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Published in:
[Publication information missing]

2006

Size-Resolved Emission Factor for Particle Generation Caused by Studded Tires – Experimental Results

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INTRODUCTION

The European 24-hour limit value for particle matter with an aerodynamic diameter less than 10 µm (PM_{10}) is often exceeded during winter and early spring in the major Scandinavian cities due to the use of studded tires.

MATERIAL AND METHODS

This study was conducted on a road simulator, which consists of four electrically driven wheels running on a circular track. The simulator was fitted with studded tires of a type which is commonly used on Light Duty Vehicles (LDV) in the Scandinavian countries during the winter season and the pavement is typical for city streets. The particles were measured with an Aerodynamic Particle Sizer (APS, model 3021, TSI Inc., USA) equipped with a PM_{10}-inlet.

After the road simulator is started and accelerated to 70 km/h the particle concentration builds up and reaches a steady state. The measured change in concentration of each APS-channel over time can be described by assuming a box model.

$$C(t)=C_0\, e^{-kt}+\frac{Q}{k}(1-e^{-kt})$$

Here $C(t)$ is the concentration at time t, C_0 the initial concentration, k the first order loss rate constant and Q the particle source strength.

RESULTS

Curve fittings to the measured APS-channels of 1, 2.5 and 5 µm sized particles are shown in figure 1.

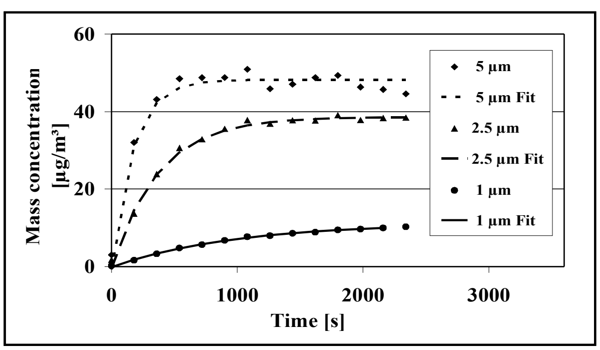

Figure 1. Curve fittings for APS-channels over time.

The particle generation rate was extracted from each channel fit and the size-resolved emission factors (E) are shown in figure 2. The sum of these emission factors gives a PM_{10} emission of 0.6 g/km.

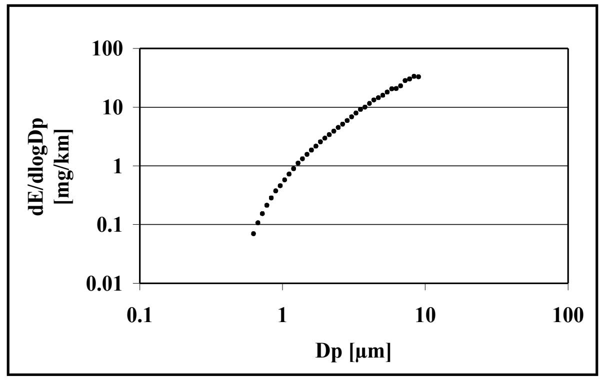

Figure 2. Size-resolved particle emission factors from LDV studded tires per km at 70 km/h.

DISCUSSION

Our estimated PM_{10} emission factor agrees with field measurements carried out in Stockholm, Sweden (Johansson, *et al.,* 2004) and Malmö, Sweden (Sjöberg and Ferm, 2005). Johansson (2004) found the PM_{10} emission factor to be 0.68 g/vehicle km in Stockholm in March when 70% of the vehicles were equipped with studded tires and Sjöberg and Ferm (2005) found an emission factor of 0.40 g/vehicle km in Malmö, when the studded tire density was 40%.

Keywords: *Traffic emission, PM_{10}, Road wear*

REFERENCES

Johansson, C., Norman, M., Omstedt, G., Swietlicki, E. (2004). Particles in urban areas – sources, concentrations and the effects of different actions on the concentration levels measured as PM_{10}. SLB, Stockholm, Sweden, Report 4:2004

Sjöberg, K., Ferm, M., (2005). Measurements of PM_{10} and $PM_{2.5}$ in Malmö, IVL, Stockholm, Sweden, Report U 1756.

