Assessment of costs for VOC abatement technologies

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Agenda

- Introduction
- VOC abatement in the automotive sector
- VOC abatement in the packaging printing sector
- Characteristics of ERICCa_VOC

Introduction

Task	Determination of costs of VOC emission reduction measures is one of the tasks assigned to TFTEI in the workplan for 2015-2016
Mandate	France proposed to exchange information on cost data of VOC abatement technologies through TFTEI on the basis of the work carried out in 2003-2006 by EGTEI (and used in the current BREF STS), in order to deliver this information to Sevilla for the revision of BREF STS.
Funding	The work is primarily financed by ADEME
Activities	TFTEI focuses in a first step on two activities: flexible packaging printing and car manufacturing
Responsability	**CITEPA**: car manufacturing **KIT**: packaging printing

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Automotive Sector – State of progress

Exchange of information

- 5 meetings organized in Paris and in Brussels with ACEA
- Contacts with oxidizer suppliers
- TFTEI template created to collect data
- Pieces of information already provided
- Methodology mostly validated

Open task

- Data still missing (examples of investments for some techniques)
- Some methodological issues to be validated with ACEA

Automotive Sector – Coating steps

- The automobile body is assembled from a number of welded metal sections. The body and the different parts to be coated, are all processed through the same metal preparation steps.

- Surface coating of an automobile body is a multi-step operation carried out on an assembly line conveyor system. Although finishing processes vary from plant to plant, they have some common characteristics. The different coating steps are as follows:

Paint shop

1. Pretreatment (corrosion protection)
2. Electrophoretic coating (E-coat) (corrosion protection)
3. Sealing and dampling
4. Primer (smoothing, spreading, stone chip protection, UV protection)
5. Base coat (colour, colour effects, UV protection)
6. Clear coat (shine, appearance, scratch and chemical resistance)
7. Cavity preservation
8. Paint reworking

Automotive Sector – Reference installations

Reference installations

There are 5 reference plants corresponding to classical paint shop families.

	1 *SB*	2A *SB-MIX*	2B *SB-MIX*	3 *WB*	4 *Integrated process*
Primer	SB	WB	SB	WB	-
Base coat	SB	SB	WB	WB	WB
Clear coat	SB	SB	SB	SB	SB

SB: entirely solvent-based coating / WB: all paint layer except CC are water based/ SB-MIX: mix between solvent-based and water-based coatings / Integrated process: primerless paint shop

Common parameters

- Annual production: 200 000 car bodies per year (passenger cars only), corresponding to 2x8 shiftworks loaded (corresponds to 60 jph)
- Electrophoretic coating area: 97 m^2

Automotive Sector – SB versus WB

SB *vs.*WB

The technical differences between SB and WB paint shop families exist at several levels:

- spray coating system,
- intermediate dryer between base coat and clear coat,
- primer dryer oven heating curve,
- construction material for paint booths,
- use of electrically charged bells,
- paint window,
- drying speed.

Due to these differences in paint shop design a change from solvent-based to water-based spray coats cannot be made without radical modification of the paint shop construction.

Automotive Sector – Variability between plants

For a given reference installation, data variability between plants is associated in particular with:

Primary measures

- the application technique and transfer efficiency,
- the collecting of solvent,
- the optimizing of cleaning solvent,

Secondary measures

- the establishment of air treatment for the oven/dryer,
- the establishment of air treatment for the spray booth,
- the quality of coating and fashion: by example the construction of two-tone cars (after the body has been completely coated with one colour, part of the surface is masked and the body is reintroduced to the base coat line to apply the second colour. This results in additional VOC emission.)

Automotive Sector – Methodology

Initial state

- Total emissions of the reference plants in the initial state (without use of primary and secondary measures) based on data provided by industry through solvent management plan (SMP) expressed in g/m^2.

