7.4 Solvent and Other Product Use

7.4.1 Application of Paint

7.4.1.1 Manufacture of Automobiles

This sector (CORINAIR 94 SNAP source category 06 01 01) has been subdivided according to painted objects into four sub-chapters, dealing with:

- passenger cars: SNAP 06 01 01 01,
- truck cabins: SNAP 06 01 01 02,
- trucks: SNAP 06 01 01 03,
- busses: SNAP 06 01 01 04.

Surface coating is the application of decorative or protective materials in liquid or powder form to substrates. These coatings normally include conventional solvent-based paints, varnishes, lacquers and water-based paints. Emissions of NMVOC occur in paint application operations because of evaporation of the solvent used in order to thin paints at the coating facilities or used for equipment cleaning. All unrecovered solvents can be considered as potential emissions. The major factor affecting these emissions is the amount of volatile matter contained in the paint. After application of coating by a variety of methods, the surface is air or heat dried to remove the volatile solvents from the coated surface. [3]

7.4.1.1.1 Manufacture of Passenger Cars

This source category (SNAP 94 extension 06 01 01 01) covers the coating of new cars which fall under the UN/ECE definition of vehicles of category M1 and of category N1 in so far as they are coated at the same installation as M1 vehicles.\(^1\)

1 Technology Description

The automobile body is assembled from a number of welded metal sections. The body and the parts to be coated all pass through the same metal preparation process. [cf. 2]

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. Major steps of such processes may include: preliminary cleaning, phosphating, electrophoretic coating (also called electrocoating or electrodeposition), application of primer, curing of primer, application of topcoat(s), curing of topcoat(s), underbody sealing and sealing of seams, cavity corrosion protection, and repair painting before assembly. It is increasingly common to use a two-coat topcoat consisting of a basecoat and a clearcoat instead of a one-coat topcoat. Within the paint process, NMVOC-emissions

\(^1\) M1: vehicles used for the carriage of passengers and comprising not more than eight seats in addition to the driver's seat.

N1: vehicles used for the carriage of goods and having a maximum mass not exceeding 3.5 Mg.
are emitted from the application of electrophoretic coating to the application of clearcoat. [3, 23, 24]

Application of a coating takes place in a dip tank or via spray booths. The air flow balance in the spray booth must be such that the solvent concentration does not exceed the prescribed maximum values for the personnel working there. Drying/curing occurs in the flash-off area and bake oven. The term “drying” is used for the evaporation of solvent from the applied coat and the “curing” of the paint coat by chemical reactions. The typical facilities for application and curing are contiguous in order to prevent exposure of the wet body to the ambient environment before the coating is cured. [cf. 2]

Requirements to Paints

The following requirements must be fullfilled by the coatings to meet given specifications:

- protection: resistance against corrosion (humidity), deformations (shocks), impacts (projections of stones), scratches, sunlight, hydrocarbons, acids, etc.;
- quality of final aspect: impression of deepness in the colour, absence of paint “grains”, brightness.

The primary purpose of electrophoretic coating is to give complete protection against corrosion inside and outside. The filler coat serves not only to improve the appearance (covering the substrate), but also and primarily to give protection against road grit (by elasticity) and to provide an intended rupture point within the filler layer. The topcoat serves not only to improve appearance (gloss, colour, brilliance), but also has important functions in protecting against chemical and physical environmental influences (sunshine, rain, chemicals, fuels, car-wash plants, and mechanical impact or stress). [24]

Composition of Paints

In order to respect the requirements mentioned above, paints consist of:

- pigments, to give the colour and opacity to the paint;
- binders, which submit adherence and resistance against mechanical and chemical strain;
- solvents and plasticisers to ease suppleness and applicability;
- additives to improve aspect, biological properties, conservation, transports, etc.

The water-based immersion and spray paints primarily used are ethylene glycol ether, propylene glycol, ether, their esters, alcohols, and methoxypyrrolidone. Solvent-based paints may additionally contain mainly esters, aromatics, white spirit, ketones and terpenes.

