Final Background Document
on the sector

Heat set offset

Prepared in the framework of EGTEI

Prepared by CITEPA, Paris

Summary

Data currently used in RAINS are displayed in this paragraph for three different countries. Data for other countries are downloadable on http://www.iiasa.ac.at/~rains/voc_review/single.html

Four reference installations are defined according to the annual ink consumption (t ink/y).

Four primary and two secondary measures are defined.
Table 5.3.1 summarizes the emission factors with the corresponding abatement efficiencies for each combination measure.
Table 5.3.2 summarizes investments and operating costs for each combinations.

If a measure is missing in the document, national experts have to contact the Secretariat to add it in the background document.

Tables to be filled in by national experts are displayed :

Table 6.2.1 : Country specific data (electricity, natural gas, wages). These costs are entered only once in the database.

Table 6.2.2 : Activity levels of Reference Installations. Consumptions of ink (t/y) in each type of reference installation (RI) is required.

- Total activity (t ink/y) has to be estimated from 2000 to 2020 and distributed according to the different installations.
- If no detailed information is available in 2000, total activity can be divided equally between all RI (i.e.: 25% for each one).
- If no prevision on the structure of this sector is available (for 2005 to 2020), the proportions used in 2000 can be used. But total activity (t/y) should evolve.

Table 6.2.3 : Application rate and applicability.

- If detailed information is available, table 6.2.3 can be filled in.
- If only sparse information is available, then table 6.2.3 can be filled in with the same "Application rates" for all RI (this corresponds to the filling of table 6.2.4).

Table 6.2.5 : Unabated emission factor

The default data mean can be modified in a range of ± 10%.

Investments and operating costs of primary measures have been provided by industrial experts. For secondary measures, costs are calculated from the equations of the document "Methodology".

Sector : Heat set offset

SNAP : 06 04 03 01 or NFR 3 D OTHER including products containing HMs and POPs.
The last two digits of the SNAP codes have been added for EGTEI purposes : they do not exist in the SNAP code nomenclature.

The heat set offset printing technique is used for printing magazines, catalogues and books mainly with non-absorbent papers. [1]

ACTIVITY : ink consumption (t/year)
POLLUTANT CONSIDERED : VOC

1 Data from the bibliography

Following data are just displayed for comparison reasons

1.1 Data currently used in the RAINS model [6], [9]

In the RAINS model, sub-sectors of the printing industry are treated separately (i.e : flexography and rotogravure in packaging, rotogravure in publication, screen printing and offset printing).

1.1.1 Control options

Three control options are considered in RAINS for "Offset printing" :

- Measure 00 : Reference case.
- Measure 01 : primary measure and enclosure : this measure includes good housekeeping, reduction of the isopropanol consumption, optimization of the dampening system, use of vegetable oil-based cleaning agents, as well as enclosure (applicability 100%; reduction efficiency : 30%).
- Measure 02 : use of solvent free inks (radiation curing) and solvent management plan (applicability 10%; efficiency : 95%).
- Measure 03 : enclosure and thermal incineration (applicability : 80%; efficiency : 75%).

Combinations of these techniques are also considered in the RAINS model.
Furthermore, it is considered that 10% of new installations (NI) will use radiation curing inks and that all new installation will introduce Measure 01.

1.1.2 Abatement costs

Examples for three countries are displayed below :

No comments are made on the figures displayed in the following tables because no further information is available.
Data on the other countries are downloadable on
http://www.iiasa.ac.at/~rains/voc_review/single.html

Table 1.1.2.1 : French situation

Activity level 1990 : 13,340 kt ink (existing installations);
2010 : 1,518 kt ink (existing installations) + 13,663 kt ink (New Installations)
VOC emission scenario business as usual : 1990 : 7,3 kt VOC (existing installations);
2010 : 0,25 kt VOC (existing installations) + 2,5 kt VOC (New Installations)

Measure	Emission factor [kt VOC / kt of ink]	Efficiency [%]	Technical Eff, [%]	Applicability [%]	Unit cost [€$_{1990}$/t VOC]
00	0,7200	0	0	0	0
01	0,5000	31	31	100	16
02	0,6530	9	93	10	0
03	0,2340	68	75	90	1 118
01+03	0,1625	77	77	100	1 099
01+02	0,4550	37	37	100	12
01+02+03	0,1175	84	84	100	1 008
00 NI	0,4500	0	0	0	0
03 NI	0,1163	74	74	100	1 824

