Final Background Document
on the sector

Dry Cleaning

Prepared in the framework of EGTEI

Prepared by CITEPA, Paris

Summary

1. Data from the bibliography (p.3)

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

2. Short technology description (p.6)

3. EU regulation : Directive 1999/13/EC of 11 march 1999 (p.7)

4. Definition of Reference Installations (p.7)

Two reference installations are defined according to the annual quantity of textiles cleaned (t textiles cleaned/y).

5. Emission abatement techniques and costs (p.7)

Five primary and one 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. These costs are entered only once in the database.

6. Data to be provided by national experts for the completion of the database for their own country (p.10)

Tables to be filled in by national experts are displayed :
Table 6.2.1 : Country specific data (Perchloroethylene, hydrocarbons, water).
Table 6.2.2 : Activity levels of Reference Installations. Consumptions of solvent (t/y) in each type of reference installation (RI) is required.

- Total activity (t solvent/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%.
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 (p.13)

Explanations about the figures are given in this paragraph. Investments and operating costs of primary and secondary measures have been provided by industrial experts.

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Sector : Dry Cleaning

SNAP 06 02 02 or NFR 3 B

This sector covers dry cleaning of textiles, leather and furs. Dry cleaning involves the cleaning of fabrics with non-aqueous organic solvents.

<u>ACTIVITY</u> : tonnes of textiles cleaned (t / year)
<u>POLLUTANT CONSIDERED</u> : NMVOC

1 Data from the bibliography

1.1. Data currently used in the RAINS model [3] [9]

RAINS category "surface cleaning" included in "solvent use" takes into account two sectors : dry cleaning and degreasing of textiles or garnements.
For dry cleaning, two types of machines are distinguished : machines with open and closed cicuit. Open-circuit machines are regarded as uncontrolled technology. The closed-circuit machines can be subdivided into conventional and new generation types. The conventional type has internal refrigerated condensers.
The activity level is represented by the quantity of textiles cleaned [3]

1.1.1. Control options

Based on information provided in several studies [3], RAINS distinguishes three control options for dry cleaning :

- Activated carbon adsorption and good housekeeping, applicable to existing open-circuit machines. The technical efficiency assumed is 60 %.
- Conventional closed-circuit machines. The technical efficiency assumed is 76 %.
- New generation closed-circuit systems. A technical efficiency of around 90% is taken into account.

Existing and new installations are treated separately with appropriate emission factor and unit cost.

1.1.2. Abatement measure costs

Costs of the combination of techniques range from 500 to 4500 € $_{1990}$ / t VOC non-emitted.

Examples for three countries are displayed :

No comments are made on the figures displayed bellow because no further information is available. Data at a county level are downloadable on
http://www.iiasa.ac.at/~rains/voc_review/single.html

Table 1.1.2.1 : Abatement costs taken into account in the RAINS model

	Emission factors g VOC/kg textiles cleaned	Applicability %	Technical efficiency %	Cost € 1990/t VOC
France: activity level existing installations : 1990: 170 895 t textiles, 2010 : - new installations : 1990 : - , 2010: 188 395 t textiles; **VOC emissions scenario business as usual**: existing installations : 1990: 13 240 t, 2010 : - new installations : 1990 : - , 2010: 4 140 t				
EXISTING				
No control	125	0	0	0
Good housekeeping and adsorption	50	100	60	583
Conventional closed-circuit machine	30	100	76	528
New generation closed-circuit machine	10	100	92	1210
NEW INSTALLATIONS				
No control	30	0	0	0
Conventional closed-circuit machine - Existing	30	100	0	/
New generation closed-circuit machine	10	100	67	4448
Germany (New and Old Laenders) : activity level existing installations : 1990: 298 000 t textiles, 2010 : 3 450 t textiles new installations : 1990 : - , 2010: 324 510 t textiles; **VOC emissions scenario business as usual**: existing installations : 1990: 30 380 t, 2010 : 100 t new installations : 1990 : - , 2010: 7 140 t				
EXISTING				
No control	125	0	0	0
Good housekeeping and adsorption	50	100	60	583
Conventional closed-circuit machine	30	100	76	528
New generation closed-circuit machine	10	100	92	1210
NEW INSTALLATIONS				
No control	30	0	0	0
Conventional closed-circuit machine - Existing	30	100	0	/
New generation closed-circuit machine	10	100	67	4448