Application Process

First, surfaces are wiped with solvent to eliminate traces of oil and grease (preliminary cleaning step). Second, a phosphating process prepares surfaces for the primer application. Since iron and steel rust readily, phosphate treatment is necessary to prevent this. Phosphating also improves the adhesion of the primer and the metal. The phosphating process occurs in a multi-stage washer, with detergent cleaning, a series of rinsings, and coating of the metal surface with zinc phosphate. The parts and bodies then pass through a water spray cooling process. If solvent-based primer is applied, the parts are then oven dried. [cf. 2]
The high quality standards demanded today for corrosion protection can only be met by using the electrophoretic coating method. The process is called cathodic or anodic depending on whether the workpiece is used as cathode or anode. Mostly the cathodic process is used. An electrophoretic coating is applied to protect the metal surface from corrosion and to ensure good adhesion of subsequent coatings. The composition of the bath is about 5 to 15 vol.-% solids, 2 to 10 vol.-% solvent, and the rest water. The solvents used are typically organic compounds of higher molecular weight and low volatility, like ethylene glycol monobutyl ether. After coating, the car body is rinsed to remove any paint particles not electrically deposited.

After electrophoretic coating, a primer is applied to build film thickness, to fill in surface imperfections, and to permit sanding between the primer and topcoat. Primers are applied by a combination of manual and automatic spraying and can be solvent- or water-based. Powder primer is used at one light duty truck plant.

The topcoat provides the variety of colours and surface appearance to meet customer demands. Topcoats are applied in one to three steps to ensure sufficient coating thickness. An oven bake may follow each topcoat application, or the coating may be applied wet on wet. At a minimum, the final topcoat is baked in a high-temperature oven. Topcoats in the automobile industry traditionally have been solvent-based lacquers and enamels. There is a general trend in Europe to increase the solids concentration of the paints and to introduce water-based coatings. Powder topcoats have been tested at several plants.

The current trend in the industry is towards basecoat/clearcoat (BC/CC) topcoating systems, consisting of a relatively thin application of highly pigmented solid or metallic base coat followed by a thicker clearcoat. These BC/CC topcoats have more appealing appearance than do single coat metallic topcoats, and competitive pressure is expected to increase their use. The solvent content of most BC/CC coatings in use today is higher than that of conventional enamel topcoats. However, development and testing of lower solvent containing BC/CC coatings (high solids) are being done, by automobile manufacturers and coating suppliers.

Following the application of the topcoat, the body goes, if necessary, to a touch up line or a touch up box for final repair of damaged coating. Finally, after completion of the paint application process, the car body is conveyed to the trim operation area, where vehicle assembly is completed.

### 2 Emission Sources

The application and curing of the primer and topcoat account for about 80 % of the NMVOC emitted from assembly plants. Final topcoat repair, cleanup, and miscellaneous sources such as the coating of small component parts and application of sealants, account for the remaining 20 %. Several factors affect the mass of NMVOC emitted per vehicle from surface coating operations in the automotive industry, these are among others: NMVOC-content of coatings, solids-content of coating, surface coated per vehicle, film thickness, transfer efficiency of application techniques.

Approximately 75 to 90 % of the NMVOC emitted during the application and curing process is emitted from the spray booth and flash-off area, and 10 to 25 % from the bake oven. This emission split is heavily dependent on the types of solvents used and on transfer efficiency of application techniques. With improved transfer efficiencies and the newer coatings, it is
expected that the rate of NMVOC emitted from the spray booth and the flash-off area will
decrease, and the rate of NMVOC emitted from the bake oven will remain fairly constant.
High solid coatings will tend to have a greater fraction of emissions from the bake oven. [2, 3]
The greater the quantity of solvent in the coating composition, the greater will be the
emissions. Primers and solids coating have a solids concentration of 50 to 60 %, basecoats
between 20 and 30 % and clearcoats between 50 and 60 % [23]. Emissions are also influenced
by the surface of the parts being coated, the coating thickness, the configuration of the part,
and the used application technique. [cf. 2]
For the methodology as presented in [1], small cars have been estimated to have an average
surface of below 70 m$^2$, medium size cars of between 70 and 90 m$^2$, and large cars of above
90 m$^2$. The corresponding emission factor has on average been estimated with about 220 g/m$^2$
for the USA [cf. 1]. In the European automobile industry, much lower emission factors can be
realised, due to numerous emission reduction measures, which have been implemented. An
average emission factor of 100 g/m$^2$ corresponding to an average solvent consumption of
8 kg/vehicle has been reported [22].
By applying both water-based technology and secondary abatement options in the same
equipment, low emission values (around 25 g/m$^2$) could be obtained for green field sites.
However, costs are excessive and the techniques cannot be applied in existing facilities. [23]

