1.A.3.b vi - Road Transport: Automobile Tyre and Brake Wear

Short description

In sub-categories *1.A.3.b vi - Road transport: Automobile tyre and brake wear* emissions from automobile tyre and brake wear in RT are reported. Therefore, these sub-category is an important source for a) particle emissions and b) emissions of heavy metals, POPs etc. included in these particles.

Method	AD	EF	Key Category
T1, T3	NS, M	CS	**L & T**: TSP, $PM_{2.5}$, PM_{10}, Pb, BC

Methodology

Activity data

Abrasive emissions from tyre and brake wear are estimated based on vehicle-type specific mileage data.

For detailed mileage data, please see superordinate chapter on abrasive emissions from road vehicles.

Emission factors

The tier1 emission factors used here have been derived from the 2019 version of the EMEP/EEA air pollutant emission inventory guidebook. [1)]

[!– The tier1 emission factors used here have been derived within a literature study in 2006. During this study, average amounts of particulate wear per km and for different types of brakes or tyres (= EF<sub>PM - specific<sub>) were derived from which annual amounts of PM emissions can be estimated as follows:

math \begin{gather} EM(PM)_\text{ annual, type of vehicle} = EF(PM)_\text{ specific, per km} \cdot Mileage_\text{ annual, type of vehicle} \end{gather} math

Table 1: Average wear rates [mg TSP / vehicle km] for different types of road vehicles

		= **Ø Wear rate for…**
= **Vehicle type**	= **…tyres**	= **…brakes**
~ Passenger Cars	> 90	> 14
~ Motorcycles	> 45	> 7
~ Mopeds	> 23	> 3.5
~ Light Duty Vehicles	> 150	> 29

~ Heavy Duty Vehicles	> 600	> 67
thereof: Trucks	> 800	> 67
thereof: Buses	> 500	> 67

Based on average contents of heavy metals in tyres and brakes per gram of emitted particulate matter (also derived during the literature study), emission factors for HM and PAHs were estimated as follows:

math \begin{gather} EF(HM)_\text{ per km, type of vehicle} = EM(PM)_\text{ per km, type of vehicle} \cdot ØHM-content_\text{ type of brake or tyre} \end{gather} math

Table 2: Average heavy metal contents [mg HM / kg TSP] in particulate matter from tyre and brake wear

					= Ø HM content in particulate matter from…			
	= …tyre wear				**= …brake wear**			
= HM	= all vehicles	= PC & LDV	= HDV: Truck	= HDV: BUS	= MTW			
~ Cd	> 2	> 11	> 0	> 0	> 11			
~ Pb	> 14.5	> 8,580	> 180	> 180	> 8,580			
~ Hg	> 0.02	> 0	> 25	> 25.00	> 0			
~ As	> 1.6	> 9	> 42	> 42.00	> 9			
~ Cr	> 1.8	> 130	> 5,400	> 5,400	> 130			
~ Cu	> 2.8	> 113,400	> 231,000	> 231,000	> 681,000			
~ Ni	> 1.8	> 240	> 335	> 335	> 240			
~ Se	> 20	> 20	> 20	> 20	> 20			
~ Zn	> 11,500	**1**		> 36,600	> 9,250	> 9,250	> 36,600	
~ Zn	> 19,500	**2**						
1								
2								

From these PM-based emission factors, emission estimates for HM and PAHs are estimated as follows:

math \begin{gather} EM(HM)_\text{ annual, type of vehicle} = EF(HM)_\text{ per km, type of vehicle} \cdot Mileage_\text{ annual, type of vehicle} \end{gather} math

In contrast to passenger cars, LDVs and HDVs, as there are no aggregate HM or PAH contents available for motorized two-wheelers as a whole but for mopeds and motorcycels separately, and as estimates have to be provided as sum for all motorized two-wheelers (MTWs) within the NFR tables, the emission factors applied here represent annual implied values. These IEFs display weighted values calculated from the named specific tier1 EFs for mopeds and motorcycles and the annual mileages for both kind of motorized two-wheelers.

math \begin{gather} IEF_\text{ annual, MTWs} = (EF_\text{ mopeds} \cdot Mileage_\text{ annual, mopeds} + EF_\text{ motorcycles} \cdot Mileage_\text{ annual, motorcycles}) / Mileage_\text{ annual, mopeds + motorcycles} \end{gather} math

Here, as the *mopeds : motorcycles* mileage ratio changes annually, the IEFs change on an annual basis, too. (As these changes occur in the fourth decimal place or later, they are not diplsayed in the

overview tables below.) –]

