Final Background Document
on the sector

Leather coating

Prepared in the framework of EGTEI

Prepared by CITEPA, Paris

Summary

Sector : Leather Coating

SNAP 06 03 13 or NFR 3 A Paint application

ACTIVITY : consumption of coatings (tonnes / year)
POLLUTANT CONSIDERED : VOC

This document has been reviewed in cooperation with the European and Italian Leather Industry Associations (COTANCE & UNIC) [5], [7].

1 Data from the bibliography

Following data are displayed for comparison reasons

1.1 Data currently used in the RAINS model [1], [2]

In the RAINS model, leather coating is not considered as a separated sector. This sub-sector is studied as a part of "Industrial Use of Paints in Other Industrial Use of Paints". This sector encompasses the ship building industry, manufacture of plastic and metal articles, wood products industry.

1.1.1 Control options

In RAINS, the following groups of control options are considered :

- NoC : Reference case.
- HAM : Package of good housekeeping and other primary measures (solvent management plans, modification of spray application techniques to improve transfer efficiency) (applicability 40-45%; reduction efficiency : around 65%).
- SUB : Substitution with alternative coatings (applicability : 80%; reduction efficiency : 77 to 88% depending of solvent contents of alternative coating).
- A_INC : Add-on techniques : thermal and catalytic incineration (application potential is limited; reduction efficiency : 95%). Activated carbon adsorption and biological bed are not currently studied.

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 : 194,954 kt paint used; 2010 : 220,688 kt paint used, **VOC emission scenario business as usual :** 1990 : 83,32 kt VOC; 2010 : 50,27 kt VOC.					
Measure	**Emission factor [kt VOC / kt of paint]**	**Efficiency [%]**	**Technical Eff, [%]**	**Applicability [%]**	**Unit cost [€$_{1990}$/t VOC]**
NoC	0,6311	0	0	0	0
HAM	0,4334	31	67	47	56
SUB	0,3555	44	87	50	902
A_INC	0,2414	62	95	65	2 068
HAM+SUB	0,3305	48	48	100	863
HAM+A_INC	0,2315	63	63	100	2 044
HAM+A_INC-SUB	0,1396	78	78	100	1 771

Table 1.1.2.2 : German situation (Old Laender)

Activity level 1990 : 350,000 kt paint used; 2010 : 398,475 kt paint used, **VOC emission scenario business as usual :** 1990 : 211,76 kt VOC; 2010 : 107,61 kt VOC.					
Measure	**Emission factor [kt VOC / kt of paint]**	**Efficiency [%]**	**Technical Eff, [%]**	**Applicability [%]**	**Unit cost [€$_{1990}$/t VOC]**
NoC	0,7200	0	0	0	0
HAM	0,5040	30	68	44	-136
SUB	0,2144	70	88	80	791
A_INC	0,2754	62	95	65	1 812
HAM+SUB	0,1880	74	74	100	6 97
HAM+A_INC	0,2646	63	63	100	1 705
HAM+A_INC-SUB	0,1698	76	76	100	1 630

Table 1.1.2.3 : German situation (New Laender)

Activity level 1990 : 69,000 kt paint used; 2010 : 78,557 kt paint used, **VOC emission scenario business as usual :** 1990 : 49,68 kt VOC; 2010 : 29,09 kt VOC.					
Measure	**Emission factor [kt VOC / kt of paint]**	**Efficiency [%]**	**Technical Eff, [%]**	**Applicability [%]**	**Unit cost [€$_{1990}$/t VOC]**
NoC	0,7200	0	0	0	0
HAM	0,5040	30	68	44	-136
SUB	0,2144	70	88	80	791
A_INC	0,2754	62	95	65	1 812
HAM+SUB	0,1880	74	74	100	6 97
HAM+A_INC	0,2646	63	63	100	1 705
HAM+A_INC-SUB	0,1698	76	76	100	1 630

Table 1.1.2.4 : Hungarian situation

Activity level 1990 : 3,542 kt paint used; 2010 : 3,925 kt paint used, **VOC emission scenario business as usual :** 1990 : 2,36 kt VOC; 2010 : 2,60 kt VOC.					
Measure	**Emission factor [kt VOC / kt of paint]**	**Efficiency [%]**	**Technical Eff, [%]**	**Applicability [%]**	**Unit cost [€$_{1990}$/t VOC]**
NoC	0,7288	0	0	0	0
HAM	0,5047	31	68	45	27
SUB	0,2190	70	87	80	773
A_INC	0,2787	62	95	65	1 791
HAM+SUB	0,1908	74	74	100	744
HAM+A_INC	0,2675	63	63	100	1 760
HAM+A_INC-SUB	0,1720	76	76	100	1 664

1.2 Situation in Finland [3]

According to [3], emissions into the air from tanneries are not considered significant. Tanneries in Finland do not focus on off-gas treatment and their VOC emissions are not monitored due to the fact that Finnish tanneries use non-solvent-based finishing chemicals.