Table 1.1.2.2 : German situation (Old Laender)

Activity level 1990 : 20,3 kt ink (existing installations);
2010 : 5,260 kt ink (existing installations) + 21,039 kt ink (New Installations)
VOC emission scenario business as usual : 1990 : 14,62 kt VOC (existing installations);
2010 : 1,05 kt VOC (existing installations) + 4,48 kt VOC (New Installations)

Measure	Emission factor [kt VOC / kt of ink]	Efficiency [%]	Technical Eff, [%]	Applicability [%]	Unit cost [€$_{1990}$/t VOC]
00	0,7200	0	0	0	0
01	0,5000	31	31	100	16
02	0,6530	9	93	10	0
03	0,2880	60	75	80	1 118
01+03	0,2000	72	72	100	1 048
01+02	0,4550	37	37	100	12
01+02+03	0,1550	78	78	100	1 014
00 NI	0,4500	0	0	0	0
03 NI	0,1538	66	66	100	1 938

Table 1.1.2.3 : German situation (New Laender)

Activity level 1990 : 1,389 kt ink (existing installations);
2010 : 0,360 kt ink (existing installations) + 1,439 kt ink (New Installations)
VOC emission scenario business as usual : 1990 : 1,0 kt VOC (existing installations);
2010 : 0,07 kt VOC (existing installations) + 0,31 kt VOC (New Installations)

Measure	Emission factor [kt VOC / kt of ink]	Efficiency [%]	Technical Eff, [%]	Applicability [%]	Unit cost [€$_{1990}$/t VOC]
00	0,7200	0	0	0	0
01	0,5000	31	31	100	16
02	0,6530	9	93	10	0
03	0,2880	60	75	80	1 118
01+03	0,2000	72	72	100	1 048
01+02	0,4550	37	37	100	12
01+02+03	0,1550	78	78	100	1 014
00 NI	0,4500	0	0	0	0
03 NI	0,1538	66	66	100	1 938

Table 1.1.2.4 : Hungarian situation

Activity level 1990 : 0,056 kt ink (existing installations); 2010 : 0,031 kt ink (existing installations) + 0,031 kt ink (New Installations) **VOC emission scenario business as usual :** 1990 : 0,04 kt VOC (existing installations); 2010 : 0,02 kt VOC (existing installations) + 0,01 kt VOC (New Installations)					
Measure	**Emission factor [kt VOC / kt of ink]**	**Efficiency [%]**	**Technical Eff, [%]**	**Applicability [%]**	**Unit cost [$€_{1990}$/t VOC]**
00	0,7200	0	0	0	0
01	0,5000	31	31	100	16
02	0,6530	9	93	10	0
03	0,2880	60	75	80	1 118
01+03	0,2000	72	72	100	1 048
01+02	0,4550	37	37	100	12
01+02+03	0,1550	78	78	100	1 014
00 NI	0,4500	0	0	0	0
03 NI	0,1538	66	66	100	1 938

1.2 Situation in UK [7]

This sector is treated in [7]. Four general measures are described for the printing industry in general :

- Measure 01 : waste minimization and improved cleaning techniques.
- Measure 02 : substitution with radiation curing inks, modified inks, water based system, cleaning fluids and non toxic inks.
- Measure 03 : abatement technique (incineration).
- Measure 04 : solvent recovery.

For heat set web off-set, the following techniques are described :
Waste minimization consists in a reduction of solvents used (especially for cleaning solvents).
Non or low Solvent Inks and Cleaners : traditional inks can be replaced by reactive inks systems including catalytic cure, electron beam and UV. Isopropanol can be replaced by alternative based on vegetable oil and other higher boiling point alcohols.
Pollution abatement : in the UK, 60% of all heat set web off-set processes are fitted with air pollution abatement equipment. This share is estimated at 85% of installations with an annual solvent consumption above 25 tonnes. These abatement techniques are either thermal or catalytic incinerators. Adsorption is not suited to heat set web off-set inks.
Condensers are more and more used as a preliminary technique to recover some solvents and to minimize the sizing of the incinerator.

Table 1.2.1 : Costs incurred for VOC reduction

Measure	**Investment / installation [€]**	**Operating cost / installation [€ / y]**
01	≈ 0	≈ 0
02	≈ 0	≈ 0
03	300 000*	30 000*

* assumes modifications are half the costs of a new abatement system.