Hungary : activity level : existing installations : 1990: 4 061 t textiles, 2010 : 4061 t textiles new installations : 1990 : - , 2010: 4 061 t textiles; **VOC emissions scenario business as usual**: existing installation : 1990: 510 t, 2010 : 510 t new installation : 1990 : - , 2010: 200 t				
EXISTING				
No control	125	0	0	0
Good housekeeping and adsorption	50	100	60	583
Conventional closed-circuit machine	31.3	100	75	546
New generation closed-circuit machine	10	100	92	1210
NEW INSTALLATIONS				
No control	50	0	0	0
Conventional closed-circuit machine - Existing	31.3	100	38	2932
New generation closed-circuit machine	10	100	80	1824

Investments and operating costs are no more detailed in the current documents. According to information received from IIASA, costs have been mainly derived from study [10].

1.2. Situation in the UK [6]

Two basic types of dry cleaning machine are used : open-circuit machines and closed-circuit machines. The newer closed circuit machines incorporate integral refrigerated condensers. Open-circuit machines are gradually being replaced by closed-circuit machines in most dry cleaning shops, small and large. Both types of machine can be fitted with carbon recovery units, although this is not often an economically viable option for controlling solvent emissions. There is an increasing number of hydrocarbon machines being sold, which do not use chlorinated solvents but hydrocarbons.

According to [6], closed-circuit machines emit roughly 10 g solvent/kg textiles cleaned, compared to around 80 g for an open-circuit machine (these figures include contained solvents in waste products taken away for disposal or recycling, which are excluded from the 20 g /kg limit in the Directive).
In UK, the industry is in the course of changing over to closed-circuit machines or hydrocarbon machines for commercial reasons largely due to lower overall operating costs but also because of improved reliability. Although closed-circuit machines have slightly higher energy consumption and longer operating cycles, significant savings are achieved in solvent usage which provides a substantial pay-back in relation to investing in a reconditioned open-circuit machine.

The cost of a new closed-circuit machine is around 34 500 – 37 500 € for a 11 and 18 kg load machine. Operating costs, taking into account solvent consumption, energy and water and residue disposal are about 40% lower per load for a closed-circuit machine than for an open-circuit machine.

The cost of a carbon recovery unit is between 5250 and 6000 € for a 11 and 18 kg load machine respectively.
The average cost of reducing VOCs emissions in the dry cleaning sector under the Directive is of the order of 159 € / tonne of VOC reduced.

2 Short technology description

The dry cleaning process can be divided into 6 steps : washing the fabric in solvent, spinning to extract excess solvent, drying by tumbling in a hot air stream and recovery of solvent (using of the cooling unit of the heat-pump in paralell), deodorisation (using of the cooling unit of the heating pump only), and epuration of the drying circuit and regeneration of used solvent in case of carbon active epurator.

The primary components and circuits of a dry cleaning machine are :

- cage,
- solvent circuit : solvent storage tanks, button trap, solvent filter, still boiler, still condenser and water separator,
- drying circuit and solvent recovery: air circulating system, lint filter, heating pump, air heater, fan.

The textiles are cleaned in a solvent bath. After cleaning, the solvent is drained and the residual solvent is removed by centrifugal extraction. After washing, the clothes are dried in the same tumbler in a closed loop heated air stream including one heating pump (closed-circuit machines). Drying is carried out by circulating a stream of warm air through the cleaned garments. To recover the solvent during the drying, the cooling exchanger of the heating pump is used.
Deodorisation is carried out in the final stage, using only the cooling exchanger of the heating pump. On machines with carbon unit epurator, one epuration of the drying circuit is achieved before unloading.
In that last case, the used solvent is regenerated (usually at the end of each day) by feeding it through filters to remove any solid material such as fluff, dirt and fat from it. For this purpose the filter is coated with a filtering powder, such as diatomaceous earth or silica. Some other machines can also use a cartridge filter which is drained and disposed off after several hundred cycles. But today, most of time, the machines are fitted with “Ecological” filters : very fine filter in Nylon regenerated by centrifugation, sending the solid material to the stiller in order to extract and recycle the solvent that these materials contain.

