Road Dust – Sources, Properties and Abatement Strategies

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Since the EG directive on particulate matter took effect, road dust has emanated as one of the most important air pollutant in many parts of Europe. Further, it is a traffic related air pollution not controlled by rules and laws and is therefore seldom abated. Since the directive is based on mass concentration, the relatively coarse road dust particles play an important role for PM concentrations, especially on local scale.

Road dust is a complex mix of dust with sources that vary in space and time. In Spain and other Mediterranean countries, road dust might originate in dust blown in from Sahara as well as local building sites and wear from pavements, tyres and brakes. In Nordic countries, on the other hand, road dust is a problem mainly in winter and spring, when pavement wear from studded tyres as well as winter gritting make up the bulk material. This large variation in time and space strongly affects the methods and possibilities to mitigate emissions.

Emission of road dust under dry conditions is twofold: either wear particles are emitted directly to the air or they are suspended from a depot of dust on the road surface by passing vehicles. Most of the road dust is coarser than the inhalable fraction but can be further disintegrated into finer fractions by vehicle action. The contribution from the two processes is complex and also very variable depending on the distribution of sources and ambient conditions.

An important component of road dust is mineral particles. The inhalable fraction of wear dust from road pavements peak around 4–5 µm and go down to about 0.5 µm in size. In countries with sub-zero degrees winter conditions, mineral dust from grit and pavement wear often dominates. Studded tyres wear the pavement, but the grit also acts as a sand paper between vehicles and the pavement, to form dust. Pavement stone materials in Nordic countries are chosen to withstand studded tyre wear, while this is not a prioritized stone material property in central Europe. It has been shown that also pavements used in central Europe overrun with summer tyres and unstudded winter tyres emit mineral dust, implying that stone material properties are important for road dust formation also outside cold winter regions.

Tyre and brake wear is another important component of road dust. As with other sources, these vary a lot in time and space, depending on the characteristics of the traffic flow. In contrast to the bulk mineral particles, these are dominated by organic species and metals like Copper Antimony, Zinc etc. For tyre wear, there are quite diverse data concerning size distribution, but there seem to be an inhalable fraction at around a few µm or even smaller. Brake wear dust has a large inhalable fraction that peak around a few µm.

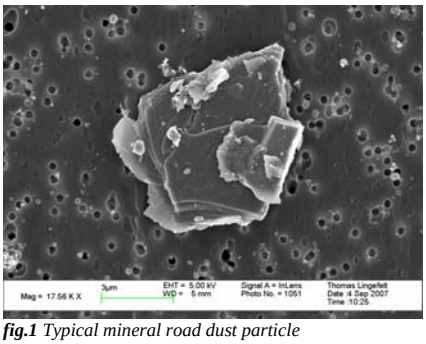

fig.1 *Typical mineral road dust particle*

As mentioned, road dust emissions can be mitigated in many different ways, through either reducing the particle formation or by reducing the suspension to the air. Road dust with local sources, such as road wear can be mitigated through improving pavement properties, winter services and studded tire use (if applicable) or by reducing dust emissions from other local sources contributing to the road dust depot.

fig.2 Dust binding

Under wet conditions, road dust is not emitted to the air as PM, but rather spread to the road surroundings in splash and spray from the traffic. This fact is in many cases used to control road dust emissions through dust binding. Under non-freezing conditions water is used to clean streets, but for better duration and use also under freezing conditions, different types of dust binder have been tested and are in use in some places around Europe. In some Nordic cities, magnesium chloride and calcium chloride as well as the more environmental friendly CMA is used.

A seemingly natural abatement strategy for road dust would be street cleaning. Despite this, many trials show that street cleaning is ineffective when it comes to reducing PM10, while a few show slightly positive results. It seems as if in long term there is a positive effect, while it is hard to reduce high PM10 concentrations from day to day. Both cleaning techniques and strategies need development and should have a potential to be more effective in the future than today.

palabras clave: Polvo, PM10, inhalable, dispersion

key words: Dust, PM10, inhalable, dispersion

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The key to mitigating road dust is to understand the source contributions and adapt an optimal abatement strategy that take into account techniques for reducing both particle production and dispersion. These efforts will differ for different regions, climates, road conditions and traffic regimes, why knowledge dissemination concerning research in this field in different countries is essential to find optimal, applicable strategies.