Table 1: Default emission factors applied

~ Source	= **Tyre Wear**						= **Brake Wear**					
~ Vehicle Type	= **PCs**	= **LDVs**	= **HDVs**	= **Buses**	= **MTWs**	**1**	= **PCs**	= **LDVs**	= **HDVs**	= **Buses**	= **MTWs**	**1**
< **Particulate Matter**, in [mg/km]												
< BC	> 1.07	> 1.69	> 4.50	> 4.50	> 0.552	> 0.750	> 1.17	> 3.265	> 3.265	> 0.444		
< PM_{2.5}	> 4.49	> 7.10	> 18.9	> 18.9	> 1.93	> 2.93	> 4.56	> 12.7	> 12.7	> 1.44		
< PM₁₀	> 6.400	> 10.1	> 27.0	> 24.3	> 2.80	> 7.35	> 11.5	> 32.0	> 28.8	> 3.63		
< TSP	> 10.7	> 16.9	> 45.0	> 45.0	> 4.60	> 7.50	> 11.7	> 32.7	> 32.7	> 3.70		
< **Priority Heavy Metals**, in [µg/km]												
< Pb	> 1.88	> 2.97	> 4.26	> 3.10	> 0.810	> 45.5	> 71.0	> 199	> 199	> 22.5		
< Hg	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0		
< Cd	> 0.050	> 0.079	> 0.114	> 0.083	> 0.022	> 0.168	> 0.262	> 0.734	> 0.734	> 0.083		
< **Other Heavy Metals**, in [µg/km]												
< As	> 0.041	> 0.064	> 0.092	> 0.067	> 0.017	> 0.506	> 0.790	> 2.21	> 2.210	> 0.250		
< Cr	> 0.255	> 0.402	> 0.576	> 0.419	> 0.109	> 17.3	> 27.0	> 75.7	> 75.7	> 8.55		
< Cu	> 1.86	> 2.94	> 4.21	> 3.06	> 0.800	> 383	> 598	> 1,674	> 1,674	> 189		
< Ni	> 0.320	> 0.505	> 0.723	> 0.526	> 0.138	> 2.45	> 3.83	> 10.71	> 10.71	> 1.21		
< Se	> 0.214	> 0.338	> 0.484	> 0.352	> 0.092	> 0.15	> 0.234	> 0.655	> 0.655	> 0.074		
< Zn	> 79.5	> 126	> 180	> 131	> 34.2	> 65.1	> 102	> 284	> 284	> 32.1		
POPs												
< PCDD/F	= NA	= NA	= NA	= NA	= NA	= NA	= NA	= NA	= NA	= NA		
< **PAHs**, in [µg/km]												
< B[a]P	> 0.032	> 0.049	> 0.134	> 0.120	> 0.013	> 0	> 0	> 0	> 0	> 0		
< B[b]F	> 0.038	> 0.063	> 0.161	> 0.144	> 0.019	> 0	> 0	> 0	> 0	> 0		
< B[k]F	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0	> 0		
< I[..]P	> 0.019	> 0.028	> 0.082	> 0.072	> 0.006	> 0	> 0	> 0	> 0	> 0		

< ∑ PAHs 1-4	> 0.090	> 0.140	> 0.379	> 0.336	> 0.038	> 0	> 0	> 0	> 0	> 0										
1																				