This ongoing study is financed by The Swedish Emission Resarch Programme (EMFO).

New particle formation in the urban atmosphere of elsinki during 1

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INTRODUCTION

Urban aerosol particles in Helsinki have been investigated for several years (Hussein et al. 2004). The investigations, so far, have been with respect to traffic emissions and meteorological conditions or other anthropogenic aerosol particle emissions. New particle formation (NPF) has not yet been investigated in Helsinki. On the other hand, NPF analysis have been well established at the boreal forest in Nordic countries as well as in the Finnish Lapland. It has been found that there is a specific yearly pattern in how often NPF are observed (Dal Maso et al. 2005 and Vehkam ki et al. 2004).

In this study we aim to investigate NPF events in Helsinki (60 10 N and 24 57 E, urban background) by utilizing the continuous aerosol particle number size distribution measurements since 1997.

MET ODOLOG

The aerosol particle measurements were performed with a Differential Mobility Particle Sizer (DMPS) (Aalto et al. 2001, okinen et al. 1997). The measurements were made at two different locations in Helsinki (Hussein et al. 2004): 1) nearby downtown at Siltavuori during May 5, 1997 March 4, 2001, 2) SMEAR III measurement station at Kumpula (about 3 km north east Siltavuori) where the aerosol particle measurements have been since March 5th 2001.

The measured particle size range was 7 500 nm until March 9th 2003 when we upgraded the DMPS system to measure particle number size distributions with a wider size range between 3 1000 nm.

The visual analysis of NPF events was performed in daily bases. Day data sets were viewed randomly without any knowledge of the day or weather conditions. The whole data set was analysed four times. First two times there were partial figures including only the data range 7 500nm and in the two other investigations the full detection range was taken into consideration. That give us possibility to compare these two measuring system.

NPF events were classified in four different classes and one non-classified class. The days where there was more than a 3 hours gap or bad data were removed from the analysis. Class 1 contains days where there were clearly identified NPF events (figure 1). Class 2 includes days with high potential for NPF events; it means that there was identifiable growth or the NPF event tail, so it can not be classified as an event day. The days which were clearly not NPF event days, were classified in class 3. Class 4 included the days which were not identified to previous classes.

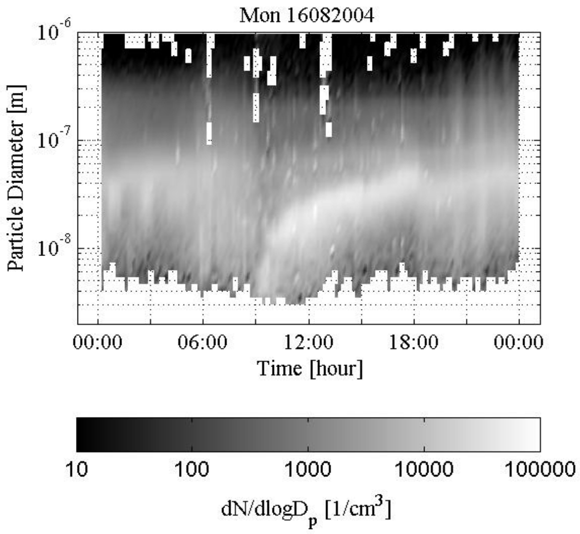

Figure 1. New particle formation event in August 2004, defined as class 1

RESULTS AND DISCUSSION

Urban air contains lot of anthropogenic aerosol particles (Anttila 2004, Laakso et al. 2003), as can be determined by the fact that the class 4 have a greater number of days classified to it. The probability of each class is shown in the figures 2 and 3, it is calculated as a 30 day sliding mean, where the number of event days was divided by the number of analyzed days.

Similar annual pattern for NPF events have been observed at the boreal forest in Southern Finland (Dal Maso et al. 2005) and in the rural part of Northern Finland (Vehkam ki et al. 2004). However, the probability observe NPF events in Helsinki is much lower than in these two other places because of the traffic emissions and high urban background particle number concentrations. Class 3 supports both class 1 and 2 on its behaviour as it was defined non-even class.