MANUFACTURE OF PAINTS, INKS AND GLUES

SYNOPSIS SHEET

Prepared in the framework of EGTEI

1. Activity description and EGTEI contribution - summary

This sector covers the manufacture of all types of paints, varnishes, stains as well as inks and adhesives. A wide number of products, formulated to meet a variety of service requirements, are available. These products are destined among others to aircrafts, automobiles, ships, wooden and metal furniture, packaging, textile fibres, domestic uses etc.
Only physical operations as weighing, mixing, grinding, tinting, thinning, and packaging take place; no chemical reactions are involved. These operations are carried out in large mixing tanks at approximately room temperature.

This activity emits NMVOC originating from solvent losses. Emission losses may arise from several steps in the process. Major emission sources are: fugitive losses during the manufacturing process, losses during filling and cleaning activities, losses from product clinging to the vessels and equipment and fugitive losses during mixing of preparations and storage of solvents.

NMVOC emissions from this sector may vary significantly from country to country according to the rate of use of the different techniques. At a EU25 level in 2000 (according to RAINS: version CP_CLE_Aug04(Nov04)), NMVOC emissions were 53.2 kt representing 0.50% of total NMVOC emissions. Total activity being 7,917.4 kt of products manufactured, average emission factor is about 6.7 kg NMVOC/tones of product meaning that emissions from this sector are already partly treated in EU25. These estimations could be modified in a near future due to information delivered by national experts during bilateral consultations in 2005 with CIAM.

Manufacture of coating preparations, varnishes, inks and adhesives is addressed by the European Directive 1999/13/EC (SED) [1] related to the reduction of NMVOC emissions from the use of solvents in some industrial activities. In order to be able to better represent the impact of this Directive in terms of emission reduction and costs, **it has been considered as an individual activity by EGTEI [2]**. This sector was not considered separately in the previous RAINS version [5] and **EGTEI has been able to develop a specific approach to estimate costs of reduction techniques**. The methodology was developed on data from the literature [3], [4]. Data provided by EGTEI (emission factors and costs) have been implemented in the new RAINS version for the modelling work carried out in the scope of the CAFÉ programme and the revision of the Gothenburg Protocol and national emission ceiling Directive.

The representative unit used is the amount of products (i.e. paints, inks and glues) manufactured annually (t/year). Two reference installations (RI) are defined according to the type of products manufactured (i.e. solvent or water-based products).

Two primary measures are considered based on the way the process is handled: “usual” practices where fugitive emissions are not contained and “good practices” where the process is covered to reduce losses.

Solvent recovery unit is the only secondary measure considered for this sector as solvents are raw materials which can be reused in the process.

EGTEI provides default emission factors (EF) with abatement efficiencies, investments and variable and fixed operating costs (OC) as well as unit costs (€/t NMVOC abated and €/activity unit) for all the combinations of measures according to the installation size.

The cheapest way of reducing NMVOC emissions is good practices which allows installations being in compliance with the Directive requirements. This can be explained because the uncontrolled case is an extreme situation where no solvent is recovered. When solvents are properly handled and reused, variable costs are reduced dramatically proportionally to NMVOC emissions.

National experts have to collect 3 country specific parameters (wages, electricity and steam costs) and 1 country and sector specific parameters (solvents recovered costs). The first ones can be very easily found. The second one can be defined with the help of national associations. EGTEI provides default costs for country and specific parameters which can be used if no better data exist. National experts have also to provide the activity trend from 2000 to 2020, the activity shares according to the different RI as well as the application and applicability rates of each abatement technique.

As the representation of this sector in RAINS [7] is now based on the EGTEI proposal, it is recommended to national experts to complete ECODAT with country specific parameters which are not known from CIAM.

In the future however, any new technology which could be developed should be considered by EGTEI in the background document to continuously improve the representation of the sector and the EGTEI capacity to describe new technologies. Cost parameters might also be continuously revised whenever it is justified.

2. European regulation

As mentioned above, the European Directive 99/13/EC [2] applies to this sector (annex IIA, n°17).

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

- by complying with the canalised and fugitive emission limit values,
- by introducing a reduction scheme to comply with total emission limit values defined as a percentage of solvent input.

The SED applies to installations with a solvent consumption above 100 t per year. Emission limit values defined in the SED are presented in table 2.1. All obligations are not described in this chapter.

Table 2.1: Emission limit values for coil coating

	Solution I		Solution II
Solvent consumption threshold [t/y]	**VOC emission limit value in residual gases [mg C / Nm^3]**	**Fugitive emissions % of solvent input***	**Total emission limit values % of solvent input***
100 – 1,000	150	5	5
> 1,000	150	3	3

* 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 used in the installations).

