Category		Title
NFR	2.D.3.c	Asphalt roofing
SNAP	040610	Asphalt roofing materials
ISIC		
Version	Guidebook 2019	

Coordinator
Jeroen Kuenen

Contributing authors (including to earlier versions of this chapter)
Marc Deslauriers and Mike Woodfield

Contents

1 Overview

The present chapter covers emissions from the asphalt roofing industry. The industry manufactures saturated felt, roofing and siding shingles, and roll roofing and sidings. Most of these products are used in roofing and other building applications. This source category covers emissions of non-methane volatile organic compounds (NMVOC), carbon monoxide (CO) and particulate material from all related facilities, with the exception of asphalt blowing, which is inventoried separately under NFR source category 2.D.3.g 'Chemical products'.

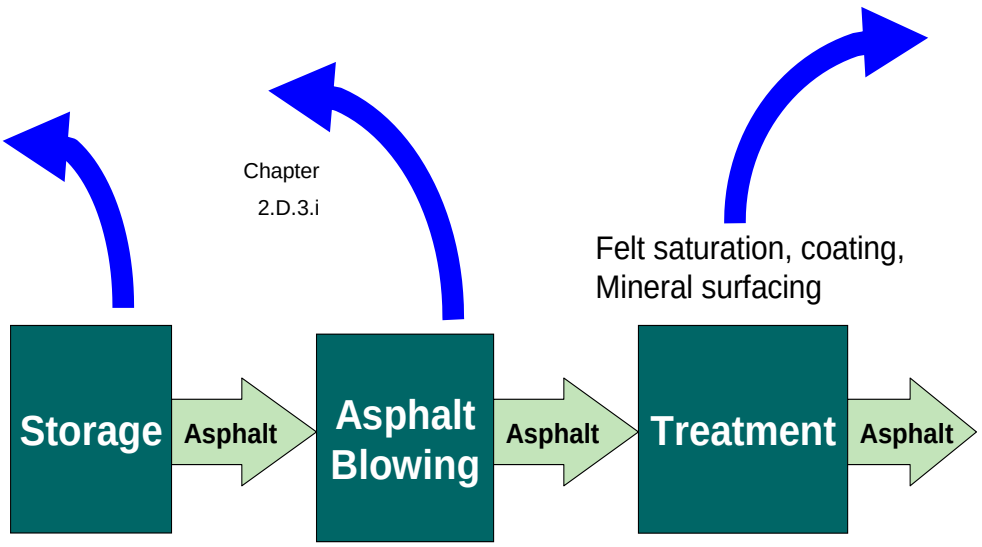
Combustion emissions of e.g. sulphur oxides (SO_x) and nitrogen oxides (NO_x) occurring during the asphalt roofing processes are inventoried under source category 1.A.2.g.i.

2 Description of sources

2.1 Process description

Asphalt felt, roofing and shingle manufacture involves the saturation or coating of felt. Heated saturant and/or coating asphalt is applied through dipping and/or spraying. Key steps in the process include asphalt storage, asphalt blowing (included in NFR source category 2.D.3.g), felt saturation, coating and mineral surfacing. When glass fibre is used in place of paper felt, the saturation step is eliminated.

Figure 2.1 Process scheme for source category 2.D.3.c Asphalt roofing



2.2 Techniques

For asphalt-saturated felt, a typical manufacturing line consists of a paper feed roll, a dry looper section, a saturator spray section (may not be used), a saturator dipping section, steam-heated drying-in drums, a wet looper, water cooled rollers, a finish floating looper and a roll winder.

For asphalt shingles, smooth rolls and mineral-surfaced rolls, the manufacturing line is similar to the felt line, with the addition of a filled asphalt coater, a granule applicator, a press section, water cooled rollers, a finish floating looper and either a roll winder or a shingle cutter and stacker. Filled asphalt coating is prepared by mixing heated coating asphalt with a mineral stabilizer (filler), which may or may not be pre-dried.

Detailed descriptions of these processes may be found in US EPA (1980).

