TYRE PRODUCTION

SYNOPSIS SHEET

Prepared in the framework of EGTEI

1. Activity description and EGTEI contribution - summary

This source category covers the production of all kinds of tyres, e.g. for passenger cars, trucks, mopeds, etc. As conventional tyre production plants have production lines of 800 to 1,200 m length, spread over different buildings, fugitive emissions represent the major source of NMVOC emissions.

This activity emits VOC coming from solvents which are predominantly used to increase rubber “tack” at certain stages of the manufacturing process and to offset natural drying. Solvents are also used for cleaning purposes. NMVOC emissions from this sector may vary significantly from country to country according to the production techniques used. At a EU25 level for the year 2000 (according to RAINS: version CP_CLE_Aug04(Nov04)), NMVOC emissions were 22 kt representing 0.21% of total NMVOC emissions. Total activity being, 3,552 kt of tyre produced, average emission factor is about 6.2 kg NMVOC/t of tyre meaning that emissions from this sector are already partly treated in EU25 (unabated emission factor being 10 kg/t of tyre). These estimations could be modified in a near future due to information delivered by national experts during the bilateral consultation in 2005.

Tyre production is addressed by the European Directive 1999/13/EC (SED) [1] (as part of rubber conversion) 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 term of emission reduction and costs, **it has been considered as an individual activity by EGTEI [2]**. This sector was not considered as an individual sector in the previous RAINS version [3]. It was part of the category “Products Not Incorporating Solvents” including a wide range of different processes such as rubber and polyvinylchloride (PVC) processing. **EGTEI has been able to develop an approach for representing this sector and estimate costs of reduction techniques**. The methodology for this sector was developed in close cooperation with the European Association of the Rubber Industry (BLIC) [4]. Presently, RAINS has been modified and integrates EGTEI proposals. **Data provided by EGTEI (emission factors and costs) have been implemented in the new RAINS version model** [5] 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 tyre manufactured (t/year). Only one reference installation (RI) has been defined with the BLIC to simplify the work of national experts.

Three primary measures are considered based on the types of products used in the process. A new process allowing to reduce the solvent consumption and to comply with the SED requirements has been developed. For installations which cannot modify their production lines, a thermal oxidiser can be used to be in compliance with the SED emission limit values. No other secondary measure is considered.

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 three primary measures and one secondary measure according to the installation size.

The production line modification (primary measure PMC02) is the cheapest way to achieve the SED requirements (136 €/t VOC abated or 1.0 €/t of tyres produced). A thermal oxidiser can be used when primary measures are not technically viable. Unit costs are higher (1,050 €/t VOC abated or 7.9 €/t of tyre produced). The first primary measure defined for this sector (PMC01) does not enable compliance with the SED targets. It is used as a first step to reduce VOC emissions in some plants.

National experts have to collect 3 country specific parameters (wages, electricity and natural gas costs) and 1 country and sector specific parameter (cost of solvents used). The first ones can be very easily known. The second one can be defined with the help of national rubber associations. EGTEI provides default costs for country and specific parameters which can be used if no better national data exist. National experts have also to provide the trends in activity level from 2000 to 2020 as well as the application and applicability rates of each abatement technique.

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

EGTEI proposals for the representation of tyre production and definitions of abatement techniques have been considered in the last update of RAINS [5]. 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 capacity of EGTEI to describe new technologies.

2. European regulation

As mentioned above, the European Directive 99/13/EC [1] applies to this sector (annex IIA, n°18).

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

by complying with the canalised and fugitive emission limit values (option I),

by introducing a reduction scheme to obtain an equivalent emission level (in particular by replacing conventional products with a high solvent content with low-solvent or solvent-free products: option II).

The SED applies to installations with a solvent consumption above 25 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 tyre production

	Option I		Option 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 used*]**
> 15	20	25	25

* 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 the process cycle).

The strict respect of total emissions (option II) defined in table 2.1 leads to an emission factor of 2.5 kg of VOC/tonne of tyre produced.

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 the reference installation

This sector being rather homogeneous, only one reference installation is considered according to its annual production expressed in tonnes of tyres produced per year. This unit is more appropriate than the number of tyres produced because all kinds of tyres are taken into account in this study.