The average costs of compliance for the whole printing industry are expected to vary between 200 and 2500 € / tonne of VOC reduced under the Directive (for medium (15-25 tonnes of solvent/y) and large (> 25 tonnes of solvent/y) installations respectively).

1.3 Situation in Norway [8]

The report covers only the general increase in the use of products without solvents. No special costs are associated with this measure.

2 Short technology description [1]

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.
Heat set 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 [3]).
Emissions to air arise primarily from the organic solvents contained in inks. 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. Solvents driven off through evaporation from the inks 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.

3 EU regulation : Directive 1999/13/EC of 11 March 1999 [2]

Operators concerned can conform to the Directive in either of the following ways :

- by complying with the canalized and the fugitive emission limit values.
- by introducing a reduction scheme to obtain an equivalent emission level, (in particular by replacing conventional products with high solvent content by low-solvent or solvent-free products : in this case, this only applies to cleaning agents and dampening solutions. It does not applies to the inks).

The EC Directive applies to installations with a solvent consumption above 15 t per year.

Emission limits for application of the Directive are presented in table 3.1.

Table 3.1 : Emission limits

Solvent consumption threshold [t / y]	VOC emission limit value in residual gases [mg C / Nm^3]	Fugitive emissions [% of solvent input*]
15-25	100	30
> 25	20	30

* Solvent input : quantity of organic solvents used as input into the process in the time frame over which the mass balance is being calculated (purchased solvent) + quantity of organic solvents recovered and reused as solvent input into the process (recycled solvents are counted every time they are put back into process cycle).

All obligations of the Directive are not described in this chapter.

4 Definition of Reference Installations

Reference installations are defined according to their consumption of ink per year. The number of presses are also indicated. This information is important because the total installation’s exhaust gas flow rate depends on it. These definitions are reported from [1] and have been updated with [3].

Reference installations are presented in table 4.1.

Table 4.1 : Reference installations

Reference Installation Code RIC	Description
01	Small Reference Installation : 1 small press; ink consumption : 30 t / y
02	Medium Reference Installation: 2 small presses; ink consumption : 100 t / y
03	Large Reference Installation: 4 large presses; ink consumption : 400 t / y
04	Very Large Installation: 8 large presses; ink consumption : 1 000 t / y

According to [3], installations with a solvent consumption lower than 15 t/y are extremely rare. They do not warrant a separate reference.

5 Emission abatement techniques and costs

5.1 Definitions of primary measures

Inks used within heat set offset printing 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 VOC, and the rest evaporates during the drying stage, which occurs at high temperatures (200 to 300 °C).

In this sector, only ink’s emissions are always captured and generally routed to the incinerator. Cleaning agents are not captured for safety reasons and the dryer is usually turned off during cleaning periods (temperature of the dryer are too high and explosion might occur if the dryer is running). Some 10% of isopropanol emissions (dampening solution) are captured by the dryer and then treated in the incinerator.
To reduce VOC emissions, the more efficient solution is to reduce fugitive emissions especially from isopropanol and cleaning agents.

According to [3], the following primary measures can be implemented :

- *Reduced consumption of isopropanol used in dampening solutions :* over the last years, isopropanol concentration has been reduced either through substitution with products containing less volatile organic compounds or via optimisation of the dampening system. In certain cases, a total suppression of isopropanol is realisable but substitution products generally contain ether glycols.
- *Usual cleaning agents can be replaced by agents with higher flash points :* these agents are less volatile and can be collected more easily to be eliminated outside the installation. In some cases high boiling solvents can be used that are not VOC.
- *Process changes*: For some application fields, a change to water and therefore alcohol-free dry offset process is possible. This process is very particular and suited for niche markets only and can not be used to replace works handled with heat set offset printing. This measure has not been studied in this report.

Three primary measures are presented hereafter : these measures are defined according to the corresponding fugitive emissions. Below, fugitive emissions are expressed as a percentage of solvent input and not as a percentage of ink weight (later in this report (§ 7.3), the correspondence between fugitive emissions in g/kg of ink used and fugitive emissions in percentage of solvent input, is made).

Measure 00 “base case” represents a 45% fugitive emissions situation [3].
Measure 01 represents a 30% fugitive emissions situation [3]. This situation corresponds to the limits imposed by the EU VOC Directive.
Measure 02 represents a 25% fugitive emissions situation [3]. This measure goes further than the Directive limit. We can assume that this proportion of fugitive emissions will be lowered in parts of the industry in the future.