Indeed, the drycleaning machines are equipped with distillation units, which are always enclosed within the machine. Distillation is periodically required to reclaim the solvent by separating it from the soluble and insoluble soil extracted from garments. A distillation unit consists of an electrically or steam heated boiler, a water cooled still condenser, a water separator and a pipe for discharging solvents to the distilled pure solvent tank. The distillation systems either operate continuously (load by load) or more often overnight, in which case the entire solvent content of the main tanks is purified.

3 EU Regulation : directive 99/13/CE of 11 march 1999 [2]

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

There is only one emission limit value both for existing and new installations. This limit value is of 20 g of solvent emitted per kg of textiles cleaned and dried.
New machines must be in compliance immediately with the Directive requirements and existing installations must comply by the year 2007.

4 Definition of reference installations

Two reference installations are considered. They differ by their size (quantity of textiles treated per year).
An investigation on 18 european countries [1] gives an average of 23 t of textiles treated per installation in one year. Two sizes of installation are mainly encountered and are retained as reference installation :

- installations that treat around 15,5 t of textiles per year (average on 8 european countries [1])
- installations that treat around 35,4 t of textiles per year (average on 8 other european countries [1])

According to [10], 68% of dry cleaning machines have a capacity of 11 to 20 kg.
Reference installation 01 is considered to have a capacity of 11 kg and to be operational 5 times a day on 250 days/an.
Reference installation 02 is considered to have a capacity of 20 kg and to be operational 7 times a day on 250 days/an.

Table 4.1: Reference installation

Reference Installation Code	Description	Capacity (kg textiles /load)	Lifetime [y]
01	Installation with 15,5 t/y of textiles cleaned	11	10 to 15
02	Installation with 35,4 t/y of textiles cleaned	20	10 to 15

5 Emission abatement techniques and costs

5.1 Definitions of primary measures

The main primary measures are the switch from open-circuit machines (older design and condensation of solvent through cold water with venting to the atmosphere) towards conventional and new generation closed circuit machines.

Open-circuit machines and main closed-circuit machines use perchloroethylene (PER). PER is the main solvent used in dry cleaning but it is classified R40 (suspected carcinogenic effect – insufficient proof).

Conventional closed-circuit PER machines

These machines are equipped with a heating pump then with integral refrigerated condensers (deodorisation using only the cooling exchanger in the last step of the drying phase). They allow a more efficient solvent recovery than with open-circuit machines and have therefore relatively low solvent emissions.

New generation closed-circuit PER machines

These machines are equipped with a heating pump, then with integral refrigerated condensers (deodorisation using only the cooling exchanger in the last step of the drying phase), with a much more efficient drying circuit, with one drying control and additionnally, with an activated carbon filter (epurator), which reduces during the final step of the drying process (epuration) the last traces of solvent prior to unloading (concentration < 300 ppm inside the drum). This machine type has lower solvent emissions.

Hydrocarbon machines

Hydrocarbons solvents can be substitute to PER in closed-circuit machines (But these solvent are flammable, what is a problem in some countries).

Wet Cleaning

One alternative to any type of solvent is wet cleaning. It uses a minimum of water together with some detergents. Wet cleaning is made at low temperature. Nevertheless it can be applied without risk only for textiles that have to be washed at maximum 40°C (a maximum of 40% of textiles can be treated with this technique depending of the carelabel "W inside a circle" (W for wetcleaning, standard to be published)).

Supercritical CO_2 :

This is an emergent technique that is only in test phase. At supercritical conditions (beyond 75 bars and 35°C), (intermediate state between liquid and gas), CO_2 has solvent properties which are adjustable with the variation of temperature and pression. This solvent is clean and easily recoverable in making it pass by again in a gas state at the end of the cycle.

