Final Background Document
on the sector

Winding wire Coating

Prepared in the framework of EGTEI

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Summary

Sector: Winding wire coating (Enamelled Wire)

SNAP: 060108 or NFR 3A Paint application

ACTIVITY: production of winding wires (t / y)
POLLUTANT CONSIDRED: VOC

This is a simplified document. This sector has been studied separately because it is covered by the VOC Directive [2].

The European Association EUROPACABLE [1] has strongly participated in the elaboration of this background document.

EU 15 production of enamelled wires [1]

	1990	2010-estimated
Enamelled wire production-(tonnes/year)	286 000	442 000
Enamel consumption [t / y]	28 600	44 200

Data come from a survey at a European level.

1 EU regulation : Directive 1999/13/EC of 11 March 1999 [2]

Operators concerned can conform to the Directive by complying with the total emission limit values. Directive applies to installations with a solvent consumption above 5 t per year.

Emission limits for application of the Directive are presented in table 1.1.

Table 1.1: Emission limits

All obligations of the Directive are not described in this chapter.

Solvent consumption threshold [t / y]	**Total emissions limits [g VOC / kg wires]** (for installations manufacturing wires with a diameter ≤ 0,1 mm)	**Total emissions limits [g VOC / kg wires]** For all other installations
> 5 t	10	5

2 Definition of the Reference Installation [1]

The Reference installation is defined according to its production of winding wire per year.

The reference installation is presented in table 2.1.

Table 2.1: Reference installation

Reference Installation Code RIC	**Description**
01	Medium Installation : output: 20 000 t / y (between 5 000 to 35 000 t / y)

3 Definition of the measures [1]

3.1 Primary measures

In the production of enamelled wire a film of wax is applied to the surface of the enamelled wire before it is wound on to a delivery reel. Traditionally the wax is applied from a dilute solution in organic solvent (0,5-2%).
There are now two methods available for applying solid wax to the wire surface. One method uses wax coated string in contact with the surface and the other is by applying a molten wax to the surface of the wire.
The advantage is the elimination of fugitive emissions.
Disadvantages are:
- ✓ high cost with no pay-back : a typical site has approximately 200 lines,
- ✓ some technical problems,
- ✓ restrictions: this can not be used on very fine wires.

Table 3.1.1: Average share of solvent emissions from wax compared to total emissions

	Description
"conventional application system"	Use of solvent based wax Solvent from Wax as % of total solvent : ~7

3.2 Secondary measures

In the production of enamelled wire, a thin film of polymer is applied to the wire in a number of layers. The polymer is applied from a solution in organic solvents and the solvent content varies according to the wire diameter- round wires from 0,015- 6,0 mm and rectangular section up to 80 mm². The solvent content of the solution varies from 60 to 80%.
In the enamelling oven, the solvents are evaporated from the wire and the solvent laden air passed over a catalyst (with efficiency between 90 and 97% depending on the age of the enamelling machine) and the energy released from the combustion of the solvents for use in the process. This recovered heat accounts for approximately 50% of the heat used in the process and allows maximum destruction of VOC.

Two different situations are defined:
- ✓ ovens from 1990 with an abatement efficiency of 90%,
- ✓ ovens with an abatement efficiency of 97%. According to [1], all ovens in 2010 will be "modern" ones.

The situation in 2000 can be defined as an average situation.

3.3 Aggregated measure

Measures defined are a mix of primary and secondary ones. They are presented in table 3.3.1.

Table 3.3.1: Aggregated measure definition

Aggregated measure code (MC)	**Description**
00	Solvent content in the enamel : 70% Abatement efficiency of the oven [%] : 90
01	Solvent content in the enamel : 62% Reduced emissions from the wax application process Reduced fugitive emissions Abatement efficiency of the oven [%] : 97

4 Explanatory notes [1]

Emission factors and operating costs have been defined with [1].