2.3 Emissions

The processes that contribute to emissions from asphalt roofing manufacturing are:

- the roofing manufacturing line;
- the delivery, transfer, and storage of asphalt and mineral products used in the manufacture of roofing products;
- the blowing of asphalt (inventoried under source category 3.C).

Emission sources included in the present chapter are summarised in Table 2.1.

Table 2.1 Asphalt roofing manufacture — sources of emissions.

Emission source	Pollutant
Saturator	Particulate and gaseous hydrocarbons
Wet looper	Gaseous hydrocarbons
Coater-mixer tank	Particulate hydrocarbons, gaseous hydrocarbons, and inorganic particulates
Coater	Particulate hydrocarbons, gaseous hydrocarbons, and inorganic particulates
Surface application	Inorganic particulates
Sealant strip application	Gaseous hydrocarbons
Asphalt storage tank	Gaseous hydrocarbons and particulate
Materials handling	Inorganic particulates
Filler dryer	Inorganic particulate, combustion gases

2.4 Controls

The following process controls can be used to minimise emissions:

- dip saturators, rather than spray or spray-dip saturators;
- asphalts that inherently produce low emissions;
- reduced temperatures in the asphalt saturant pan;
- reduced asphalt storage temperatures.

Add-on emission controls are summarised in Table 2.2.

Table 2.2 Emission controls for asphalt roofing manufacture

Emission sources	Control devices	Comments
Saturator, wet looper and coater	Afterburner, high energy air filter, electrostatic precipitator, mist eliminators, fabric filters, or wet scrubbers	These sources usually share a common enclosure and are ducted to a common control device.
Coater-mixer	High velocity air filter	Fumes may be routed to common control device (see above).
Asphalt storage tanks	Mist eliminator	May be routed to common control device during production periods.
Mineral surfacing and granule application	Bag-house, wet scrubber, cyclone	
Granule and mineral delivery, storage and transfer	Bag-house(s), wet scrubber, cyclone	Storage and conveyors are usually enclosed to prevent moisture pick-up.

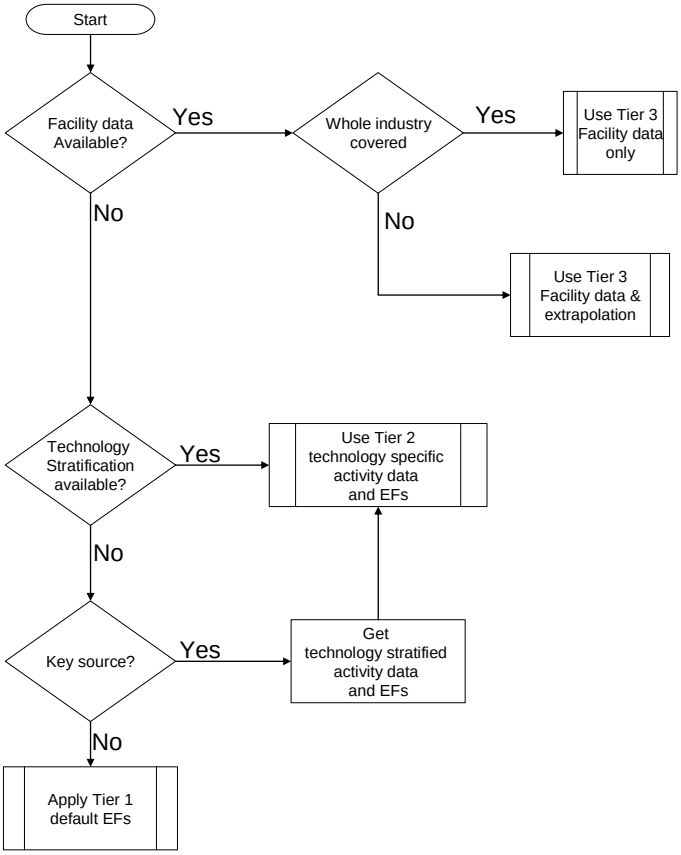
3 Methods

3.1 Choice of method

Figure 3.1 presents the procedure to select the methods for estimating process emissions from the asphalt roofing industry. The basic approach is as follows:

