

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><math display="block">\begin{gathered} EM(PM)_{\text{annual, type of vehicle}} = EF(PM)_{\text{specific, per km}} \cdot \text{Mileage}_{\text{annual, type of vehicle}} \end{gathered}\begin{gathered} EF(HM)_{\text{per km, type of vehicle}} = EM(PM)_{\text{per km, type of vehicle}} \cdot \varnothing_{HM\text{-content}_{\text{type of brake or tyre}} \end{gathered}

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:

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:

$$\text{EM(HM)}_{\text{annual, type of vehicle}} = \text{EF(HM)}_{\text{per km, type of vehicle}} \cdot \text{Mileage}_{\text{annual, type of vehicle}}$$

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 motorcycles 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.

$$\text{IEF}_{\text{annual, MTWs}} = (\text{EF}_{\text{mopeds}} \cdot \text{Mileage}_{\text{annual, mopeds}} + \text{EF}_{\text{motorcycles}} \cdot \text{Mileage}_{\text{annual, motorcycles}}) / \text{Mileage}_{\text{annual, mopeds + motorcycles}}$$

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 displayed 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							
< PM ₁₀	> 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							
< Σ 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 _{<sub>2.5</sub>}	> 4.49	> 7.10	> 18.90	> 18.90	> 1.93	> 2.93	> 4.56	> 12.74	> 12.74	> 1.44							
PM _{<sub>10</sub>}	> 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							

[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](#)

¹⁾ (bibcite 1)