2 Short technology description [4]

2.1 Structure of the European leather industry (year 1996)

		Production (1 000 m²)	
Country	**Number of tanneries**	**Cattle/calf**	**Sheep/goat**
Austria	7	5 011	
Belgium	7	1 226	1 000
Denmark	3	1 300	
France	113	6 600	5 700
Finland	9	1 841	
Germany	37	10 600	200
Greece	150	2 100	2 500
Ireland	4	4 000	250
Italy	2400	155 500	39 000
Netherlands	14	3 617	
Norway	3	1 100	40
Portugal	100	9 700	980
Spain	255	25 200	21 965
Sweden *	5	2 200	22
Switzerland	4	5 440	88
United Kingdom	55	10 000	3 500

* Also 200 000 m² from elk and reindeer is produced.

According to COTANCE [7], a portion of production presented in above are not coated : this is the case for suede, nubuck, leather vegetable tanned (leather for soles or for luxury leather goods) or tanned with their hair or wool on (as in the case of double-face).

COTANCE estimates that 30% of the European leather production (including cattle / calf and sheep / goat production) are finished in a way that does not require any coating. There might be slight deviations from that rate at national levels but this can be chosen as a European standard if no better national statistics exist.

2.2 Techniques used

The production process in a tannery can be split into four main categories : hide and skin storage and beam house operation, tanyard operations, post-tanning operations and finishing operations.
VOC are emitted during the finishing process. Finishing operations include several mechanical treatments as well as the application of a surface coat. The selection of finishing processes depends on the specifications of the final product. Water-based systems are increasingly favoured.
According to [5], if the article required has a medium or low level, it is possible to use a water based solution. If the article needs a high quality, a very soft hand and a very fine grain, solvent based products need to be used.

The purpose of applying a surface coat is to provide protection from contaminants (i.e. water, oil, soiling), to provide colour, to provide modifications to handle and gloss performance, to provide attractive fashion or fancy effects, to meet other customer requirements.
The following types of application methods can be distinguished :

- ✓ Padding or brushing the finishing mix onto the leather surface,
- ✓ Spray coating, which involve spraying the finishing material with pressurised air in spray cabinets,
- ✓ Curtain coating, which is passing the leather through a curtain of finishing material,
- ✓ Roller coating, which is an application of finishing mix through roller, transfer coating, which is the transfer of a film/foil onto leather previously treated with an adhesive.

3 EU regulation : Directive 1999/13/EC of 11 March 1999 [6]

Operators concerned can conform to the Directive by complying with the total emission limit value.

Directive applies to installations with a solvent consumption higher than 10 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 / year]	Total emissions [g VOC / m² of leather produced]
10 - 25	85
> 25	75
> 10 *	150

* For leather used in furnishing, or for small products such as bags, belts, wallets…

Requirements of the Directive are not all described in this chapter.

4 Definition of Reference Installations

To simplify the document, only one reference installation is defined. As emission factors expressed in g VOC/m² differ significantly from one installation to another, the reference installation is defined according to the quantity of coatings consumed per year (tonnes of coatings / year). This approach gives more flexibility to national experts.

Table 4.1 : Reference installations

Reference Installation Code RIC	Description
01	Medium installation : 40 tonnes / year

5 Emission abatement techniques and costs

5.1 Definition of primary measures

5.1.1 Measures currently available

According to [4], in the finishing process, water-based systems are increasingly favoured because of environmental concerns about organic solvents and in order to comply with regulations.
Base coats are generally water-based. If very high standards of topcoat are required, then solvent-based systems cannot always be substituted by aqueous-based systems.
In order to achieve equal characteristics with low-organic solvent and water-based systems, cross-linking agents for the finishing polymers often have to be used. The toxicity of these agents is problematic, but commercial products offer the agents in a less toxic and less volatile form. Nevertheless, special measures have to be taken to prevent accidents in handling and applying these agents.