The strict respect of total emission limit values (as defined in table 2.1) leads to emission factors between 9.5 and 15.9 g VOC/kg product for the first reference installation (RIC01) and between 4.7 and 7.8 g VOC/kg product for the second reference installation (RIC02) for annual solvent consumptions above or under 1,000 tonnes respectively.

The compliance date for existing installations is October 30th, 2007. Following the transcription of the Directive in Member States, this date can be different from country to country. For example, in France, the compliance date is October 30th, 2005.

3. Methodology developed within EGTEI to represent the sector

3.1 Definition of reference installations

Two reference installations are described below according to their production output (expressed in tonnes of products / year) and their type of production (solvent or water-based products). Only products containing solvents are considered in the activity definition (powder and other types of products without solvents are not taken into account).

- Ø The type of production is considered because it influences greatly emission factors (kg COV / tonne of product).
- Ø Only medium installations are considered because the size does not significantly influence cost assessments. However, the size influences the type of abatement measure to be used (either primary or secondary) but this can be taken into account when defining the control strategy.

Table 3.1.1: Reference installations

Reference Installation Code RIC	Description	Technical characteristics
01	Medium Installation :product production : 15,000 tonnes/year Production mix : 45 % of water-based coatings (4 wt.-% average solvent content), 50 % high solvent-based coatings (50 wt.-% solvent content), 5 % other products (100 wt.% solvent content)	Full load hours: 4,000 h/y [NMVOC]: 1 g/m^3 Flow rate: 20,600 m^3/h Solvent input (I*): 4,770 t/y
02	Medium Installation :product production : 15,000 tonnes/year Production mix : 80 % water-based coatings (4 wt.-% average solvent content), 15 % high solvent-based coatings (50 wt.-% solvent content), 5 % other products (100 wt.% solvent content)	Full load hours: 4,000 h/y [NMVOC]: 1 g/m^3 Flow rate: 10,300 m^3/h Solvent input (I*): 2,355 t/y

* As mentioned in the Solvent Management Plan implemented by the SED [2], inputs of organic solvents (I) equal the quantity of organic solvents or their quantity in preparations purchased (I1) + the quantity of organic solvents recovered and reused as solvent input into the process (I2). In this sector, I = I1 because no solvent is recovered. All solvents consumed are assumed to be emitted when no add-on technique is used.

3.1.1 Definition of primary measures

According to USEPA [3], the overall average emission factor for this sector is 3.4% of the solvent input. Only primary measures based on good practices are taken into account since emissions are presently low. These measures are:

- Ø Recovery of solvent vapours during raw material distribution,
- Ø Unloading of the barrels with fork lifts to avoid leakages,
- Ø Coverage of mobile reactors,
- Ø Use of heavier solvents to reduce fugitive emissions,
- Ø Use of cleaning agents containing less solvents,
- Ø Use of automatic cleaning devices whenever possible,
- Ø Recycling of cleaning solutions…

Table 3.1.1.1: Primary measures

Primary Measure Code PMC	Description
00	• Usual practices
01	• Good practices

PMC 01 allows installations being in compliance with the SED requirements (this corresponds to total emissions representing 2.5% of solvent input).

3.1.2 Definition of secondary measures

Secondary measures are either carbon adsorption or condensation to recycle solvents lost. Conditions are not optimal for thermal oxidation: many vents have to be treated leading to high flow rates with low VOC concentrations. In addition, solvents are raw materials which can be reused into the process: oxidation is not considered in EGTEI.

Table 3.1.2.1: Secondary measures

Secondary Measure Code SMC	Description
00	No secondary measure
01	Upgrading of the condensation units or carbon adsorption and solvent recovery

SMC 01 allows installations being in compliance with the SED requirements (this corresponds to total emissions representing 1.75% of solvent input).

4. Country specific data to be collected

Different types of country specific data have to be collected to give a clear picture of the situation in each Party. EGTEI proposes default values for the economical parameters which can be modified by the national expert if better data are available.

For this activity as for all NMVOC sectors, country specific economical parameters are used to calculate variable operating costs. They are presented in table 4.1 as the default costs proposed by EGTEI (these costs are entered only once in ECODAT).

Table 4.1: Country specific costs

Parameters	Default costs provided by EGTEI	Country specific costs
Electricity [€/kWh] (net of taxes)	0.0686	To be provided by national experts
Steam [€/kg] (net of taxes)	0.016	To be provided by national experts
Wages [€/h]	25.9	To be provided by national experts

For this sector, an additional country and sector specific parameter is necessary to calculate variable operating costs. It corresponds to the cost of solvents recovered in the process. A default figure is given in table 4.2.

