TRANSPHORM

Transport related Air Pollution and Health impacts –

Integrated Methodologies for Assessing Particulate Matter

Collaborative Project, Large-scale Integrating Project

SEVENTH FRAMEWORK PROGRAMME

ENV.2009.1.2.2.1 Transport related air pollution and health impacts

Deliverable D1.2.6, type R

Report on emission factors for wear particles from railways

Due date of deliverable:	project month 30
Actual submission date:	project month 30

Start date of project: 1 January 2010 Duration: 48 months

Organisation name of lead contractor for this deliverable: IVL

Scientist responsible for this deliverable: Erik Fridell

Revision: [1]

Contents

Report on emission factors for wear particles from railways

Erik Fridell

IVL, Swedish Environmental Research Institute, Box 5302, 40014 Gothenburg, Sweden

Introduction

The emission of wear particles from railways is not a well-studied topic. However, there are some studies relating to particle levels and health risks for underground stations for commuter trains and subways. Particle concentrations is becoming an important factor when designing underground stations regarding ventilation and in some cases moving doors in between the tracks and the platform. There are also some studies of particle concentrations inside trains and in the vicinity of stations and railways. However, when it comes to reports on emission factors where the emissions are expressed as gram of particle emissions per train km or equivalent, there is only little data and thus the uncertainties must be considered as large.

Concentration measurements

Typical concentrations reported for underground platforms vary between 1500 and 40 $\mu g/m^3$ for PM_{10} and between 480 and 16 $\mu g/m^3$ for $PM_{2.5}$ (Abbasi 2012). The particle size distribution measured at stations peak at 2- 6 μm (Gustafsson 2012). The filters that have been analysed are usually dominated by Fe followed by Cu and Al (Abbasi 2012). In some cases also large fractions of Si, Ca and K have been reported (Fridell 2011). The latter are likely from re-suspended minerals from the railway.

Emission factors

The emission factors of wear particles and re-suspended particles can be expected to depend on a number of factors such as: train speed, train acceleration, rail curvature, means of breaking (mechanical or regenerating), brake-pad material, rail material, wheel material, contact line material, weight and length of train. Table 1 give emission factors for three types of trains presented by Fridell 2010 from tunnel measurements. Note the large uncertainty range.

Table 1. Emission factor of non-exhaust particles from trains (Fridell 2010).

Train type	*PM_{10} Emission factor (g/train-km)*	*Range (g/train-km)*
Regional	0.24	0.05–0.9
Commuter	0.48	0.1–1.6
Freight	2.9	0.7–9

Fridell (2010) also give emission factor adjusted for train length, i.e. as g/(train-km * train-m). These can be found in Table 2.

Table 2. Emission factor of non-exhaust particles from trains (Fridell 2010).

Train type	*PM_{10} Emission factor (mg/train-km * train-m)*	*Range (mg/train-km * train-m)*
Regional	3.1	0.6–11
Commuter	11	2–35
Freight	5.3	1–15

The number emissions reported by Fridell (2010) are in the range of 10^8 – 10^{10} per train-km for the size range 0.3 – 3 μm measured with an optical instrument. From on-board measurements it is known that the concentration measured under a moving train will vary with orders of magnitude depending on whether mechanical brakes are applied (Fridell 2011) as well as depending on the rail curvature.

References

Abbasi, Saeed, Sellgren, Ulf, Olofsson, Ulf, Particle emission from rail vehicles : A literature review. Proceedings of the Institution of Mechanical Engineers, Part F: Journal of Rail and Rapid Transit, 2012

Erik Fridell, Martin Ferm and Anders Ekberg, Emissions of particulate matters from railways – Emission factors and condition monitoring, Transportation Research D, **15**, 240 (2010)

Erik Fridell, Anders Björk, Martin Ferm and Anders Ekberg, On-board measurements of particulate matter emissions from a passenger train, Journal of Rail and Rapid Transit, **225**, 99 (2011)

Mats Gustafsson, Goran Blomqvist, Erik Swietlicki, Andreas Dahl, Anders Gudmundsson, Inhalable railroad particles at ground level and subterranean stations – Physical and chemical properties and relation to train traffic, Transportation Research Part D 17 (2012) 277–285