Table 5.1.1.1 : Primary measures

Primary Measure Code PMC	Description
00	Use of solvent based products (85 wt. % solvent content)
01	Use of water based products (30 wt. % solvent content)

5.1.2 Emerging techniques [4]

- ✓ Powder coating is generally seen as unsuitable for leather because leather cannot withstand the high temperatures in the stove and because the methods for applying the powder are not applicable for leather, which is neither electrically conductive nor a good conductor of heat. However, low temperature formulations are becoming available, and some research is being carried out to develop the technique for the leather industry.
- ✓ Solvent-free finishing : top coat formulations which are completely free of organic solvents are not yet widely available or being used for upholstery leather for automotive and furniture used. A problem associated with solvent-free finishes is that the finish may form droplets on the leather due to its poor flow properties. A number of technologies are emerging allowing for a (near) elimination of solvents in urethane dispersions and acrylic emulsions.

5.2 Definition of secondary measures

According to [5] when solvent based products need to be used, a treatment system of emissions is needed.
Thermal oxidisers might be too expensive for small tanneries. Biological treatment can be an alternative. These methods can give good abatement efficiencies only if a maximum of emission sources are collected and routed to the treatment device.

Table 5.2.1 : Secondary measures

Secondary Measure Code SMC	Description
00	No secondary measure
01	Thermal oxidation
02	Biofiltration

5.3 Emission factors and costs data for the different combinations

The combination PMC 02 (water based products) – SMC 01 or 02 are not considered because they seem unrealistic.

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

RIC PMC SMC	VOC emission factor [t VOC / t coating]	Abatement efficiency [%]	Q	CI %
01 00 00	1,02	0	3	30
01 00 01	0,19	81,4	3	30
01 00 02	0,19	81,4	3	30
01 01 00	0,36	64,7	3	30

Q : quality of the data
CI : coefficient of variation (%)

Table5.3.2 : Investments and operating costs

RIC PMC SMC	Investment [€]	Q	CI %	Variable OC [€ / year]	Fixed OC [€ / year]	Q	CI %
01 00 00	0	-	-	0	-	-	-
01 00 01	600 000	4	25	10 650	30 000	4	25
01 00 02	170 000	4	25	8 000	8 500	4	25
01 01 00	0	4	-	0	-	4	-

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 and operating costs provided,

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	Costs used in the tool	Costs
Electricity [€/kWh]	0,0686	
Natural gas [€/kWh]	0,0192	
Wages [€/h]	25,9	

- Total activity level carried out 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 : Total activity levels in absolute value (tonnes of coatings consumed / y)

RIC	2000	CI%	2005	CI%	2010	CI%	2015	CI%	2020	CI%
01										
Default values proposed for CI		10		20		50		100		100

If only national productions of leather coated are available in the statistics, consumption of coatings can be assumed from these figures.

It has to be reminded that only a part of the leather production is coated. According to COTANCE [7], 30% of the European production do not need any coating as defined in chapter 2.1.

For explanations on the coefficient of variation (CI), please refer to the Methodology.

- 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 rate and Applicability

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									
01 00 01									
01 00 02									
01 01 00									
Total RIC 01	**100**	**100**		**100**		**100**		**100**	

Table 6.2.4 : Unabated emission factor [t VOC / tonne of coating sued]

PMC SMC	Default data mean	CI %	User input mean	CI %
00 00	1,02	30		

"Default data means" 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 Consumption factors

According to [4], organic solvent content in finishing systems are the following :

Table 7.1.1 : Organic solvent content in finishing systems

Finishing system	Organic solvent content [%]
Organic solvent thinnable lacquer	80-90
Water thinnable lacquer emulsion	40
Water-based system	5-8

In average, organic solvent contents of 85% are used for solvent based products and 30% for water based products.
The consumption of cleaning solvents has been derived from real examples [8]. These solvents represent 20% of the solvents of the products.