- If detailed information is available: use it;
- If the source category is a key category, a Tier 2 or better method must be applied and detailed input data must be collected. The decision tree directs the user in such cases to the Tier 2 method, since it is expected that it is more easy to obtain the necessary input data for this approach than to collect facility-level data needed for a Tier 3 estimate;
- The alternative of applying a Tier 3 method, using detailed process modelling is not explicitly included in this decision tree. However, detailed modelling will always be done at facility level and results of such modelling could be seen as 'Facility data' in the decision tree.

Figure 3.1 Decision tree for source category 2.D.3.c Asphalt roofing



3.2 Tier 1 default approach

3.2.1 Algorithm

The Tier 1 approach for emissions from asphalt roofing uses the general equation:

$$E_{pollutant} = AR_{production} \times EF_{pollutant} \qquad (1)$$

Where:

$E_{pollutant}$ = the emission of the specified pollutant

$AR_{production}$ = the activity rate for the asphalt roofing

$EF_{pollutant}$ = the emission factor for this pollutant

This equation is applied at the national level, using annual national total production of the asphalt roofing industry. Information on the production, suitable for estimating emissions using the simpler estimation methodology (Tier 1 and 2), is widely available from national statistics or United Nations statistical yearbooks.

In cases where specific abatement options are to be taken into account a Tier 1 method is not applicable and a Tier 2 or Tier 3 approach must be used.

3.2.2 Default emission factors

The Tier 1 approach and emission factors assume an averaged or typical technology and abatement implementation in the country and integrate all sub-processes within the industry from inputting raw materials to the final shipment of the products off site. The default emission factors given in Table 3.1 are from US EPA (1995). The share of PM_{10} and $PM_{2.5}$ is assumed to be 25% and 5% based on the emission distributions from hot mix asphalt plants (US EPA, 2004). This is a non-combustion source and therefore emissions of BC can be considered insignificant[1].

Emissions of NO_x and SO_x originate from combustion. Guidance on estimating these emission factors can be found in chapter 1.A.2.f.i.

Table 3.1 Tier 1 emission factors for source category 2.D.3.c Asphalt roofing

Tier 1 default emission factors					
	Code	Name			
NFR source category	2.D.3.c	Asphalt roofing			
Fuel	NA				
Not applicable	SO_x, NH_3, As, Cr, Cu, Ni, Se, Zn, HCH, DDT, PCBs,				
Not estimated	NO_x, Pb, Cd, Hg, PCDD/F, Benzo(a)pyrene, Benzo(a)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB,				
Pollutant	Value	Unit	95 % confidence interval		Reference
			Lower	Upper	
CO	9.5	g/Mg shingle	3	30	US EPA (1995)
NMVOC	130	g/Mg shingle	40	400	US EPA (1995)
TSP	1 600	g/Mg shingle	500	5 000	US EPA (1995)
PM_{10}	400	g/Mg shingle	130	1 200	US EPA (1995)/US EPA (2004)
$PM_{2.5}$	80	g/Mg shingle	30	240	US EPA (1995)/US EPA (2004)
BC	0.013	% of $PM_{2.5}$	0.006	0.026	US EPA (2011 file no.: 91148)

3.2.3 Activity data

In order to estimate emissions, production data are required by plant or for the sector. The relevant activity statistics used in Tier 1 is the production of shingles.

3.3 Tier 2 technology-specific approach

3.3.1 Algorithm

The Tier 2 approach is similar to the Tier 1 approach. To apply the Tier 2 approach, both the activity data and the emission factors need to be stratified according to the different techniques that may occur in the country.