SMP

- SMP is a mass balance with inputs and outputs of solvents within the installation. To set the initial state, solvent inputs (I1) and solvents contained in collected wastes (O6) and in preparations recovered for reuse (O8) are considered.
- The initial state does not include air treatment (O5), corresponding to secondary measures, which is why these data are collected separately.
- The total VOC emissions in the initial state are derived by the following formula: **I1 – O6 – O8 (maximum value)**

Automotive Sector – Methodology

Primary measures	Types of primary measures considered
Definition	• Solvent management (collection, SMP…), • Optimizing cleaning cycles, • Improvement of transfer efficiency and application technology.
Cost	• Data provided by car industry with examples of investment cost
Reduction of VOC emissions	• Deducted from SMP and examples from car industry

Automotive Sector – Methodology

Secondary measures	Types of secondary measures considered

Definition	• Thermal oxidation on:
	  • ovens/dryers
	  • spray booths
	• With or without adsorption on Zeolite wheel (concentration step) followed by thermal oxidation

Cost	• Estimated with the tool ERRICa_VOC • Data collected from car industry and oxidator suppliers
Reduction of VOC emissions	• Deducted from SMP: quantities of solvents destroyed (O5)

Automotive Sector – Methodology

Output data

• **Cost efficiency analysis**
From annual costs and reductions of VOC emissions associated with the reduction measure (primary or secondary), cost efficiency ratio can be calculated from the following formula:

Cost efficiency ratio (€/g/m2) = annual cost (€)/annual reduction of VOC emissions (g/m2)

• The cost efficiency ratio can also be expressed in €/car body

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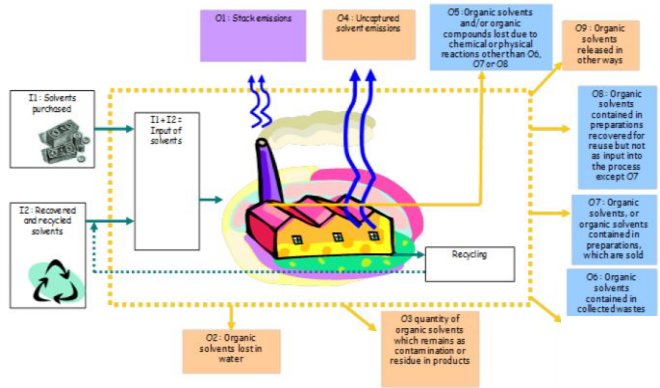
Packaging Printing Sector - Specifics

Plants	Solvent Consumption > 200t/a
Technologies	Printing: *Flexography, Rotogravure* Laminating Coating (Cleaning Agents)
Primary Measures	**Substitution:** Water-based inks, UV curing inks, etc. Solvent-based inks with lower solvent content **Better capture rate and management of solvents**
Secondary Measures	**Oxidation:** Recuperative (with or without catalyst) Regenerative **Adsorption and Solvent Recovery**

Packaging Printing Sector - Specifics

Flue Gas	Typical VOC concentrations: > 1g/m³ => **Usually no preconcentration necessary**
Solvent Management Plan	**Important flows:** • **I1** • **(I2)** • **O1** • **O4** • **O6** • **O8**



Packaging Printing Sector - Specifics

Industry Information

- Investment decisions are massively influenced by technical/economical aspects

⇒ Emission reduction is often not the primary motivation

- The technical feasibility of recycling solvents is influenced by the number of solvents in use
- The installed equipment is also influencing the usage of solvents (in case of solvent recovery installation, single-solvent is favored whenever possible)

Cross-Media Effects

- Oxidators may cause other emissions (NO_X, CO_2, etc.)
- The use of water-based or low-solvent inks may negatively influence the operating conditions of secondary measures
- Water-based inks can cause ground water emissions

Packaging Printing Sector

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Primary Measures

Investment	To be defined / expected to be input data
Operating Cost	Higher product prices Consideration of cleaning agents