[!–

~ Material					= **Tyre Wear**					= **Brake Wear**
~ Vehicle type	= **PCs**	= **LDVs**	= **HDVs**	= **Buses**	= **MTWs^^1^^**	= **PCs**	= **LDVs**	= **HDVs**	= **Buses**	= **MTWs^^1^^**
Particulate Matter [mg/km]										
PM_{2.5}	> 4.49	> 7.10	> 18.90	> 18.90	> 1.93	> 2.93	> 4.56	> 12.74	> 12.74	> 1.44
PM₁₀	> 6.40	> 10.10	> 27.00	> 24.30	> 2.80	> 7.35	> 11.47	> 32.00	> 28.80	> 3.63
TSP	> 10.70	> 16.90	> 45.00	> 45.00	> 4.60	> 7.50	> 11.70	> 32.65	> 32.65	> 3.70
Heavy Metals [µg/km]										
Priority HM										
Pb	> 1.31	> 2.18	> 8.70	> 7.25	> 0.56	> 120.00	> 249.00	> 12.00	> 12.00	> 51.11
Hg	> 0.002	> 0.003	> 0.012	> 0.010	> 0.001	> 0.00	> 0.00	> 1.68	> 1.68	> 0.00
Cd	> 0.18	> 0.30	> 1.20	> 1.00	> 0.08	> 0.15	> 0.32	> 0.00	> 0.00	> 0.07
Other HM										
As	> 0.14	> 0.24	> 0.96	> 0.80	> 0.06	> 0.13	> 0.26	> 2.81	> 2.81	> 0.05
Cr	> 0.16	> 0.27	> 1.08	> 0.90	> 0.07	> 1.82	> 3.77	> 361.80	> 361.80	> 0.77
Cu	> 0.25	> 0.42	> 1.68	> 1.40	> 0.11	> 1,588	> 3,289	> 15,477	> 15,477	> 4,056
Ni	> 0.16	> 0.27	> 1.08	> 0.90	> 0.07	> 3.36	> 6.96	> 22.45	> 22.45	> 1.43
Se	> 1.80	> 3.00	> 12.00	> 10.00	> 0.80	> 0.28	> 0.58	> 1.34	> 1.34	> 0.12
Zn	> 1,035.00	> 1,725	> 11,700	> 9,750	> 442	> 512	> 1,061	> 620	> 620	> 218
POPs [µg/km]										
PCDD/F	= NA	= NA	= NA	= NA	= NA	= NA	= NA	= NA	= NA	= NA
PAH										
B[a]P	> 0.03	> 0.05	> 0.13	> 0.12	> 0.01	= NA	= NA	= NA	= NA	= NA
B[b]F	> 0.04	> 0.06	> 0.16	> 0.14	> 0.02	= NA	= NA	= NA	= NA	= NA
B[k]F	= IE	= IE	= IE	= IE	= IE	= NA	= NA	= NA	= NA	= NA
I[..]P	> 0.02	> 0.02	> 0.08	> 0.07	> 0.01	= NA	= NA	= NA	= NA	= NA
∑ PAHs 1-4	> 0.09	> 0.14	> 0.38	> 0.34	> 0.04	= NA	= NA	= NA	= NA	= NA

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+ Discussion of emission trends *(emissions from wear/abrasion only; no fuel combustion included)*

> **NFR 1.A.3.b vi - Emissions from Tyre and Brake Wear** is key source for emissions of

> **PM<sub>2.5<sub>**, **PM<sub>10<sub>**, **TSP** and **Lead (Pb)**.

All reported emissons from tyre and brake wear are connected directly to the mileage driven by the road vehicles covered.

++ Particulate Matter - PM<sub>2.5<sub>, PM<sub>10<sub>,TSP and BC

gallery size="medium" : 1A3bvi_EM_PM2.5.PNG gallery

++ Heavy metals - Lead (Pb)

The emissions of heavy metals are as well linked directly to the trend of mileage.

gallery size="medium" : 1A3bvi_EM_Pb.png gallery

[!–

++ Particulate Matter - PM<sub>2.5<sub>, PM<sub>10<sub>,TSP and BC

gallery size="medium" : 1A3bvi_EM_PM2.5.PNG : 1A3bvi_EM_PM10.png : 1A3bvi_EM_TSP.png : 1A3bvi_EM_BC.png gallery

gallery size="medium" : 1A3bvi_EM(PM)_Tyre.png : 1A3bvi_EM(PM)_Brake.png gallery

++ Selected heavy metals - Chromium, Nickel and Zinc

The emissions of heavy metals are as well linked directly to the trend of mileage.

gallery size="medium" : 1A3bvi_EM_Cr.png : 1A3bvi_EM_Cu.png : 1A3bvi_EM_Zn.png gallery

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Recalculations

Activity data (mileage) have been revised due to the regular revision of the TREMOD model. (see superordinate chapter]).

However, the biggest changes occur in the tier1 **emission factors** that have been revised fundamentally in order to be in line with the tier1 default values provided in the EMEP/EEA Guidebook 2019. Unfortunately, the variety of old and revised emission factors cannot be compared here in a comprehendible way.

For more information on recalculated emission estimates for Base Year and 2018, please see the pollutant-specific recalculation tables following chapter 8.1 - Recalculations].

Planned improvements

Besides a routine revision of the underlying model, no specific improvements are planned.

FAQs

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bibliography : 1 : EMEP/EEA, 2019: EMEP/EEA air pollutant emission inventory guidebook 2019; https://www.eea.europa.eu/publications/emep-eea-guidebook-2019; Copenhagen, 2019. bibliography

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[1)] (bibcite 1)