Table 4.2: Country and sector specific economic parameter

Parameter	Default cost provided by EGTEI [€/kg]	Country and sector specific cost [€/kg]
Solvent recovered [€/kg] (net of taxes)	1.0	To be provided by national experts

The best source of information for the determination of solvent cost is the national association.

Default data are used to calculate variable and annual abatement costs presented in table 5.1.

Information concerning activity levels from 2000 to 2020 as well as the description of the control strategy is also necessary (these data can be directly entered in the database ECODAT). A full definition of the work to be done by national experts is provided in the general EGTEI methodology [9].

In this sector, emission factors are dependant on the type of products being manufactured. Two emission factors are defined according to the reference installation considered. National experts can modify these default unabated emission factors proposed by EGTEI to represent the reference situation for all Parties, in a range of ± 10%. If the modification is higher than 10%, then appropriate explanations are required.

Table 4.3: Unabated emission factors [kg of NMVOC / t of product containing solvents]

Default emission factor	User specific emission factor
11 (for RIC 01)	To be provided by national expert
5.5 (for RIC 02)	To be provided by national expert

5. Default emission factors and cost data defined with the EGTEI methodology

Table 5.1 gives an overview of all data provided by EGTEI for this sector: default emission factors (EF) with abatement efficiencies, investments, and variable and fixed operating costs (OC) as well as unit costs (per t NMVOC abated and per unit of activity).

Variable costs account for electricity, steam and labour used for secondary measures and savings from solvent recovery. Fixed operating costs are only considered for secondary measures and correspond to 5% of the recovery section (for maintenance and insurance). As no data are available, it is assumed that fixed operating costs are the same for all primary measures so no additional costs are taken into account (that is why fixed operating costs appear as 0 costs in table 5.1).

Table 5.1: Default emission factors (EF), abatement efficiencies and costs for each combination

RIC PMC SMC	NMVOC EF [kg NMVOC / t product]	Abatement efficiency [%]	Investment [k€]	Variable OC [k€ / year]	Fixed OC [k€/y]	Unit cost [€/t NMVOC abated]	Unit cost [€/t product]
01 00 00	11.0	0.0	0	0.0	0	0	0
01 01 00	8.0	27.3	415	-45.0	0	-171	-0.51
01 00 01	5.5	50.0	1,400	-64.5	70	2,159	11.87
02 00 00	5.5	0.0	0	0.0	0	0	0
02 01 00	4.0	27.3	415	-22.5	0	659	0.99
02 00 01	2.75	50.0	710	-30.0	35	2,245	6.17

Unit costs [€/t of NMVOC abated] are obtained by dividing the annual total additional cost of a measure by the amount of NMVOC abated (costs and emissions are compared to the uncontrolled measure PMC 00/SMC 00).

As shown in table 5.1, the cheapest way of reducing NMVOC emissions is the good practices because solvents can be directly reused in the process with rather low investments. The use of a secondary measure is higher. Investments are derived from reference [4] proportionally to the amount of VOC abated. For reference installation 02, air volumes to be treated are lower than for RIC01 so the investment is also much lower.

6. Relevance of EGTEI information for Integrated Assessment Modelling (IAM)

In the previous RAINS version [5], the manufacture of paints, inks and glues was studied together with other sector such as asphalt blowing. Techniques considered were basic emission management, reformulation of the products, secondary measures such as thermal oxidation and combinations of these measures.

In the EGTEI document, the type of product manufactured (reformulation) is now taken into account in the definition of the reference installation and thermal oxidation is not considered as a viable option for this sector.

EGTEI provides a specific approach to test the impact of the current legislation as well as the maximum achievable reduction scenario.

Data provided by EGTEI (emission factors and costs) have been implemented in the new RAINS version [7] for the modelling work carried out in the scope of the CAFÉ programme and the revision of the Gothenburg protocol. For this activity, data provided by national experts through ECODAT can then be directly used by CIAM for introduction in the RAINS model.

7. Perspective for the future

In the future, any new technology which could be developed should be considered by EGTEI in the background document to continuously improve the representation of the sector. Costs should also be reviewed regularly on the basis of new available information as this information was pretty scarce.