Table 3.1.1: Reference installation

Reference Installation Code RIC	Description	Technical characteristics
01	Production of tyres: 30,000 t / y	Full load hours: 8,000 h/y [VOC]: 1.5 g/m^3 Flow rate: 20,000 m^3/h Solvent input (I)*: 300 t/y

* As mentioned in the Solvent Management plan defined in the Directive [2], the 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.

3.2 Definition of emission abatement techniques

3.2.1 Primary measures

Primary measures are based on process optimisation or new processes enabling the use of new products emitting less NMVOCs.

Table 3.2.1.1: Primary measures

Primary Measure Code PMC	Description
00	• Production of 100 % vulcanised rubber • Use of 100 % solvent-based adhesives, coatings, inks and cleaning agents (90 wt.-% solvent content)
01	• Production of 100 % vulcanised rubber. ***Process optimisation*** (examples : avoiding wasting of solvent, limiting emission devices - Use of auto-spray systems instead of hand mopping components - Dip tank on extruder instead of hand brushing treads with dissolution). • Use of 70 % solvent-based adhesives, coatings, inks and cleaning agents (90 wt.-% solvent content)
02	• Production of 100 % vulcanised rubber. ***New processes*** (example: adhesive rubber band use – New type of building machine associated with extruder – New technology extrusion.). • Use of 25 % solvent-based adhesives, coatings, inks and cleaning agents (90 wt.-% solvent content)

3.2.2 Secondary measures

Only one secondary measure is defined: a thermal oxidiser can be used to reach the same abatement efficiency than the primary measure 02 defined above.

Table 3.2.2.1: Secondary measures

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

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
Natural gas [€/GJ] (net of taxes)	5.926	To be provided by national experts
Wages [€/h]	25.9	To be provided by national experts

For the production of tyres, an additional country and sector specific parameter is necessary to calculate variable operating costs. It corresponds to the solvent used cost. The default value is presented in table 4.2.

Table 4.2: Country and sector specific economic parameter (net of taxes)

Parameter	Default cost provided by EGTEI [€/kg]	Country and sector specific cost [€/kg]
Solvent costs [€/kg]	1.5	To be provided by national experts

The best source of information for the determination of country and sector specific economic parameters is the rubber industry national association and it is recommended to national experts to contact it.

Default data have been used to calculate variable and annual unit 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 [8].

Activity data have been provided for three countries by the BLIC [4]. They can be checked by national experts.

Table 4.3: Activity forecasts for three countries from 2000 to 2020 (kt of tyres)

Country	2000	2005	2010	2015	2020
France	839.2	829.0	877.0	925.0	973.0
Germany	794.6 (2001)	939.7	1,061.4	1,183	1,304,7
Spain	541.6	625.1	708.5	792.0	875.5

National experts can also modify the default unabated emission factor 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 4.4: Unabated emission factor [kg of NMVOC / t of tyres]

Default emission factor	Country specific emission factor
10	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 the production of tyres: 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 unit costs per unit of activity.

Variable costs account for the savings on raw materials for the primary measures and electricity, natural gas and labour if a thermal oxidiser is used. Fixed operating costs are only considered for the secondary measure and correspond to 5% of the thermal oxidiser investment (for maintenance and insurance). As no economic parameters 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).

Investments and variable operating costs of secondary measures presented in table 5.1 are calculated from the equations defined in the document “derivation of secondary measure costs: thermal oxidation” downloadable on EGTEI website [6]. Energy can be recovered from exhaust gases in some cases but this assumption is not considered in the variable cost calculation. Technical characteristics of the installations are given in table 3.1.1.

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

RIC PMC SMC	NMVOC EF [kg NMVOC / t of tyre]	Abatement efficiency [%]	Investment [k€]	Variable Operating Costs [k€ / year]	Fixed Operating Costs [k€/y]	Unit cost [€/t NMVOC abated]	Unit cost [€/t of tyre]
01 00 00	10	0	0	-	-	-	-
01 00 01	2.5	75	1,000	63	50	1,050	7.9
01 01 00	7	30	40*	- 135	-	-1,467	-4.4
01 02 00	2.5	75	5,000	- 337.5	-	136**	1.0

* Probably underestimated because this measure has generally been already implemented and industry experts do not know exactly its associated costs.
** Annual savings of 337.5 k€ on the purchase of solvents are assumed with the new process.