Table 7.1.2 : Consumption factors (CF)

RIC PMC SMC	Coating [t/y]	Solvents [t/y]	Cleaning solvents [t/y]	Solvent CF [t solvent / t of coating used]
01 00 00	40	40 × 0,85 = 34	34 × 0,2 = 6,8	(34 + 6,8) / 40 = 1,02
01 01 00	40	40 × 0,30 = 12	12 × 0,2 = 2,4	(12 + 2,4) / 40 = 0,36

7.2 Emission factors (EF)

- ✓ In installations where the application and drying process are not enclosed and without secondary abatement devices, all the solvent used is emitted into the air.
- ✓ In installations with secondary abatement devices, only fugitive emissions occur (i.e.10% of emissions are uncontained). An abatement efficiency of 90% is assumed.

Table 7.2.1 : Emission factors (EF)

PMC SMC	Solvent CF [t / t of coating used]	VOC EF [t VOC / t of coating used]	Abatement efficiency [%]
00 00	1,02	1,02	0,0
00 01	1,02	1,02 × (0,9 × 0,1 + 0,1) = 0,19	81,4
00 02	1,02	1,02× (0,9 × 0,1 + 0,1) = 0,19	81,4
01 00	0,36	0,36	64,7

7.2 Derivation of cost data

Primary measures

According to [5], costs of water finishing and solvent finishing products are comparable and their application do not need any change in the production system. The choice is a consequence of the market and the customers request.

No difference in costs is considered for primary measures

Secondary measure

Two types of abatement techniques can be used : incineration or biofiltration. Adsoprtion is not suitable for this sector because a large range of solvents among which ketones is used. It wouldn't be easy to distillate the solvents for recycling and ketones may lead to carbon ignition.

According to [4] (p.38), untreated organic solvent emissions from finishing process can vary between 800 and 3 500 mg/m^3 in conventional processes. 50% of emissions arise from spray-finishing machines, 50% from dryers.
The following assumptions on annual working time and on VOC concentrations in the waste gas streams have been made :

Medium reference installations : 1 840 h / y
VOC-concentration is assumed to be 1,5 **g / m^3** in average in the gas stream.

Gas flow rates are calculated thanks to the previous figures assuming that 90% of the total VOC-emissions are captured.

0,9 × capacity [t coating/y] × EF [g VOC/ t coating] / (VOC conc. [g/m^3] × production time [h/y])

Investments and operating costs are based on the equations displayed in the document "Methodology". Operating costs are country specific : figures in table 7.2.3 are displayed as examples.

Table 7.2.1 : Flow rate calculations

RIC PMC SMC	Calculations	Flow rate [m^3/h]
01 00 01	0,9 × (40 × 1 020 000) / (1,5 × 1 840)	13 300
01 00 02	0,9 × (40 × 1 020 000) / (1,5 × 1 840)	13 300

Table 7.2.3 : Emission factors, flow rates, investments, operating costs and technical lifetime for secondary measures

RIC PMC SMC	Flow rate [m^3 / h]	Investment [€]	Fixed OC [€ / year]	Variable OC [€ / year]	Tech. Lifetime [year]
01 00 01	13 300	600 000	30 000	10 650	10
01 00 02	13 300	170 000	8 500	8 000	10

8 References

[1] Z. KLIMONT; M. AMANN; J. COFALA. Estimating costs for Controlling Emissions of Volatile Organic Compounds (VOC) from Stationary Sources in Europe. Interim Report IR-00-51. IIASA. August 1, 2000. http://www.iiasa.ac.at/~rains/voc_review/voc_ir-00-51.pdf

[2] Review of data used in RAINS-VOC model. http://www.iiasa.ac.at/~rains/voc_review/single.html

[3] V KUSTULA, H. SALO, A. WITICK, P. KAUNISMAA. The Finnish Background Report for the EC documentation of best Available Techniques for Tanning industry. Finnish environment institute. Report n°426. Helsinki 2000.

[4] Integrated pollution Prevention and Control (IPPC). Reference Document on Best Available Techniques for the tanning of Hides and Skins. May 2001. http://eippcb.jrc.es/pages/BActivities.htm

[5] Personal communication from UNIC : Italian association of the leather industry. May 2003. http://www.unic.it

[6] 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.

[7] Personal communications from COTANCE : European association of the leather industry. 2003.

[8] N. ALLEMAND, R. BOUSCAREN, N. AVCI, T. ZUNDEL. Impact économique de la directive européenne sur la limitation des émissions de COV en provenance de l'utilisation des solvants en France. Tome II. Février 2000.