3 Primary Emission Reduction Measures
Relevant primary measures as considered in [1] are increase of transfer efficiency of the
application technique, and the use of low-solvent paints (incl. water-based paints) in order to
comply e. g. with currently negotiated EU emission limit values.

3.1 Improvement of Application Efficiency
Within the industrial coating of automobiles, high requirements do exist regarding optical
quality of the coatings, and therefore, only spraying techniques are used for application of
primers and topcoats [4]. Currently, immersion painting is mainly used for the application of
the filler (electrophoretic coating). With spray painting, only a part of the paint is effectively
used (overspray). Spray losses are determined by the product's shape and the spray equipment
used. [3] Transfer efficiencies for conventional air atomised spraying without electrostatic
charge range from 18 to 35 % [22].
Although electrostatic application of spray paints is used for many automatic applications, it
can generally not be used for hand spray applications [23].

Technical Aspects
Improvements in the transfer efficiency (fraction of the solids in the total consumed coating
which remains on the surface) decrease the amount of coating which must be used to achieve
a given film thickness, thus reducing emissions of NMVOC to the ambient air. By
electrostatic spraying, charged paint particles are attracted to an oppositely charged surface.
[3]
The application of electrostatic spraying induces further advantages [6]:

- reduced amounts of waste to be disposed,
- reduced pollution of the coating and drying cabins, resulting in a reduced consumption of cleaning solvents,
- savings in coating time, which may lead to an increase of the capacity.

Different electrostatic spraying processes do exist [cf. 6, 16]:

- electrostatic atomisation process,
- electrostatic spinning bell,
- electrostatic airless and airmix processes: as for electrostatic spinning bells, both conventional and high conductive paints can be used. However, these processes are not commonly used in the automotive industry, since they present some difficulties for meeting specifications [22].

In the case of electrostatic spraying of water-based paints, the paint supplying system must undergo isolation to avoid short circuits; furthermore, a decrease in application efficiency of 10 – 15 % can be observed when using water-based paints. It must also be mentioned that a complete electrostatic application of metallic coats is currently not possible for reasons of aspect. [22]

Figure 7.4.1.1.1.1-1 gives a schematic drawing of the principle of electrostatic spraying processes.

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**Figure 7.4.1.1.1-1**: Basic principle of electrostatic spraying processes [4]
These improved application processes achieve transfer efficiencies from 60 up to 80% [22], even 95% in case of large and smooth surfaces to be coated [3]. Most car manufacturers are using electrostatic applications for automatic operations, however some applications still need to be manual, such as interior spraying. Also basecoat applications typically comprise after an electrostatic application, a pneumatic step to obtain the appearance required by the customer. [23]

**Economic Aspects**

Information on costs is given in the attached technical data sheet.

**3.2 Switch to Low Solvent Products**

Conventional solvent-based paints consist of between 40 and 80 wt.-% solvent, 40 to 50 wt.-% for primers, solids coatings and two-coat clearcoat. Basecoats in the past had solvent concentrations between 84 and 90 wt.-%, whereas modern basecoats still contain between 70 and 80 wt.-% solvent. A further increase of solids concentrations in the basecoat is not in line with the customers expectations regarding paint appearance. It would also require total new paint application systems. [23]

**Technical Aspects**

**3.2.1 Medium and High Solids**

In order to reduce the solvent content of the paint, high solids (HS) and medium solids (MS) are used, the average solvent content of which presently ranges from 30 to 40 wt.-% and 50 to 55 wt.-% respectively. [8]

**3.2.2 Water-Based Coatings**

For several years, water-based coating materials have continuously gained importance on the paint market, since the switch to water-based coatings (solvent content between 10 to 15 wt.-%) leads to several advantages:

- due to their very low solvent content, water-based coatings achieve a high NMVOC-emission reduction rate;
- spraying guns can be cleaned with reduced amounts of cleaning solvents, since rinsing with water is possible;
- less drastic security measures have to be taken compared to solvent-based paints;
- environmental quality for workers is improved regarding occupational health.