It has to be highlighted that these values are average figures at a country level but are not representative of a particular installation. Primary measure 02 has been added to represent the case of countries going further than the regulation.

Table 5.1.1 : Primary measures

Primary Measure Code PMC	Description
00	Conventional heat set ink (content of 45 wt.-% mineral oils) and impregnation with isopropanol and solvent-based cleaning agents. Fugitive emission of 45% of input.
01	Conventional heat set ink (content of 45 wt.-% mineral oils) and reduced consumption of isopropanol and of cleaning agents with high flash points. Fugitive emissions of 30% of input
02	Conventional heat set ink (content of 45 wt.-% mineral oils) and reduced consumption of isopropanol and of cleaning agents with high flash points. Fugitive emissions of 25% of input

5.2 Definitions of secondary measures

Almost all installations around Europe are equipped with an incinerator. This device is placed on the dryer and solvents evaporating from the ink are treated.

Table 5.2.1 : Secondary measures

Secondary Measure Code SMC	Description
00	No secondary measure
01	Thermal incineration

5.3 Emission factors and costs data for the different combinations

Table 5.3.1 : Emission factors (EF) and abatement efficiencies for each relevant combination

RI PMC SMC	EF NMVOC [g / kg of ink]	Abatement efficiency [%]	Q	CI %
01 00 00	727,5	0	4	20
01 00 01	376,5	48,2	4	20
01 01 00	541	25,6	4	20
01 01 01	203	72,1	4	20
01 02 00	510	29,9	4	20
01 02 01	173,6	76,1	4	20
02 00 00	727,5	0	4	20
02 00 01	376,5	48,2	4	20
02 01 00	541	25,6	4	20
02 01 01	203	72,1	4	20
02 02 00	510	29,9	4	20
02 02 01	173,6	76,1	4	20
03 00 00	727,5	0	4	20
03 00 01	376,5	48,2	4	20
03 01 00	541	25,6	4	20
03 01 01	203	72,1	4	20
03 02 00	510	29,9	4	20
03 02 01	173,6	76,1	4	20
04 00 00	727,5	0	4	20
04 00 01	376,5	48,2	4	20
04 01 00	541	25,6	4	20
04 01 01	203	72,1	4	20
04 02 00	510	29,9	4	20
04 02 01	173,6	76,1	4	20

Q : Quality of data
CI : Coefficient of variation

Table 5.3.2 : Investments and operating costs

RI PMC SMC	Investment [€]	Q	CI %	Variable OC [€/y]	Q	CI %	Fixed OC [€/y]	Q	CI %

01 00 00	0	-	-	0	2	-	0	-	-
01 00 01	442 000	4	25	2 800	4	25	22 100	4	25
01 01 00	10 000	5	15	0	2	-	0	-	-
01 01 01	452 000	4	25	2 800	4	25	22 100	4	25
01 02 00	10 000	5	15	0	2	-	0	-	-
01 02 01	452 000	4	25	2 800	4	25	22 100	4	25
02 00 00	0	4	-	0	2	-	0	-	-
02 00 01	647 000	4	25	9 700	4	25	32 300	4	25
02 01 00	20 000	5	15	0	2	-	0	-	-
02 01 01	667 000	4	25	9 700	4	25	32 300	4	25
02 02 00	20 000	5	15	0	2	-	0	-	-
02 02 01	667 000	4	25	9 700	4	25	32 300	4	25
03 00 00	0	4	-	0	2	-	0	-	-
03 00 01	950 000	4	25	30 500	4	25	47 500	4	25
03 01 00	80 000	5	15	0	2	-	0	-	-
03 01 01	1 030 000	4	25	30 500	4	25	47 500	4	25
03 02 00	80 000	5	15	0	2	-	0	-	-
03 02 01	1 030 000	4	25	30 500	4	25	47 500	4	25
04 00 00	0	4	-	0	2	-	0	-	-
04 00 01	1 390 000	4	25	52 100	4	25	69 500	4	25
04 01 00	160 000	5	15	0	2	-	0	-	-
04 01 01	1 550 000	4	25	52 100	4	25	69 500	4	25
04 02 00	160 000	5	15	0	2	-	0	-	-
04 02 01	1 550 000	4	25	52 100	4	25	69 500	4	25

6 Data to be provided by national experts for the completion of the database for their own country

The following tasks are required :

6.1 Validation work

For representing costs in this sector, the national expert is invited to comment the methodology defined by the Secretariat.