8. Bibliography

[1] Council Directive 1999/13/EC of 11 March 1999 on the limitation of emissions of volatile organic compounds due to the use of organic solvents in certain activities and installations.
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[9] Methodology: http://citepa.org/forums/egtei/egtei_index.htm
[10] CITEPA: National reference centre for emission inventories
[11] FIPEC: French federation of paint, ink and adhesive industries

ANNEXE: Example of data collection and use of EGTEI data – Case of France

A. Country specific data collection and scenario CLE developed

The French national expert has been able to complete ECODAT for this sector with the help of CITEPA [10].

All data have been provided to CIAM for the bilateral consultation France – CIAM in March 2004.

Country and sector specific economic parameters

Country specific parameter costs have been defined from costs encountered in the medium size industry which are monthly published by official French statistic organisations.

Table A.1: French specific costs

Parameters	French specific costs
Electricity [€/kWh] (net of taxes)	0.05
Steam [€/kg] (net of taxes)	0.0131
Wages [€/h]	23.4

As no better solvent cost is available, the default one is used for describing the French situation.

Table A.2: French and sector specific data (net of taxes)

Parameter	Default cost [€/kg]	French and sector specific cost [€/kg]
Solvent recovered	1.0	1.0

Activity level

The activity forecast from 2000 to 2020 comes from data developed by the French expert: it is based on the added value trend between 1995 and 2001 for the branch “chemistry, rubber and plastics” which corresponds to an annual increase of 4.29% between 2000 and 2020. Activity in 2000 is derived from annual statistics delivered by the French association FIPEC [11]. Respective shares (kt products/y) of total activity level carried out on each reference installation from 2000 to 2020 are derived from NMVOC emissions defined in 2000 in the French inventory. RIC02 share is assumed to evolve with time (i.e. from 14.6% in 2000 to 70% in 2020) because of the water-based product production increase.

Table A.3: Activity levels on Reference Installations (kt of products containing solvents / year)

RIC	2000	2005	2010	2015	2020
01	903.6	913.7	805.2	596.0	735.3
02	154.5	391.6	805.2	1,390.7	1,715.7
Total (kt)	1,058.0	1,305.3	1,610.4	1,986.7	2,451.0

Current legislation control scenario (CLE)

In the current legislation control scenario (CLE), the application rates of the different abatement techniques depend on the regulation implemented and on the compliance dates.

In 2000, the rates of use of the different reduction techniques are estimated according to the total emissions defined in the scope of the French emission inventory [10] (carried out for the French ministry of Ecology). It is assumed that no measure is implemented.

In 2005, only 50% of the activity is assumed to be treated with PMC 01 to respect the total emission limit value of 3%. The remaining activity share complies already with the 5% emission limit required for installations consuming less than 1,000 tonnes of solvents per year. From 2010 to 2020, all installations will be equipped with good practices as processes are replaced.

The application rates and applicability factors for the CLE scenario are presented in table A.4.

Table A.4: Definitions of the CLE scenario

RIC PMC SMC	Application rate in 2000 [%]	Application rate in 2005 [%]	Appl. [%]	Application rate in 2010 [%]	Appl. [%]	Application rate in 2015 [%]	Appl. [%]	Application rate in 2020 [%]	Appl. [%]
01 00 00	100	50	100	0	100	0	100	0	100
01 01 00	0	50	100	100	100	100	100	100	100
01 00 01	0	0	100	0	100	0	100	0	100
Total RIC 01	**100**	**100**	**-**	**100**	**-**	**100**	**-**	**100**	**-**
02 00 00	100	50	100	0	100	0	100	0	100
02 01 00	0	50	100	100	100	100	100	100	100
02 00 01	0	0	100	0	100	0	100	0	100
Total RIC 02	**100**	**100**	**-**	**100**	**-**	**100**	**-**	**100**	**-**

Appl.: applicability factor

B. Trends in emissions and total costs of the CLE scenario

Data shown in the table below are directly provided by ECODAT and based on input parameters defined in chapter A.

Table B.1 presents NMVOC emissions from 2000 to 2020 and total annual costs of emissions reduction for the CLE scenario.

Table B.1: Trends in emissions and total annual costs of emission reductions in the CLE scenario

	2000	2005	2010	2015	2020
NMVOC emissions	**t NMVOC**	**t NMVOC**	**t NMVOC**	**t NMVOC**	**t NMVOC**
CLE scenario	10,789	10,540	9,662	10,331	12,745
Annual total costs	**k€/year**	**k€/year**	**k€/year**	**k€/year**	**k€/year**
CLE scenario	0	-40	384	1,070	1,320

Emissions shown in table B.1 for the year 2000 according to the CLE scenario have been calculated with EGTEI emission factors. Emissions defined in the French inventory for the year 2000 are about 10 kt of VOC which is close enough from EGTEI data.