However, due to the presence of water and oxygen, water-based paints may lead to corrosion problems for the spraying equipment. In order to minimise this effect, critical parts of the application equipment should be made of special steel or of plastic. [10] Furthermore, due to a lower content of solids in water-based paints, application efficiencies are reduced and thus the coating consumption is higher with water-based coatings than with conventional solvent-based coatings. Since the evaporation kinetic of water-based paints is significantly different from that of solvent-based ones, temperature and hygrometry in the application cabin must undergo particular control, and specific curing equipment, which does not exist in solvent-
based paint application lines, must be introduced. Therefore, an application line which has been designed for solvent-based coatings can hardly be modified into a water-based paint application line.

In one German car manufacturing plant, the entire coating process (including clearcoat with a solvent content of 15 wt.-%) is water-based. Modern water-based operations use electrostatic applications. Half of European automobile manufacturing facilities use the water-based electrodeposition process whereas in Canada, all manufactures of passenger cars use this process.

### 3.2.3 Powder Coatings

Powder coatings are solvent-free products, which require electrostatic application. They have been tested in the automobile manufacture, but remain delicate to use, since they do not permit to meet the high requirements regarding optical quality. Light colour variations may still occur between two powder charges.

Powder coatings are so far not state-of-the-art in the automobile industry for body painting. However, according to [13, 14], powder coatings are currently in development and are expected to find application in the automobile manufacture in few years, but limited to clearcoat applications. Powder clearcoat is currently being used by one car manufacturer in Germany. Applications where customers expectations are not that high, such as for trucks, are also possible. Intensive research is made on powder coating since its environmental qualities are remarkable.

- low emissions, even emission-free, which means also minimal problem with odours;
- low or no waste generation;
- no generation of waste water;
- possibility of powder recovery;
- high application efficiency.

However, powder coating has the following disadvantages:

- film thickness is difficult to control and influences appearance substantially;
- the reclamation of powder is not easy (problems with clogging and ageing);
- scratch and marring resistance is more difficult to obtain;
- application window (temperature, humidity) is very narrow;
- cannot be manually applied, which requires different solution for interiors;
- very high investments and increased operating costs.

**Economic Aspects**

Information on costs is given in the attached technical data sheet.
3.3 Solvent Management / Good Housekeeping

3.3.1 Recovery of Purge Solvent

Technical Aspects

Especially where different colours are sprayed through the same paint system, a purge between each colour change is required. In the past, these purges were dumped into the spray booth water recirculation system and hence emitted. Modern paint equipment includes recovery of the purge solvents. Recovered solvent can be reclaimed and reused, at least for less critical applications. [23]

Economic Aspects

Information on costs is given in the attached technical data sheet.

3.3.2 Batch Painting

Technical Aspects

Purging between each vehicle can be avoided in the case several vehicles (5 to 20 or more) are painted in the same colour one after the other. This can only be done if sufficient storage of vehicles is available to allow for this type of mixing. [23]

Economic Aspects

Information on costs is given in the attached technical data sheet.

3.3.3 Solvent Management Plan

Technical Aspects

A good solvent management that controls all solvents used and includes programs for improvement has proven to provide good results and substantial savings in solvent usage. [23] As far as possible, low-solvent cleaning agents should be used, and the cleaning work should be performed in such a way that the solvents used can be separately captured and disposed of. The consumption of solvents needed for cleaning the interior of the spray booth can be reduced by adhesively covering the walls with film or sheeting, which for cleaning is then pulled off and disposed of. However, this will create waste problems.

Economic Aspects

Information on costs is given in the attached technical data sheet.