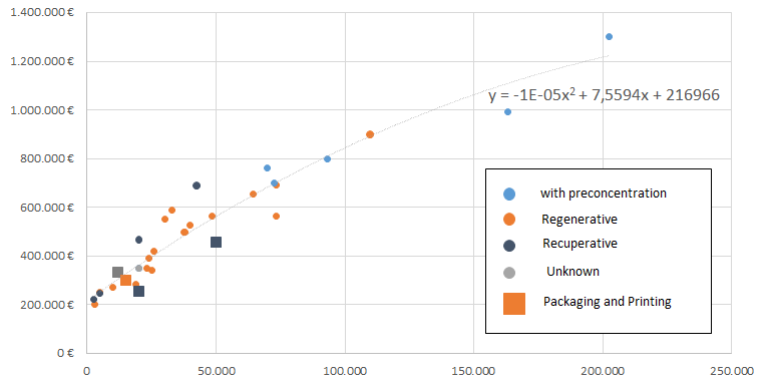
Results:

New emissions	Adapted emission calculation according to the VOC content of the replacing products
Total Costs of 1° Meas.	Sum of annualized investment and operating costs

Oxidation: Investment

Investment Curve

- Cost examples of manufacturers, plant operators and literature data
- Updated to EURO 2014 using CEPCI (where necessary)
- A factor for auxiliary installations is considered to determine the total investment



Oxidation: Operating Costs

Variable Operating Cost	Fixed Operating Cost	Benefits
• Electricity cost • Natural gas cost • Cost of labor (maintenance)	• Maintenance cost (without labor) • Insurance and taxes	• If there is the possibility to recover heat for secondary energy consumption, the surplus of energy can be calculated as a benefit

Results:

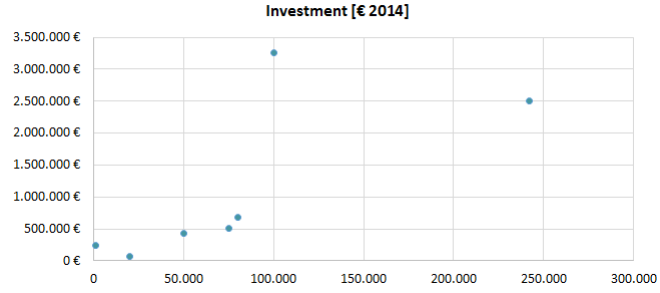
Stack emissions	Adopted emission calculation according to the VOC abated (Considering 1° and 2° measures)
Total Costs of 2° Meas.	Sum of annualized investment and operating costs reduced by benefits (if existing)

ERICCa_VOC

Adsorption: Investment

Investment Curve

- Cost examples of manufacturers, plant operators and literature data
- Updated to EURO 2014 using CEPCI (where necessary)
- Gathering cost data is a lot more difficult as the technology is not applied as frequently as oxidation
- Deriving a cost curve is not yet possible



ERICCa_VOC

Adsorption: Investment

Current methodology (EPA):

Adsorber Geometry

1. Input data:
   - Number of desorption and adsorption units
   - Adsorption time
   - Maximum Flow Rate
2. Calculation of desorption time
3. Calculation of required amount of activated carbon
4. Calculation of length, diameter and surface of the adsober unit

Investment function

1. $\text{Invest}_{\text{perunit}}[€] = \left(271\left[\frac{€}{\text{m}^2}\right] \cdot \text{Surface}[\text{m}^2]^{0.778}\right)$

Adsorption: Operating Costs

Variable Operating Cost	Fixed Operating Cost	Benefits
• Electricity cost • Carbon cost • Cost of vapor/nitrogen • Cost of labor (maintenance)	• Maintenance cost (without labor) • Insurance and taxes	• Benefits from recovered solvents (either reused internally or sold externally)

Results:

Stack emissions

Adopted emission calculation according to the VOC abated (Considering 1° and 2° measures)

Total Costs of 2° Meas.

Sum of annualized investment and operating costs reduced by benefits

Summary, Outlook and Open Tasks

Results of ERICCa_VOC	• Total annual costs of emission abatement • Total emissions abated • Specific abatement costs (per kg VOC abated)
Open Tasks	• Updating, validating and improving investment curves • Visit plants and continue discussions and collaboration with plant operators and equipment manufacturers • Adding reference data into the tool • Integrating pre-concentrating components • Developing documentation: – Manual – Technical Document
Outlook	• Integrating sector specific data and calculations of other sectors

Thank you very much for your attention! Questions?

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