Table 5.1.1 : Primary measures

Primary Measure Code	Description
00	Open-circuit machine
01	Conventional closed-circuit PER machine
02	New generation closed-circuit PER machine
03	Hydrocarbon machines
04	Wet cleaning

5.2 Definitions of secondary measures

One main secondary measure is the switch from open-circuit machines towards open-circuit machines with an acivated carbon filter.
Activated carbon filter can also be added on closed-circuit machines which are not already equipped with.

Table 5.2.1 : Secondary measures

Secondary Measure Code	Description
00	none
01	Activated carbon filter

5.3 Emission factors and costs data for the different abatement techniques

Table 5.3.1: Emission factors of VOC and abatement efficiencies for applied emission abatement techniques.

Combination code	EF NMVOC [g/kg textiles cleaned] mean value	Abatement efficiency [%]	EF NMVOC CI %	Q
01 00 00	177	0	20	4
01 00 01	55	70	27	4
01 01 00	20	89	20	4
01 01 01	15	91	20	4
01 02 00	10	95	15	4
01 03 00	10	95	20	4
01 04 00	0	100	0	5
02 00 00	177	0	20	4
02 00 01	55	70	27	4
02 01 00	20	89	20	4
02 01 01	15	91	20	4
02 02 00	10	95	15	4
02 03 00	10	95	20	4
02 04 00	0	100	0	5

Q: data quality from 1 to 5 (see Annex 2)
Sources : [5, 6, 7, 8, 11]

It has been assumed that fixed operating cost (only for secondary measure) represent 5% of the investment but this value can be discussed.

Table 5.3.2: Costs for abatement techniques

Combination code	Invest [€] mean	Invest CI %	Q	Fixed OC [€/y] mean	OC^fix CI %	Q	Variable OC [€/y] mean	OC^var CI %	Q	Total OC [M€/y] mean	OC^tot CI %	Q
01 00 00	0	-	-	-	-	-	2 419	25	4	2 419	25	4
01 00 01	4000	30	3	200	30	3	849	25	4	1 049	25	4
01 01 00	24 150	40	2	-	-	-	399	25	4	399	25	4
01 01 01	28 150	40	2	200	30	3	334	25	4	534	25	3
01 02 00	30 000	30	3	-	-	-	270	25	4	270	25	4
01 03 00	37 950	30	3	-	-	-	846	25	4	846	25	4
01 04 00	24 150	30	3	-	-	-	483	25	4	483	25	4
02 00 00	0	-	-	-	-	-	5 524	25	4	5 524	25	4
02 00 01	5000	30	3	250	30	3	1 939	25	4	2 189	25	4
02 01 00	26 950	40	2	-	-	-	911	25	4	911	25	4
02 01 01	31 950	40	2	250	30	3	764	25	4	1014	25	3
02 02 00	35 500	30	3	-	-	-	617	25	4	617	25	4
02 03 00	41 250	30	3	-	-	-	1 933	25	4	1 933	25	4
02 04 00	24 150	30	3	-	-	-	1 103	25	4	1 103	25	4

Q: data quality from 1 to 5 (see Annex 2) - : non applicable

Sources : [1, 5, 6, 8, 11]

6 Data to be provided by national experts

The following tasks are required:

6.1 Validation work

For representing costs for dry cleaning, the national expert can use the default values provided in this report or use other costs data if justified.

- Validation of the default investment cost data provided for his own country, and
- Validation of the method of derivation of operation cost data for his own country.
- Or
- Provide other costs data for the same combination of techniques and justify these cost data.

Comments have to be sent to the secretariat in the two weeks after electronic publication of the document.

6.2 Provision of specific data

Tables to be filled in with country specific data by national experts

- Determination of country specific data to calculate variable costs (*Specific values for energy, man power…are valid for all NMVOC sectors and have to be entered in the tool only once).*

Table 6.2.1 : Country-specific data

Parameters	Country specific costs
Perchloroethylene [€/kg]	
Hydrocarbon solvents [€/kg]	
Water [€/kg]	

- Respective shares (t textiles cleaned/y) of the total activity level carried out on each reference installation in 2000, 2005, 2010, 2015, 2020.

