

GÖTEBORGS UNIVERSITET

When the Rubber Meets the Road

Ecotoxicological Hazard and Risk Assessment of Tire Wear Particles

Anna Wik

Akademisk avhandling för avläggande av
Filosofie Doktorexamen i Tillämpad Miljövetenskap
som offentligt försvaras fredagen den 10 oktober 2008, kl. 10:00,
Stora Föreläsningssalen, Institutionen för Växt- och Miljövetenskaper,
Carl Skottbergs gata 22 B, Göteborg.

Avhandlingen försvaras på engelska.
Fakultetsopponent: Professor Allen Burton, School of Natural Resources and
Environment, Cooperative Institute for Limnology and Ecosystem Research,
University of Michigan, Ann Arbor, MI

Examinator: Professor Åke Larsson, Institutionen för Växt- och
Miljövetenskaper, Göteborgs Universitet

Institutionen för Växt- och Miljövetenskaper, Göteborgs Universitet,
Box 461, 405 30 Göteborg



GÖTEBORGS UNIVERSITET

Abstract

Wik, A. 2008. When the Rubber Meets the Road – Ecotoxicological Hazard and Risk Assessment of Tire Wear Particles. ISBN: 978-91-85529-20-9

Large amounts of rubber particles are dispersed into the environment due to tire wear. The rubber contains a wide range of chemicals, including several of environmental concern. The purpose of this thesis, which is based on six papers [I–VI], was to assess the ecotoxicological hazard and risk associated with tire wear particles, with a main focus on the aquatic environment. A method was developed that enables rapid screening of the toxicity of tire particle leachates [I]. Acute and chronic toxicity of tire particle leachates to aquatic organisms was found to occur at concentrations ranging from 10 to >10 000 mg/l [I–IV]. The toxicity of wear material from different tires was found to vary with more than two orders of magnitude [I–II]. Toxicity identification studies (TIEs) identified organic compounds [II–IV] and Zn [IV] as the toxic components of tire particle leachates. Zn was also identified as the contaminant in the sediments of detention ponds, receiving road runoff, posing the highest threat to surrounding water bodies, and tire wear particles are a main source of this Zn contamination [V].

The Predicted No Effect Concentration (PNEC) was calculated, according to European chemical risk assessment guidelines, based on long term tests with the cladoceran *Ceriodaphnia dubia* and the microalgae *Pseudokirchneriella subcapitata* [IV]. The PNECs are 3.9 mg/l and 0.3 g/kg dw for water and sediments, respectively [VI]. A literature review of markers for tire wear in the environment showed tire particles to be present in surface waters, soils/sediments, air, and biota [VI]. Most of the tire particles are deposited on or close to the road surface and are then further transported by runoff water to receiving waters and sediments. The maximum Predicted Environmental Concentrations (PECs) of tire wear particles in surface water range from 0.03 to 56 mg/l, and the maximum PECs in sediments range from 0.3 to 155 g/kg dw [VI]. Thus, the upper range for PEC/PNEC ratios exceeds unity in both surface waters and sediments, meaning that tire wear particles constitute potential risks for aquatic organisms. The risk for the terrestrial environment is suggested to be restricted to the immediate road surroundings, and it is suggested that more research should be directed towards evaluating the health aspects associated with the inhalation of airborne tire particles [VI].

To conclude, the work presented in this thesis has shown that the contamination from tire wear particles needs to be reduced in order to protect receiving surface waters. This could be achieved by developing tires with more environmentally friendly constituents. Road runoff detention ponds are primary recipients of tire wear particles, and, therefore it is important that construction, environmental monitoring and management of such ponds receive increased attention.

Keywords: tire wear, tire particles, rubber, leaching tests, ecotoxicity tests, *Daphnia magna*, *Ceriodaphnia dubia*, *Pseudokirchneriella subcapitata*, *Danio rerio*, toxicity identification evaluation, road runoff, detention ponds, hazard assessment, risk assessment.