4 Secondary Emission Reduction Measures

Technical Aspects

Two techniques are used as secondary emission reduction measures in vehicle paint operations [23]:

...
• Incineration on ovens. A substantial part of the total solvents is emitted inside the oven. The exhaust of the oven is incinerated and the solvents are destroyed with an efficiency of above 90%.

• Carbon adsorption on spray booth exhaust (concentration step) followed by thermal incineration. In carbon adsorption, the solvents in the exhaust air are first concentrated on the active carbon and afterwards recovered; the concentrated solvents are destroyed, in most cases in an incinerator.

Besides these techniques, also biological options (e.g. biofilters and bioscrubbers) are increasingly being used for waste gas cleaning, but their cleaning capacity is not sufficient for use in the manufacture of automobiles [24].

**Economic Aspects**

Information on costs is given in the attached technical data sheet.

5 Side Effects

• Water-based paints will reduce occupational health problems caused by solvent containing paints. However, a pollution displacement from air towards water should be avoided. Moreover, to guarantee the conservation of water-based paints, conservation agents are added sometimes, which may result into a further disposal problem [8]. The higher energy required contributes to the global warming. A study has shown that modification to water-based systems or installation of carbon adsorption equipment may lead to the same result as regards emission reduction efficiency, the overall energy balance is slightly in favour of the carbon adsorption. [23]

• Powder coatings on the other hand generate neither waste water, nor other waste. However, recycling seems to be necessary for economic reasons, which may lead to quality problems such as colour changes and increased risks of powder pollution.

• The incineration of solvent containing waste gas will result in an increased energy consumption and additional combustion emissions, such as CO₂.

6 References


Application of Paint


[19] UK Society of Motor Manufacturers & Traders


7.4.1.1.2 Manufacture of Truck Cabins

This source category (SNAP 94 extension 06 01 01 02) covers the coating of truck cabins. A truck cabin is defined as the housing for the driver, and all integrated housing for the technical equipment, of category N2 and N3 vehicles.

1 Technology Description

As concerns the average painted surfaces of trucks, the following figures are available [3]:

**Table 7.4.1.1.2-1:** Average surface of painted truck parts [3]

<table>
<thead>
<tr>
<th>Painted objects</th>
<th>Average painted surface [m²/vehicle]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck cabins</td>
<td>60-75</td>
</tr>
<tr>
<td>Truck boxes</td>
<td>80</td>
</tr>
<tr>
<td>Truck axles</td>
<td>4-8</td>
</tr>
<tr>
<td>Truck chassis</td>
<td>11-25</td>
</tr>
</tbody>
</table>

In the methodology as presented in [1], the relevant surface of a typical truck cabin has been estimated to be 60 m².

(Cf. also the technology description dedicated to passenger cars)

2 Emission Sources

The NMVOC emissions from truck coating processes are significantly higher than for passenger cars given the fact that [3]:

- the ratio between the surface coated in spray booths and the total surface (electrocoat) is substantially higher for commercial vehicles than for passenger cars;
- nearly all applications are manual, resulting in a much lower efficiency compared to automatic spraying;
- the automatisation of the spraying system is difficult due to the low production volume and the variation in shape of the products;
- the colour range is much wider (up to one hundred different colours), which results in more frequent colour change operations and a large consumption of cleaning solvents.

Total NMVOC emissions from existing plants currently amount to 0.12 kg/m² on average for trucks, going up to 0.16 kg/m² in some cases [3].

For light duty trucks, the following subdivision of emission relevant substances and activities can be given:

---

2 N2: vehicles used for the carriage of goods and having a maximum mass exceeding 3.5 Mg but not exceeding 12 Mg.

N3: vehicles used for the carriage of goods and having a maximum mass exceeding 12 Mg.
Table 7.4.1.2-2: NMVOC emission factors for light duty truck surface coating*