The solvent input to be considered is the total solvent input for the dry cleaning sector. Table 6.2.2 must be completed. Some default values for the confidence interval are provided. They can be used by one Party if no data is available.
The methodology used in Rains for estimating the future activity level will be described in the methodology. It can be used or information can be obtain from the industry.

Table 6.2.2 : Activity levels on reference installations (t textiles cleaned / year)

RIC	2000	CI%	2005	CI%	2010	CI%	2015	CI%	2020	CI%
01										
02										
Default values proposed for CI		10		20		50		100		100

For explanation on the confidence interval refer to the methodology chapter.

- Respective percentage of combinations of reduction measures in 2000 for each reference installation and
- 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.

Some default values for the applicability factor are provided in table 6.2.4. They can be used by one Party if no data is available.

Table 6.2.3 : Percentage of use and applicability factor for each combination of reduction measures

RIC PMC SMC	Percentage of use in 2000 %	Percentage of use in 2005 %	Applicability factor 2005 %	Percentage of use in 2010 %	Applicability factor 2010 %	Percentage of use in 2015 %	Applicability factor 2015 %	Percentage of use in 2020 %	Applicability factor 2020 %
01 00 00									
01 00 01									
01 01 00									
01 01 02									
01 02 00									
01 03 00									
01 04 00									
Total RIC 01	**100**	**100**		**100**		**100**		**100**	
02 00 00									
02 00 01									
02 01 00									
02 01 02									
02 02 00									
02 03 00									
02 04 00									
Total RIC 02	**100**	**100**		**100**		**100**		**100**	

Table 6.2.4 : Default values for applicability factor for each combination of reduction measures

RIC PMC SMC	Applicability factor 2005 %	Applicability factor 2010 %	Applicability factor 2015 %	Applicability factor 2020 %
Reference installation 01				
01 00 00	100	100	100	100
01 00 01	100	100	100	100
01 01 00	100	100	100	100
01 01 02	100	100	100	100
01 02 00	100	100	100	100
01 03 00	80	100	100	100
01 04 00	40	70	70	70
Reference installation 02				
02 00 00	100	100	100	100
02 00 01	100	100	100	100
02 01 00	100	100	100	100
02 01 02	100	100	100	100
02 02 00	100	100	100	100
02 03 00	80	100	100	100
02 04 00	40	70	70	70

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 6.2.5).

Table 6.2.5 : Aggregated table (this table does not appear in the tool)

RIC PMC SMC	Percentage of use in 2000 %	Percentage of use in 2005 %	Applicability factor 2005 %	Percentage of use in 2010 %	Applicability factor 2010 %	Percentage of use in 2015 %	Applicability factor 2015 %	Percentage of use in 2020 %	Applicability factor 2020 %
Aggreg. 00 00									
Aggreg. 00 01									
Aggreg. 01 00									
Aggreg. 01 02									
Aggreg. 02 00									
Aggreg. 03 00									
Aggreg. 04 00									
Total aggreg.	**100**	**100**		**100**		**100**		**100**	

Aggreg. : Aggregation

The total of percentages of uses of each combination or reduction technique must be 100 since all the combinations are assumed to represent the different situations in this activity.
The percentage of use of the different techniques depends on the Party's regulation. If the directive is applied, combination with primary measure 00 and 01 should be forbidden in 2007. If these installations constitue a large part of the activity, it can be assumed that a certain percentage of use of primary measures 00 and 01 could remain in 2005 or later.

In the tool the absolute terms are directly entered (% for a given combination multiplied by the total activity).

Table 6.2.6 : Unabated emission factor [g / kg of textiles]

Default data mean	CI %	User input mean	CI %
177	20		

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

7 Explanatory notes

7.1 Derivation of emission factors

Emission factors in the litterature are expressed as grammes of VOC per kilogrammes of textiles cleaned. They do not depend on the capacity of the machine. Emission factors used in this study (average values) are presented in table 7.1.1.