- Validate investments provided, and
- Validate the method of derivation of operating costs.

Or

- Provide other costs for the same combination of techniques and justify them.

Comments have to be sent to the Secretariat in the two weeks after having received the document.

6.2 Provision of specific data

Tables to be filled in by national experts

- Determination of country specific data to calculate variable costs (they are valid for all VOC sectors and only have to be entered in the tool once).

Table 6.2.1 : Country-specific data

Parameters	Default values	Country specific costs
Electricity [€/kWh] (net of taxes)	0,0686	
Natural gas [€/kWh] (net of taxes)	0,0192	
Wages [€/h]	25,9	

- Respective shares (t ink/y) of the total activity level carried out on each reference installation in 2000, 2005, 2010, 2015, 2020. Some default values for the confidence interval are given. They can be used by the Party if no data are available.

Table 6.2.2 : Activity levels on Reference Installations (t ink / year)

RIC	2000	CI%	2005	CI%	2010	CI%	2015	CI%	2020	CI%
01										
02										
03										
04										
Default values for CI		10		20		50		100		100
Total	Calculated automatically by the tool									

For explanations on the coefficient of variation, please refer to the "Methodology".

- Total activity (t ink/y) has to be estimated from 2000 to 2020 and distributed according to the different installations.
- If no detailed information is available in 2000, total activity can be divided equally between all RI (i.e.: 25% for each one).
- If no prevision on the structure of this sector is available (for 2005 to 2020), the proportions used in 2000 can be used. But total activity (t/y) should evolve.

- Respective percentage of combinations of reduction measures in 2000 for each reference installation as well as if possible, the percentage of use in 2005, 2010, 2015, 2020 due to the VOC Directive or national regulations and applicability according to the definition used in the RAINS model.

Table 6.2.3 : Application and Applicability

RIC PMC SMC	Application rate in 2000 [%]	Application rate in 2005 [%]	Applicability [%]	Application rate in 2010 [%]	Applicability [%]	Application rate in 2015 [%]	Applicability [%]	Application rate in 2020 [%]	Applicability [%]
01 00 00									

01 00 01									
01 01 00									
01 01 01									
01 02 00									
01 02 01									
Total RIC 01	**100**	**100**		**100**		**100**		**100**	
02 00 00									
02 00 01									
02 01 00									
02 01 01									
02 02 00									
02 02 01									
Total RIC 02	**100**	**100**		**100**		**100**		**100**	
03 00 00									
03 00 01									
03 01 00									
03 01 01									
03 02 00									
03 02 01									
Total RIC 03	**100**	**100**		**100**		**100**		**100**	
04 00 00									
04 00 01									
04 01 00									
04 01 01									
04 02 00									
04 02 01									
Total RIC 04	**100**	**100**		**100**		**100**		**100**	

If detailed information is available, table 6.2.3 can be filled in.
If only sparse information is available, then table 6.2.3 can be filled in with the same "Application rates" for all RI (this corresponds to the filing of table 6.2.4).

Table 6.2.4 : Aggregated table (this table does not appear in the tool)

RIC PMC SMC	Application rate in 2000 [%]	Application rate in 2005 [%]	Applicability [%]	Application rate in 2010 [%]	Applicability [%]	Application rate in 2015 [%]	Applicability [%]	Application rate in 2020 [%]	Applicability [%]
Aggreg. 00 00									
Aggreg. 00 01									
Aggreg. 01 00									
Aggreg. 01 01									
Aggreg. 02 00									
Aggreg. 02 01									
Total aggreg.	**100**	**100**		**100**		**100**		**100**	

Aggreg. : Aggregation

Table 6.2.5 : Unabated emission factor [g / kg of ink]

Default data mean	CI %	User input mean	CI %
727,5	20		

The "default data mean" can be modified in a range of ± 10%.

If a measure is missing in the document, national experts have to contact the secretariat to add it in the background documents.