<table>
<thead>
<tr>
<th>Coating</th>
<th>NMVOC emission factor [kg/vehicle]</th>
<th>NMVOC emission factor [kg/h]</th>
<th>Source</th>
</tr>
</thead>
<tbody>
<tr>
<td>Primer</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solvent-based (spraying technique)</td>
<td>19.27</td>
<td>732</td>
<td>[2]</td>
</tr>
<tr>
<td>Cathodic electrodeposition</td>
<td>0.27</td>
<td>10</td>
<td>[2]</td>
</tr>
<tr>
<td>One-coat topcoat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Solvent-based spray</td>
<td>6.38</td>
<td>243</td>
<td>[2]</td>
</tr>
<tr>
<td>Water-based spray</td>
<td>2.3</td>
<td>87</td>
<td>[2]</td>
</tr>
<tr>
<td>Topcoat</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>Lacquer</td>
<td>n. a.</td>
<td>n. a.</td>
<td>[2]</td>
</tr>
<tr>
<td>Dispersion lacquer</td>
<td>n. a.</td>
<td>n. a.</td>
<td>[2]</td>
</tr>
<tr>
<td>Enamel</td>
<td>17.71</td>
<td>673</td>
<td>[2]</td>
</tr>
<tr>
<td>Basecoat/clearcoat</td>
<td>18.91</td>
<td>719</td>
<td>[2]</td>
</tr>
<tr>
<td>Waterborne</td>
<td>7.03</td>
<td>267</td>
<td>[2]</td>
</tr>
</tbody>
</table>

* Based on an average line speed of 38 light duty trucks/h.

For the methodology presented in [1] for the uncontrolled case, an emission factor of 280 g/m² has been taken for heavy duty truck cabins.

3 Primary Emission Reduction Measures

Technical Aspects

It is assumed that mainly the same measures apply as for passenger cars, however, due to lower quality requirements, there may be even more potential for substitution.

Economic Aspects

Information on costs is given in the attached technical data sheet.

4 Secondary Emission Reduction Measures

Technical Aspects

Also for secondary measures it is assumed that the same measures apply as for passenger cars.

Economic Aspects

Information on costs is given in the attached technical data sheet.
5 Side Effects

- Water-based paints will reduce occupational health problems caused by solvent containing paints. However, a pollution displacement from air towards water should be avoided. Moreover, to guarantee the conservation of water-based paints, conservation agents are added sometimes, which may result into a further disposal problem [4].
- Powder coatings on the other hand generate neither waste water, nor other waste.
- The incineration of solvent containing waste gas will result in additional combustion emissions, such as CO\textsubscript{2}, etc.

6 References


7.4.1.1.3 Manufacture of Trucks

This source category (SNAP 94 extension 06 01 01 03) covers the coating of UN/ECE categories N1 to N3 vehicles (vans and trucks).

1 Technology Description

As concerns the average painted surfaces of trucks, the following figures are available:

**Table 7.4.1.1.3-1:** Average surface of painted truck parts

<table>
<thead>
<tr>
<th>Painted objects</th>
<th>Average painted surface [m²/vehicle]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Truck cabins</td>
<td>60-75</td>
</tr>
<tr>
<td>Truck boxes</td>
<td>80</td>
</tr>
<tr>
<td>Truck axles</td>
<td>4-8</td>
</tr>
<tr>
<td>Truck chassis</td>
<td>11-25</td>
</tr>
</tbody>
</table>

The methodology presented in [1] comprises an average surface for trucks of 100 m².

(Cf. also the technology description dedicated to passenger cars)

2 Emission Sources

The NMVOC emissions from truck coating processes are significantly higher than for passenger cars given the fact that:

- the ratio between the surface coated in spray booths and the total surface (electrocoat) is substantially higher for commercial vehicles than for passenger cars;
- nearly all applications are manual, resulting in a much lower efficiency compared to automatic spraying;
- the automatisation of the spraying system is difficult due to the low production volume and the variation in shape of the products;
- the colour range is much wider (up to one hundred different colours), which results in more frequent colour change operations and a large consumption of cleaning solvents.

Total NMVOC emissions from existing plants currently amount to 0.12 kg/m² on average for trucks, going up to 0.16 kg/m² in some cases.

For the time being, an emission factor for uncontrolled emissions of 370 g/m² was taken for heavy duty trucks manufacture in the methodology as given in [1].