Table 7.1.1 : NMVOC emission factors expressed in g/kg of textiles cleaned

Type of machine	Emission factor NMVOC g/kg textiles cleaned	source
Open-circuit machine	177	[7]
Open circuit machine with activated carbon filter	55	[5]
Conventional closed-circuit PER machine	20	[11]
Conventional closed-circuit PER machine with activated carbon filter	15	[6] [11]
New generation closed-circuit PER machine	10	[5]
Hydrocarbon machines (in new generation closed-circuit machines)	10	[5]
Wet cleaning	0	

The different sources of litterature give all emission factors in the same order of magnitude [5] [7] [9] [10] [11].

7.2 Derivation of cost data

Primary measures

- Investments for new generation closed-circuit PER machines are derived from ENTEC [6] which gives costs for 11 kg and 18 kg machines. These Investments are readjust with drycleaning industry [11].
- Investments for conventional closed-circuit PER machines are derived from the previous values. According to [5] and [8], these investments represent on average 70 % of investment costs for new generation closed-circuit PER machines.
- According to [5] and [8], equipment costs for closed-circuit machines using hydrocarbon-solvents are assumed to be 10% higher than for PER due to a partially more complex technology.
- Wet cleaning equipment have a large range of costs (based on the size and sophistication of the equipment). The same investment costs are assumed than for conventional closed-circuit PER machines according to [11].

Investment costs taken into account in this document for primary measures are presented in table 7.2.1.

Table 7.2.1 : Investment costs for primary measures

Type of equipment	Investment cost (€)	
	Machine capacity : 11 kg	Machine capacity : 20 kg
New generation closed-circuit PER machine	30 000	35 500
Conventional closed-circuit PER machine	24 150	26 950
Hydrocarbon machines	37 950	41 250
Wet cleaning	24 150	26 950

Fixed operating costs are only considered for secondary measures because the replacement from a machine to an other (as define with primary measure) does not lead to additional fixed operating costs (maintenance, taxes, etc.).

Variable operating costs are considered for primary and secondary measures. According to [5], it can be assumed that electricity consumption do not vary significantly between open and closed-circuit machines. Therefore, the operating cost component accounted for, in this document, are solvent costs.

Variable operating costs presented in this document are calculated with default value of solvent cost (country specific data) given in table 7.2.2

- Cost for perchloroethylene is an average value for 14 european countries [1] (the density of perchloroethylene is 1,6226 g/ml).
- Cost for hydrocarbons are derived from [11].
- Cost for water is an average value for 10 european countries [1].

Table 7.2.2 : Default values for solvent costs [5], [1]

Type of solvent	Price [€ / kg]
Perchloroethylene	0,83
Hydrocarbons	2.6
Water	0.00107

Annual solvent costs are calculated as presented in table 7.2.3.

Table 7.2.3 : Annual solvent costs for primary measures

RIC PMC SMC	Reference installation	01	02
		Machine capacity : 11 kg	Machine capacity : 20 kg
		15 500 kg textiles cleaned/y	35 400 kg textiles cleaned/y
00 00	FE (kg/kg textiles cleaned)	0,177	0,177
	solvent rate in waste (kg/kg textiles cleaned)	0,011	0,011
	annual solvent consumption (kg/y)	2914	6655
	Annual solvent cost (€/y)	**2 419**	**5 524**
01 00	FE (kg/kg textiles cleaned)	0,02	0,02
	solvent rate in waste (kg/kg textiles cleaned)	0,011	0,011
	annual solvent consumption (kg/y)	480,5	1097
	Annual solvent cost (€/y)	**399**	**911**
02 00	FE (kg/kg textiles cleaned)	0,01	0,01
	solvent rate in waste (kg/kg textiles cleaned)	0,011	0,011
	annual solvent consumption (kg/y)	326	743
	Annual solvent cost (€/y)	**270**	**617**
03 00	FE (kg/kg textiles cleaned)	0,01	0,01
	solvent rate in waste (kg/kg textiles cleaned)	0,011	0,011
	annual solvent consumption (kg/y)	326	743
	Annual solvent cost (€/y)	**846**	**1 933**
04 00	FE (kg/kg textiles cleaned)	0	0
	annual water consumption (kg/y)	452 600	1 033 680
	Annual solvent cost (€/y)	**483**	**1 103**