Investments correspond to the cost of the modification of the production lines for PMC 01 and 02 and to the use of an add-on technique for SMC 01.

Unit costs [k€/ 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 modification of the process (PMC02). This will be the technique used in a majority of cases to comply with the SED requirements [4]. If this is not technically viable, a thermal oxidiser can be used to achieve the same reduction level.

PMC01 does not allow installations complying with the SED. It has just been used in some plants as a first step to reduce VOC emissions. It is defined to represent the situation in 2000 in many Parties.

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

In the previous RAINS version [3], the tyre production was not studied as a separate sector. It was considered as part of “Products Not Incorporating Solvents” (excluding Pharmaceuticals). This category covers a wide range of different processes but the largest portion (almost 2/3) of VOC emissions originates from rubber and polyvinylchloride (PVC) processing. Techniques considered were the use of a solvent management plant with efficiency up to 10%, the use of an add-on technique such as thermal oxidation or adsorption with an abatement efficiency of 95% and the substitution of products with efficiency as high as 100%. According to [4], substitution with such efficiency is not possible in this sector.

EGTEI provides now an approach to consider this sector and to test the impact of the current legislation. It is also possible with this methodology to determine the maximum achievable reduction.

Data provided in the EGTEI approach (emission factors and costs) have been implemented in the new version of the RAINS model [8] 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 RAINS.

7. Perspective for the future

In the future, any new technology which could be developed, as the reduction of fugitive emissions, should be considered by EGTEI in the background document to continuously improve the representation of the sector.

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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[4] European Association of the Rubber Industry. http://www.blic.be/
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[7] Rapport d'inventaire national au format UNECE/NFR et NEC
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[8] Methodology http://citepa.org/forums/egtei/egteil_index.htm
[9] CITEPA: National reference centre for emission inventories

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 the tyre production with the help of CITEPA [9].

All collected 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 organizations.

Table A.1: French specific costs

Parameters	French specific costs
Electricity [€/kWh] (net of taxes)	0.05
Natural gas [€/GJ] (net of taxes)	5.33
Wages [€/h]	23.4

As no better product costs are available, default costs for country and sector specific parameters are taken into account for describing the French situation.

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

Parameter	Default cost [€/kg]	French and sector specific cost [€/kg]
Solvents	1.5	1.5

Activity level

The activity forecast from 2000 to 2020 comes from data provided by the French national expert. It is based on the historical trend of the production (in volume) available in the French statistics. This corresponds to an annual increase of 0.92% of the production from 2000 to 2020.

Table A.3: Activity levels from 2000 to 2020 (t tyre / year)

RIC	2000	2005	2010	2015	2020
01	832,780	872,000	913,000	956,000	1,000,000

Unabated emission factor

Default emission factors are adapted to the French situation.

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 dates of compliance.

In 2000, no secondary measure was used in France. VOC emissions are directly derived from the annual industrial reports in the scope of the French emission inventory (carried out for the French ministry of Ecology) [9]. The shares of the different techniques used are determined from these reports.

For the years 2005 to 2020, it is assumed that a majority of installations will use primary measures to reduce their VOC emissions. The use of a thermal oxidiser is only assumed for 10% of total activity.

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	0	0	100	0	100	0	100	0	100
01 00 01	0	10	100	10	100	10	100	10	100
01 01 00	83.5	0	100	0	100	0	100	0	100
01 02 00	16.5	90	90	90	90	90	90	90	90
Total RIC 01	**100**	**100**		**100**		**100**		**100**	

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	5,211	2,180	2,283	2,390	2,500
Annual total costs	**k€/year**	**k€/year**	**k€/year**	**k€/year**	**k€/year**
CLE scenario	-2,921	1,485	1,555	1,628	1,703

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 5,100 tonnes. EGTEI approach allows representing very well NMVOC emissions from the tyre production. In the French inventory, NMVOC emissions are derived from industrial annual reports [7].