4.1 Definition of the emission factors

Table 4.1.1: Definition of consumption factors

Enamel consumption factor [kg enamel / kg of wire]	0,1
Solvent consumption [kg solvent / kg enamel] for MC 00	0,7
Solvent consumption [kg solvent / kg enamel] for MC 01	0,62

Table 4.1.2: Emission factors from the enamelling process

RIC MC	Emission factor [kg VOC / t wire]
01 00	1000 × 0,7 × 0,1 = 7
01 01	1000 × 0,62 × 0,03 = 1,86

Table 4.1.3: Emission factors from the fugitive emissions

RIC MC	Emission factor [kg VOC / t wire]
01 00	4,9
01 01	1,34

Table 4.1.4: Emission factors from the wax

RIC MC	Emission factor [kg VOC / t wire]
01 00	4,9
01 01	0,8

Table 4.1.5: Total emission factors

RIC MC	Emission factor [kg VOC / t wire]
01 00	7 + 4,9 + 4,9 = 17
01 01	1,86 + 1,34 + 0,8 = 4

4.2 Determination of costs

Neither over-investments nor operating costs are considered in this document. When ovens are replaced, the only choice is to buy a more efficient one. The only difference considered concerns the energy savings.

Since the 1970's enamelling machine manufacturers have reduced the energy consumption (in kWh per kg of enamelled wire product) for the enamelling process.
This has been achieved by increasing the heat transfer from the moving air stream, in the enamelling chamber, to the wire which is moving in the opposite direction to that of the air stream.
The reduction in energy usage is shown in table 4.2.1 for the two types of ovens considered in the document.

Table 4.2.1: Energy consumptions

RIC MC	Energy consumption [kWh / kg wire] *
01 00	1,5
01 01	1,0

* Only energy for enamelling oven and not ancillary equipment is considered

To calculate energy costs, a default value of 0,0686 € / kWh is used. Costs for the two aggregated measures are displayed in table 4.2.2.

Table 4.2.2: Savings

RIC MC	Energy consumption [kWh / y]	Costs [€ / y]
01 00	1,5 × 20 000 000 = 30 000 000	30 000 000 × 0,0686 = 2 058 000
01 01	1 × 20 000 000 = 20 000 000	1 372 000

4.3 Emission factors and costs data for the different combinations of measures

Table 4.3.1: Emission factors (EF) and abatement efficiencies for each relevant combination

RIC MC	VOC EF [kg / t of wire]	Abatement Efficiency [%]	Q	CI %
01 00	17	0,00	4	20
01 01	4	76,47	4	20

Table 4.3.2: Investments and operating costs

RIC MC	Investment [k€]	Q	CI %	Variable OC [k€ /y]	Q	CI %	Savings [k€ /y]	Q	CI %
01 00	0	4	-	0	4	-	0	4	-
01 01	0	4	-	0	4	-	- 686	4	25

5 Data to be provided by national experts for the completion of the database for their own country

The following tasks are required:

5.1 Validation work

For representing costs in this sector, the national expert is invited to comment the methodology defined by the Secretariat.

- Validate the default savings 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 the electronic publication of the document.

5.2 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 5.2.1: Country specific data

Parameter	Default value	Country specific cost
Electricity [€ / kWh]	0,0686	

- Total activity level in accordance with units used in the document (production of winding wires).

In order to provide IIASA with aggregated data, the following data must be collected:

Table 5.2.2: Activity levels in absolute value (production of winding wires in tonnes / y)

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

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

- Total activity (production of winding wires / y) has to be estimated from 2000 to 2020.
- Total activity should evolve.

- Respective percentage of combinations of reduction measures in 2000 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 5.2.3: Application rate and Applicability for each combination of measures

RIC MC	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			100		100		100		100
01 01			100		100		100		100
Total RIC 01	**100**	**100**		**100**		**100**		**100**	

Table 5.2.4: Unabated emission factor [g / kg of wire produced]

Default data mean	CI %	User input mean	CI %
17	20		

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 document.

6 References

[1] EWWG: the Winding Wire Business Group of EUROPACABLE.

[2] 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.