7 Explanatory notes

7.1 Solvent consumption factor (SCF)

According to data given in [4] the uncontrolled case has been defined as follows :

Table 7.1.1 : Solvent consumption factors (g solvent / kg of ink)

PMC	Mineral Oils Content [g solvent / kg ink]	Additional Consumption from Use of Isopropanol [g solvent / kg ink]	Additional Solvent Consumption from Solvent-based Cleaning Agents [g solvent / kg ink]	Solvent Consumption Factor [g solvent/kg ink]
00	425	300	100	825
01	425	167	100	692
02	425	150	100	675

7.2 Emission factors (EF)

- In installations without abatement devices, 1/3 of inks, all isopropanol and almost all cleaning agents are emitted into the air.
- In installations with abatement devices, only fugitive emissions occur. In this particular case, fugitive emissions depends on measures which have been implemented. Emission factors are calculated hereafter in table 7.2.1. We assume that all the evaporating ink and 10% of isopropanol are captured and treated with an efficiency of 97,5% (if we consider emission limits of 20 mg $C/Nm^3 \approx 40$ mg VOC/Nm^3 with average concentrations after the dryer around 1500 VOC/Nm^3). Cleaning agents used have different flash points and can be more easily collected for primary measures 01 and 02. 90% of isopropanol and the remaining share of cleaning agents evaporate as fugitive emissions.

Table 7.2.1 : Emission factors related to mass of ink for different abatement measures (g VOC / kg of ink)

PMC SMC	Ink [g / kg ink]	Isopropanol [g / kg ink]	Cleaning Agents [g / kg ink]	Total [g/kg ink]	Efficiency [%]
00 00	330	300	100×0,975=97,5	727,5	0
00 01	330×0,025=8,2	300×(0,025×0,1+0,9)=270,7	97,5	376,5	48,2
01 00	330	167	100×0,44=44	541	25,6
01 01	8,2	167×(0,025×0,1+0,9)=150,7	44	203	72,1
02 00	330	150	100×0,30=30	510	29,9
02 01	8,2	150×(0,025×0,1+0,9)=135,4	30	173,6	76,1

7.3 Fugitive emission determination

All VOCs evaporated from the ink are canalized. It is assumed that fugitive emissions represent 90% of isopropanol emissions (for PMC 00 it means 300 g/kg of ink × 0.9) and the part of cleaning agent which are not collected to be treated outside of the plant (for PMC 00, 97,5% of cleaning agents can not be captured).

This proportion of cleaning agents depends on two factors : the product's flash point and the use of press permitting to capture dirty cleaning agents.

To simplify this tricky issue, [3] proposed to use emission levels observed at a country level for the whole industry [5]. These values are average figures which can be relevant at an aggregated level.

Table 7.3.1 : Fugitive emission determination

PMC	Fugitive emissions [g/kg ink]	Fugitive emissions [% of solvent consumption]
00	300 × 0,9 + 100 × 0,975 = 367	367 × 100 / 825 = 44,5
01	167 × 0,9 + 100 × 0,44 = 194	194 × 100 / 692 = 28
02	150 × 0,9 + 100 × 0,3 = 165	165 × 100 / 675 = 24,5

These fugitive emission levels correspond to primary measure definitions.

7.4 Derivation of cost data

Primary measures

- For a reduction of isopropanol use, investments have to be done to update presses. Costs are derived from [4] and are presented in table 7.4.1.
- R&D costs (training of operators, product testing and adaptation of processes) also occur : these costs are substantial but they are not quantifiable.
- For variable operating costs : less isopropanol is used for PMC 01 and PMC 02. This product is usually replaced by other products more expensive. Furthermore, more labour is necessary (for maintenance and cleaning operations). Variable operating costs are believed to be positive [3] but can not be quantified. A figure of 0 €/y is taken into account.

Table : 7.4.1 : Investment for press update

	Small press	Large press
Investment (€)	10 000	20 000

Table 7.4.2 : Emission factors, investments, operating costs, abatement efficiencies, technical lifetime and uncertainties for primary measures

RIC PMC SMC	NMVOC Emission Factor [g / kg of ink]	Investment [€]	Variable OC [€/y]	Abatement efficiency [%]	Tech. Lifetime [y] *
01 00 00	727,5	0	0	0	10
01 01 00	541	10 000	0	25,6	10

01 02 00	510	10 000	0	29,9	10
02 00 00	727,5	0	0	0	10
02 01 00	541	20 000	0	25,6	10
02 02 00	510	20 000	0	29,9	10
03 00 00	727,5	0	0	0	10
03 01 00	541	80 000	0	25,6	10
03 02 00	510	80 000	0	29,9	10
04 00 00	727,5	0	0	0	10
04 01 00	541	160 000	0	25,6	10
04 02 00	510	160 000	0	29,9	10

* According to [3], the lifetime of a press is somewhere between 10 and 15 years. If adaptations have to be done on existing presses, the remaining lifetime of the adaptation will be limited to the remaining lifetime of the press. On average, a press lifetime of 10 years is taken into account.