The Tier 2 approach is as follows:

Stratify the asphalt roofing in the country to model the different product and process types occurring in the national industry into the inventory by:

- defining the production using each of the separate product and/or process types (together called 'technologies' in the formulae below) separately; and
- applying technology-specific emission factors for each process type:

[1] BC emission factors included in this chapter of the 2013 EMEP/EEA Guidebook version should therefore be disregarded.

$$E_{pollutant} = \sum_{technologies} AR_{production,technology} \times EF_{technology,pollutant} \quad (2)$$

where:

$AR_{production,technology}$ = the production rate within the source category, using this specific technology

$EF_{technology,pollutant}$ = the emission factor for this technology and this pollutant

A country where only one technology is implemented will result in a penetration factor of 100 % and the algorithm in equation (3) reduces to:

$$E_{pollutant} = AR_{production} \times EF_{technology,pollutant} \quad (4)$$

where:

$E_{pollutant}$ = the emission of the specified pollutant

$AR_{production}$ = the activity rate for the use of asphalt roofing materials

$EF_{pollutant}$ = the emission factor for this pollutant

The emission factors in this approach still include all sub-processes within the industry.

3.3.2 Technology-specific emission factors

This section identifies two types of saturators that may be used in the asphalt roofing process. The emission factors given in the tables below are taken from US EPA (1995) and are applicable to uncontrolled saturators with drying, in drum section (wet looper for CO) and coater. Information on other variants of the technology may be found in US EPA (1995).

Table 3.2 Tier 2 emission factors for source category 2.D.3.c, Asphalt roofing, dip saturator.

Tier 2 default emission factors					
	Code	Name			
NFR source category	2.D.3.c	Asphalt roofing			
Fuel	NA				
SNAP (if applicable)	040610 Roof covering with asphalt materials				
Technologies/Practices	Dip saturator, drying-in drums section, wet looper and coater				
Region or regional conditions					
Abatement technologies	Uncontrolled				
Not applicable	SO_x, NH_3, As, Cr, Cu, Ni, Se, Zn, HCH, PCBs,				
Not estimated	NO_x, Pb, Cd, Hg, PCDD/F, Benzo(a)pyrene, Benzo(a)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB,				
Pollutant	Value	Unit	95 % confidence interval		Reference
			Lower	Upper	
CO	9.5	g/Mg shingle	3	30	US EPA (1995)
NMVOC	46	g/Mg shingle	15	150	US EPA (1995)
TSP	600	g/Mg shingle	200	1 800	US EPA (1995)
PM_{10}	150	g/Mg shingle	50	450	US EPA (1995)/US EPA (2004)
$PM_{2.5}$	30	g/Mg shingle	10	90	US EPA (1995)/US EPA (2004)
BC	0.013	% of PM2.5	0.006	0.026	US EPA (2011 file no.: 91148)

Table 3.3 Tier 2 emission factors for source category 2.D.3.c, Asphalt roofing, spray / dip saturator.

Tier 2 default emission factors					
	Code	Name			
NFR source category	2.D.3.c	Asphalt roofing			
Fuel	NA				
SNAP (if applicable)	040610 Roof covering with asphalt materials				
Technologies/Practices	Dip saturator, drying-in drums section, wet looper and coater				
Region or regional conditions					
Abatement technologies	Uncontrolled				
Not applicable	SO_x, NH_3, As, Cr, Cu, Ni, Se, Zn, HCH, PCBs				
Not estimated	NO_x, Pb, Cd, Hg, PCDD/F, Benzo(a)pyrene, Benzo(a)fluoranthene, Benzo(k)fluoranthene, Indeno(1,2,3-cd)pyrene, HCB,				
Pollutant	Value	Unit	95 % confidence interval		Reference
			Lower	Upper	
CO	9.5	g/Mg shingle	3	30	US EPA (1995)
NMVOC	130	g/Mg shingle	40	400	US EPA (1995)
TSP	1 600	g/Mg shingle	500	5 000	US EPA (1995)
PM_{10}	400	g/Mg shingle	130	1 200	US EPA (1995)/US EPA (2004)
$PM_{2.5}$	80	g/Mg shingle	30	240	US EPA (1995)/US EPA (2004)
BC	0.013	% of $PM_{2.5}$	0.006	0.026	US EPA (2011 file no.: 91148)