---

3 N1: vehicles used for the carriage of goods and having a maximum mass not exceeding 3.5 Mg.

N2: vehicles used for the carriage of goods and having a maximum mass exceeding 3.5 Mg but not exceeding 12 Mg.

N3: vehicles used for the carriage of goods and having a maximum mass exceeding 12 Mg.
3 Primary Emission Reduction Measures

Technical Aspects

It is assumed that mainly the same measures apply as for passenger cars, however, due to lower quality requirements, there may be even more potential for substitution.

Economic Aspects

Information on costs is given in the attached technical data sheet.

4 Secondary Emission Reduction Measures

Technical Aspects

Also for secondary measures it is assumed that the same measures apply as for passenger cars.

Economic Aspects

Information on costs is given in the attached technical data sheet.

5 Side Effects

- Water-based paints will reduce occupational health problems caused by solvent containing paints. However, a pollution displacement from air towards water should be avoided. Moreover, to guarantee the conservation of water-based paints, conservation agents are added sometimes, which may result into a further disposal problem [3].
- Powder coatings on the other hand generate neither waste water, nor other waste.
- The incineration of solvent containing waste gas will result in additional combustion emissions, such as CO$_2$, etc.

6 References


7.4.1.1.4 Manufacture of Buses

This source category (SNAP 94 extension 06 01 01 04) covers the coating of UN/ECE categories M2 and M3 vehicles (buses)\(^4\).

1 Technology Description

As regards the average painted surface of buses, the following figures are available [2]:

**Table 7.4.1.1.4-1:** Average surface of painted vans and bus parts [2]

<table>
<thead>
<tr>
<th>Painted objects</th>
<th>Average painted surface (\text{[m}^2/\text{vehicle]})</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vans</td>
<td>120</td>
</tr>
<tr>
<td>Bus bodies</td>
<td>220-280</td>
</tr>
<tr>
<td>Bus chassis</td>
<td>18-25</td>
</tr>
</tbody>
</table>

For the methodology as presented in [1], an average surface area of 200 m\(^2\) has been taken for bus coating.

(Cf. also the technology description dedicated to passenger cars)

2 Emission Sources

The NMVOC emissions from van and bus coating processes are significantly higher than for passenger cars given the fact that [2]:

- the ratio between the surface coated in spray booths and the total surface (electrocoat) is substantially higher for commercial vehicles than for passenger cars;
- nearly all applications are manual, resulting in a much lower efficiency compared to automatic spraying;
- the automatisation of the spraying system is difficult due to the low production volume and the variation in shape of the products;
- the colour range is much wider (up to one hundred different colours), which results in more frequent colour change operations and a large consumption of cleaning solvents.

Total NMVOC emissions from existing plants currently amount to 500 g/m\(^2\) for buses [2]. For the methodology as given in [1], an emission factor for buses of 800 g/m\(^2\) has been taken for uncontrolled emissions.

---

\(^4\) M2: vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat, and having a maximum mass not exceeding 5 Mg.

M3: vehicles used for the carriage of passengers and comprising more than eight seats in addition to the driver's seat, and having a maximum mass exceeding 5 Mg.
3 Primary Emission Reduction Measures

Technical Aspects

It is assumed that mainly the same measures apply as for passenger cars, however, due to lower quality requirements, there may be even more potential for substitution.

Economic Aspects

Information on costs is given in the attached technical data sheet.

4 Secondary Emission Reduction Measures

According to [4], secondary measures turn out to be ecologically and economically disadvantageous, since paint application is mainly done manually. Due to this fact high air exchanges rates are required, in order to comply with occupational health obligations. Thus, in the manufacture of buses, only primary measures are considered.

5 Side Effects

• Water based paints will reduce occupational health problems caused by solvent containing paints. However, a switch of emissions from air towards water should be avoided. Moreover, to guarantee the conservation of water-based paints, conservation agents are added sometimes, which may result into a further disposal problem [3].

• Powder coatings on the other hand generate neither waste water, nor other waste.

6 References


Technical Data Sheets