Secondary Measures

Investments and operating costs for incineration are calculated with the model and depend directly on the flow rate and VOC concentration in the exhaust gas.
According to [4], press flow rates can vary between 5 000 and 10 000 m^3/h. According to [3], there is not a big difference between small and larger presses. A common average flow rate of 7 500 m^3/h has been taken for all presses.
Concentrations in heat set vary between 1 and 2 g of VOC / m^3.

Small reference installations : 1 600 h/y
Medium reference installations : 3 200 h/y
Large and very large reference installations : 4 800 h/y

Presses are in operation 80% of the time. They need to be made ready between jobs and need also to be cleaned during jobs (40% for small presses and 25% for large presses).

VOC concentrations are needed to calculate operating costs of secondary measures :

VOC concentration [g/m^3] = ([g COV / kg ink] × [kg ink/y]) / ([m^3/h] × [h/y])

Table 7.4.3 : VOC concentration calculations

RIC PMC SMC	Flow rate [m^3 / h]	Production time [h / y]	VOC conc. [g / m^3]
01 00 00	7 500	1 600×0,8×0,6 = 768	(727,5-376,5)×30 000/768/7500 = 1,8
01 01 00	7 500	768	(541-203)×30 000/768/7500 = 1,8
01 02 00	7 500	768	(510-173,6)×30 000/768/7500 = 1,8
02 00 00	15 000	3 200×0,8×0,6 = 1 536	(727,5-376,5)×100 000/1536/15000=1,5
02 01 00	15 000	1 536	(541-203)×100 000/1536/15000 = 1,5

02 02 00	15 000	1 536	(510-173,6)×100 000/1536/15000 = 1,5
03 00 00	30 000	4 800×0,8×0,75 = 2 880	(727,5-376,5)×400 000/2880/30000=1,6
03 01 00	30 000	2 880	(541-203)×400 000/2880/30000=1,6
03 02 00	30 000	2 880	(510-173,6)×400 000/2880/30000 = 1,6
04 00 00	60 000	4 800×0,8×0,75 = 2 880	(727,5-376,5)×1000000/2880/60000=2,0
04 01 00	60 000	2 880	(541-203)×1000000/2880/60000 = 2,0
04 02 00	60 000	2 880	(510-173,6)×1000000/2880/60000 = 2,0

According to [3], these are average concentrations. Many plants with not-so-modern dryers still suffer concentrations between 1 and 1,5 g/m^3. It is only with the most recent dryers that regenerative incineration (and autothermic operation) is possible today.

Investments and operating costs are based on the equations displayed in the document “Methodology”. Operating costs are country specific : figures in table 7.4.4 are displayed as examples).

Table 7.4.4 : Emission factors, investments, operating costs, abatement efficiencies, technical lifetime and uncertainties for secondary measures

RIC PMC SMC	NMVOC Emission Factor [g / kg of ink]	Investment [€]	Variable operating Costs [€/y]	Fixed operating Costs [€/y]	Tech. Lifetime [y]
01 00 01	376,5	442 000	2 800	22 100	10
01 01 01	203	442 000	2 800	22 100	10
01 02 01	173,6	442 000	2 800	22 100	10
02 00 01	376,5	647 000	9 700	32 300	10
02 01 01	203	647 000	9 700	32 300	10
02 02 01	173,6	647 000	9 700	32 300	10
03 00 01	376,5	950 000	30 500	47 500	10
03 01 01	203	950 000	30 500	47 500	10
03 02 01	173,6	950 000	30 500	47 500	10
04 00 01	376,5	1 390 000	52 100	69 500	10
04 01 01	203	1 390 000	52 100	69 500	10
04 02 01	173,6	1 390 000	52 100	69 500	10

8 References

[1] Task force on the assessment of abatement options and techniques for VOC from stationary sources. Draft background document – Prepared by IFARE for UN/ECE-May 1999

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[7] Regulatory and Environmental Impact Assessment for the Implementation of the EC Solvent Emissions Directive. Final Report. Entec UK Limited. 20 December 1999.

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9. Modifications compared to the draft document

No comment has been made on the draft document.