figures should comparable, therefore it is important that throughout the industry the same definitions are applied. A simplified version of Annex III, dedicated to the specific needs of publication gravure, can be expected to be put forward by industrial federations in the industry.

Cost

Once a proper routine is established and where necessary adequate flow meters are introduced, drawing up the monthly solvent balances will take one or two man days.

Though in principal the same thing, the annual solvent balances will take some days more due to the checking of discrepancies with the sum of the monthly balances.

2. Apply solvent recovery and reduce fugitive emissions (See benchmark figures)

Description

Since solvent recovery is easily possible, this is preferred above incineration.

The VOC directive prescribes for publication gravure a combination of an end of pipe ELV of 75 mgC/Nm³ (24h average) and maximum fugitive losses of 10 or 15% (new or existing plants). It treats the abatement efficiency and the fugitive emissions as separate subjects.

The recommended approach is different in the sense that it limits the total emission, i.e. the sum of end of pipe emissions and the fugitive emissions. There is no separate ELV for the recovery installation and no separate limit on the fugitive emissions.

It is not possible to predetermine the maximum toluene losses for all gravure plants. The variations between plants are too great. The table below contains benchmark figures.

	Benchmark figures for total toluene losses
Existing plants	10 – 15% of input
New plants	8,5 – 10% of input

All publication gravure plants are different. Especially where at present the losses are still above these benchmark figures, the operators need flexibility to achieve the benchmark solvent losses.

Flexibility is the more needed since the Occupational Exposure Limit (OEL) for toluene is lowered in most Member States from the original 100 ppm to values in the region of 50 ppm or even lower. Since fugitive losses need to be reduced mainly by sending press room ventilation to the solvent recovery installation, this increases the need for press room ventilation and thus increases the air stream with only a small toluene content.

This results in generally lower efficiency of the recovery installations and makes continued attainment of low end of pipe emission limit values disproportionately expensive. The reduction of the fugitive emissions however more than compensated for the slightly increased recovery losses.

There are several options available. Each plant will need to apply a plant specific combination of these options. Since all plants are different, they should be allowed to choose the combination of options best fitted to the existing situation:

- An efficient solvent recovery system. The end of pipe toluene losses may be no more than a few percent of the captured amount.
- Control of the recovery cycle by concentration measurement rather than fixed time intervals to increase efficiency.
- Encapsulation of presses and thus reducing the amount of press room ventilation that needs to be sent to the recovery installation. (New presses only)
- Closed cleaning machinery and direct extraction connected to the recovery installation.
- Cleaning of machine parts and doctor blades with high pressure water spray and ‘sodium bicarbonate’ or similar cleaning systems rather than toluene.
- Negative pressure in the press room to stop solvent laden air from escaping to the outside.
- LEL control on dryer systems to allow recirculation and an increase of toluene concentration in the waste gases in order to increase the average solvent concentration in the waste gasses and thus increase recovery efficiency.
- Operating procedures such that during the cleaning of cylinders in the press the dryers are left on to extract solvent laden air and send it to the recovery installation
- Air-knifes on the printed web to prevent the web from carrying along solvent laden air from the dryers
- Shutters on printing units.
- Cleaning floors with slowly evaporating solvent or solvent free cleaning agents instead of toluene. (Also has substantial Health & Safety advantages).
- Periodic intensive press cleaning by freezing with CO_2 (‘dry ice’) rather than using toluene.
- Reduction of residual toluene in printed products through increased dryer lengths (new presses only).
- Reduction of residual toluene in printed products by applying special purpose inks.

- In press cleaning of cylinders (new presses only).

Remarks

The definition of 'solvent input' is the same as used in the VOC directive:

- *The quantity of solvents and their quantity in preparations used when carrying out an activity, including solvents recycled inside and outside the installation, and which are counted every time they are used to carry out the activity.*

In order to achieve the recommended maximum emissions, a drastic reduction of the fugitive emissions is necessary. This needs to be achieved by sending solvent laden ventilation air to the solvent recovery system.

This recovery system will unavoidably have to be larger than it would be just for the waste gases coming from the dryers. It will also be less efficient, as the average toluene concentration in the air towards the recovery installation will be lower. A strict ELV for the recovering installation, in addition to the recommended low total emissions, would make such a system prohibitively expensive.