Operating costs are country specific : figures in table 7.2.4 are displayed as example

Table 7.2.4 : Emission factors, investments, total variable operating costs, abatement efficiencies for primary measures

RIC PMC SMC	NMVOC Emission Factor [g/kg textiles cleaned]	Investment [€]	Variable Operating Costs [€/y]	Abatement efficiency [%]
01 00 00	177	0	2 419	0
01 01 00	20	24 150	399	89
01 02 00	10	30 000	270	95
01 03 00	10	37 950	846	95
01 04 00	0	24 150	483	100
02 00 00	177	0	5 524	0
02 01 00	20	26 950	911	89
02 02 00	10	35 500	617	95
02 03 00	10	41 250	1 933	95
02 04 00	0	24 150	1 103	100

Secondary Measures

- Investments for activated carbon filter coms from CTTN [11]. According to [11], this investment is the same if activated carbon unit are added on open-circuit or on closed-circuit machines.

Investment cost taking into account in this document for secondary measures are presented in table 7.2.5.

Table 7.2.5 : Investment costs for secondary measures

Type of equipment	Investment cost (€)	
	Machine capacity : 11 kg	Machine capacity : 20 kg
Activated carbon filter	4 000	5 000

Fixed operating costs are assumed to represent 5% of the investment but this value can be discussed.

Variable operating costs are estimated on the same principles as for primary measures.

Table 7.2.6 : Annual solvent costs for secondary measures

	Reference installation	01	02
		Machine capacity : 11 kg	Machine capacity : 20 kg
RIC PMC SMC		15 500 kg textiles cleaned/y	35 400 kg textiles cleaned/y
00 01	FE (kg/kg textiles cleaned)	0,055	0,055
	solvent rate in waste (kg/kg textiles cleaned)	0,011	0,011
	annual solvent consumption (kg/y)	1023	2336
	Annual solvent cost (€/y)	**849**	**1 939**
01 01	FE (kg/kg textiles cleaned)	0,015	0,015
	solvent rate in waste (kg/kg textiles cleaned)	0,011	0,011
	annual solvent consumption (kg/y)	403	920
	Annual solvent cost (€/y)	**334**	**764**

Table 7.2.7 : Emission factors, investments, operating costs, abatement efficiencies for secondary measures

RIC PMC SMC	NMVOC Emission Factor [g/kg textiles cleaned]	Investment [€]	Variable OC [€/y]	Fixed OC [€/y]	Abatement efficiency [%]
01 00 01	55	4 000	849	200	70
01 01 01	15	28 150	334	200	91
02 00 01	55	5 000	1 939	250	70
02 01 01	15	31 950	764	250	91

8 References

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9 Modifications made to the draft document

Comments have been formulated by expert from Swedish EPA :
This document gives a good description of the sector and the different techniques. A follow-up study concerning the machines in Sweden was made in 1996. This study gives figures concerning the number of machines and also some figures concerning costs of machines, figures which were actual at that time. However, the figures given in the present document seems rather similar to Swedish experience by then.

9.1 Modification of Chapter 5

Fixed operating costs have been corrected in table 5.3.2 for combinaison code that include both primary and secondary measures : the 5% of investment has only to be applied on secondary measure investment what was not the case before.

9.2 Modification of Chapter 7

Table 7.2.7 has also been modified regarding the previous remark.

Abbreviations

CIAM	Centre Integrated Assessment Modelling
CITEPA	Centre Interprofessionnel Technique d'Etude de la Pollution Atmosphérique
CI%	Confidence interval
CO	Organic Components
EF	Emission factor
EPA	Environmental Protection Agency
EU	European Union
GJ	Giga Joules
IFARE	Institut Franco-Allemand de Recherches sur l'Environnement
IIASA	International Institute for Applied Systems Analysis
kW	kiloWatt
n.a.	not available
-	not existing
NFR	New Format Reporting
PMC	Primary Measure Code
Q	Quality
RAINS	Regional Air pollution Information and Simulation model
RIC	Reference Installation Code
SMC	Secondary Measure Code
SNAP	Selected Nomenclature for Air Pollution
VOC	Volatile Organic Compounds