3.3.3 Abatement

A number of add-on technologies exist that are aimed at reducing the emissions of specific pollutants. The resulting emission can be calculated by replacing the technology-specific emission factor with an abated emission factor as given in the formula:

$$EF_{technology,abated} = (1-\eta_{abatement}) \times EF_{technology,unabated} \quad (5)$$

Where:

$EF_{technology,\ abated}$ = the emission factor after implementation of the abatement

$\eta_{abatement}$ = the abatement efficiency

$EF_{technology,\ unabated}$ = the emission factor before implementation of the abatement

This section presents default abatement efficiencies for a number of abatement options, applicable in this sector.

Efficiencies equal to 0 % indicate that the abatement technique does not change the emission level of a certain pollutant.

Table 3.4 Abatement efficiencies ($\eta_{abatement}$) for source category 2.D.3.c Asphalt roofing.

Tier 2 Abatement efficiencies					
	Code	Name			
NFR Source Category	2.D.3.c	Asphalt roofing			
Fuel	NA	not applicable			
SNAP (if applicable)	040611	Asphalt roofing materials			
Technologies/Practices	Dip saturator, drying-in drum section, wet looper and coater				
Abatement technology	**Pollutant**	**Efficiency**	**95% confidence interval**		**Reference**
		Default Value	**Lower**	**Upper**	
ESP	TSP	97%	92%	100%	US EPA (1995)
	NMVOC	0%	0%	0%	US EPA (1995)
High Energy Air Filter (HEAF)	TSP	94%	83%	100%	US EPA (1995)
	NMVOC	0%	0%	0%	US EPA (1995)

Table 3.5 Abatement efficiencies ($\eta_{abatement}$) for source category 2.D.3.c Asphalt roofing.

Tier 2 Abatement efficiencies					
	Code	Name			
NFR Source Category	2.D.3.c	Asphalt roofing			
Fuel	NA	not applicable			
SNAP (if applicable)	040611	Asphalt roofing materials			
Technologies/Practices	Spray / Dip saturator, drying-in drum section, wet looper, coater and storage tanks				
Abatement technology	**Pollutant**	**Efficiency**	**95% confidence interval**		**Reference**
		Default Value	**Lower**	**Upper**	
High Energy Air Filter (HEAF)	TSP	98%	95%	100%	US EPA (1995)
	NMVOC	0%	0%	0%	US EPA (1995)

3.3.4 Activity data

Activity data on shingles production are the relevant activity statistics for using the Tier 2 emission factors. These may be obtained from specific plants or from the sector as a whole.

3.4 Tier 3 emission modelling and use of facility data

There is no available Tier 3 information for this source category.

4 Data quality

No specific issues.

5 Glossary

$AR_{production, technology}$	the production rate within the source category, using a specific technology
$AR_{production}$	the activity rate for the use of asphalt roofing materials
$E_{facility, pollutant}$	the emission of the pollutant as reported by a facility
$E_{pollutant}$	the emission of the specified pollutant
$E_{total, pollutant}$	the total emission of a pollutant for all facilities within the source category
$EF_{country, pollutant}$	a country-specific emission factor
$EF_{pollutant}$	the emission factor for the pollutant
$EF_{technology, abated}$	the emission factor after implementation of the abatement
$EF_{technology, pollutant}$	the emission factor for this technology and this pollutant
$EF_{technology, unabated}$	the emission factor before implementation of the abatement
$Penetration_{technology}$	the fraction of production using a specific technology
$Production_{facility}$	the production rate in a facility
$Production_{total}$	the production rate in the source category
$\eta_{abatement}$	the abatement efficiency

6 References

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7 Point of enquiry

Enquiries concerning this chapter should be directed to the relevant leader(s) of the Task Force on Emission Inventories and Projection's expert panel on combustion and industry. Please refer to the TFEIP website (www.tfeip-secretariat.org/) for the contact details of the current expert panel leaders.