VOC directive: Implementation of the recommendation will result in lower total emissions than the Emission Limit Values of the VOC directive. The benchmark figures for total losses are lower than those for the fugitive emissions in the VOC directive alone. This can however only be achieved economically, if it is allowed to exchange a large limitation of the fugitive emissions against an, obviously much smaller, increase of the end of pipe emissions.

Obviously the end of pipe losses may not be more than a few percent of the captured amount. The required increase of end of pipe emissions does therefore not so much regard the 24h average emissions but mainly the occasional peaks that may surpass the 1h maximum of 1.5 times the ELV.

In order to stay within the legal limitations of the VOC directive, publication gravure plants will have to use the 'Reduction Scheme' in Annex IIb. The opening sentences of this annex are self-evident:

> *The purpose of the reduction scheme is to allow the operator the possibility to achieve by other means emission reductions, equivalent to those achieved if the emission limits were applied. To that end, the operator may use any reduction scheme, specially designed for his installation, provided that in the end an equivalent emission reduction is achieved.*

Cost

Where in publication gravure, solvent recovery is limited to the waste gases from the dryers and the press room ventilation is not sent to the recovery installation, there is positive return on the investment. In this case, however the losses will come to 15 to 20% of total input.

The additional investment to reduce these losses to the benchmark level is some 2 million € per plant with four presses.

The additional running cost in the same plant will come to circa 100,000 € per year.

(Estimation based on the following: Investment in additional recovery capacity four presses circa 20,000 m³/h per press, at circa 12.50 € per marginal m³/h: 1 million €. Plus approximately the same figure for encapsulation etc. Total 2 million. For running costs: guesstimate based on figures from recovery in flexible packaging.)

3: Closed air loop ventilation (not recommended)

Description

By drastically increasing the capacity of the recovery installation and shortening the absorption/desorption cycle, it is possible to achieve very low end of pipe toluene concentrations. If in addition the exhaust air from the recovery installation is cooled, it is possible to send the air back to the printing plant. Thus, the toluene emissions can be reduced further than the benchmark figures.

The larger recovery capacity, the more frequent desorption and the need to cool the air coming back to the plant increases the energy need of the recovery process enormously. In order to keep energy consumption (and operating cost) at a reasonable level, many energy saving features need to be included in the design of the system.

4: Use water-based inks (not recommended)

Description

Some publication gravure plants experiment with water-based inks. The experiments take place on old, relatively slow, presses. The print quality still leaves much to be desired. The inks are presently not yet fit for use on new high speed presses and high quality work.

Remarks

A major problem with water-based inks is that, with the existing paper recycling processes in Europe, de-inking of the paper is impossible. Where the quantities of products printed with water-based ink make for just a very small proportion of the paper to be recycled, this does not matter.

Some 8% of the paper and board collected for recycling is printed in publication gravure. If the use of water-based inks were widespread, a major problem in paper recycling would arise. It is therefore absolutely necessary to resolve the de-inking problem before water-based, or for that matter any other new ink system, can be introduced on a large scale in publication gravure.

Cost

For one new press, the additional investment in the closed air loop system, over a traditional solvent recovery plant, would come to circa 5 million €. The additional emission reduction would be some 80 tons per year.

The additional running cost will be low because of the many integrated energy saving options.

For a whole new average plant the additional investment would come to 20 million €. Retro-fitting existing plants would be even more expensive.

Provisions

The additional investment, compared to the emission reduction, is such that closed air loop ventilation is not BAT.

5: reduce end of pipe emissions to no more than xx mg/Nm^3. (not recommended)

Description

Restricting solvent emissions by limiting the concentration of solvents in the exhaust air, takes away the much needed flexibility. It does not allow the necessary exchange between substitution and reduction of fugitives and end of pipe abatement.

FURTHER INFORMATION

THE INFORMATION ABOVE WAS PROVIDED BY INTERGRAF AND THE EUROPEAN ROTOGRAVURE ASSOCIATION IN JUNE 2001.

IT IS BASED UPON '**PRINTING AND THE ENVIRONMENT**', THE AWARD WINNING DOCUMENT PROVIDING GUIDANCE ON BEST AVAILABLE TECHNIQUES IN PRINTING INDUSTRIES.

THIS DOCUMENT COVERS ALL THE EXISTING PRINTING PROCESSES AND CONSIDERS OVER 200 DIFFERENT CANDIDATES FOR BEST AVAILABLE TECHNIQUES. IT IS AVAILABLE IN ENGLISH, SPANISH AND POLISH.

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