Emissions of Organic Pollutants from Traffic and Roads: Priority Pollutants Selection and Substance Flow Analysis

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Emissions of Organic Pollutants from Traffic and Roads: Priority Pollutants Selection and Substance Flow Analysis

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Introduction

Large quantities of organic pollutants (OPs) are emitted from vehicles, fuels, road and roadside construction materials and they are accumulated on road surfaces. Contaminated road runoff is transported to surface waters, where the OPs may pose a threat to aquatic ecosystems. Therefore, tools that facilitate the prioritization of hazardous compounds for further studies through substance flow analysis (SFA) need to be developed.

Aim and objectives

The specific goals of this research were to:
- Identify sources and quantify uses of OPs present in road runoff.
- Propose a list of Priority Pollutants (PPs) with contaminants intended to be studied further in investigations concerning their optimal elimination from road runoff.
- Compounds from the list of PPs is a subject for Substance Flow Analysis (SFA).

Methods

To identify and classify possible sources of OPs from road environments, as well as to perform the selection of PPs to be included in the SFA, the following methodology was implemented (Figure 1).

Selection criteria

Criteria supporting evaluation of collected data and the choice of PPs include:
- Risk of emission/leaching of pollutants from sources into stormwater systems.
- Emission of specific substances or groups of substances from more than one source in road environments.
- Estimation of use and quantities of OPs emitted from vehicles, fuels and construction materials in Sweden and in the EU.
- Hazardous effects on aquatic environments and humans.
- Availability of analysis methods for chosen substances.

RICH

The RICH (Ranking and Identification of Chemical Hazards) tool was used to provide information regarding physico-chemical and biological properties registered for a wide range of substances occurring in stormwater. The Figure 2 presents sorting steps in the chemical hazards assessment, performed by RICH.

Results: Selection of PPs

The first screening stage for PPs selection allowed to identify and classify the most important sources of OPs in road environment (Table 1).

Table 1. Sources of OP emission identified in traffic environment

<table>
<thead>
<tr>
<th>VEHICLES</th>
</tr>
</thead>
<tbody>
<tr>
<td>Traffic wear/dirt</td>
</tr>
<tr>
<td>Vehicle components</td>
</tr>
<tr>
<td>Fuel</td>
</tr>
<tr>
<td>Road construction materials/parking lots</td>
</tr>
<tr>
<td>Vehicle washing facilities</td>
</tr>
</tbody>
</table>

Further analysis and RICH filtration of OPs involved established selection criteria and resulted in PPs presented in Table 2.

Table 2. Examples of identified PPs

<table>
<thead>
<tr>
<th>PAH 16</th>
<th>Phthalates</th>
<th>Amides</th>
</tr>
</thead>
<tbody>
<tr>
<td>Phenanthrene</td>
<td>benzo[b]fluoranthene</td>
<td>1-aminonaphthalene</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>benzo[a]pyrene</td>
<td>1,4-naphthoquinone</td>
</tr>
<tr>
<td>Pyrene</td>
<td>benzo[k]fluoranthene</td>
<td>p-chlorobenzoic acid</td>
</tr>
<tr>
<td>Oxy-PAH</td>
<td>Phenols</td>
<td>Alkane Aldehydes C1-C40</td>
</tr>
<tr>
<td>Pyrene</td>
<td>benzo[a]pyrene</td>
<td>4-fluorotoluene</td>
</tr>
<tr>
<td>Anthracene</td>
<td>benzo[b]fluoranthene</td>
<td>2-tert-butylhexylphthalate (BBT-DBP)</td>
</tr>
<tr>
<td>Fluoranthene</td>
<td>naphthalene</td>
<td>bis(2-ethylhexyl)phthalate (DEHP)</td>
</tr>
</tbody>
</table>

Results: SFA

SAF is an analytical method developed for quantitative assessment of individual substances through a given system, specified in space and time. For this study, system boundaries are defined in Table 3.

Table 3. The system boundaries for SFA

<table>
<thead>
<tr>
<th>SUBJECT</th>
<th>SPACE FRAME</th>
<th>SOURCES</th>
<th>TIME FRAME</th>
</tr>
</thead>
<tbody>
<tr>
<td>Organic pollutants</td>
<td>Road area</td>
<td>Vehicles, road surface</td>
<td>1 year</td>
</tr>
</tbody>
</table>

Conclusions

- Ten groups of OPs to focus on in the further studies has been selected by the RICH tool filtration process method of around 1200 specific organic compounds likely to be emitted from the road and traffic environment.
- Each stage of methodology encountered limitations regarding availability of data.
- The SFA of PAHs showed that significant amount of OPs are concentrating into aquatic environment.

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Figure 1. PP selection process

Figure 2. The RICH tool filtration process (adapted from Beax, Eriksson et al. 2006)

Figure 4. SFA of PAH in Gårda

So far, an SFA for PAHs have been performed. The PAHs are divided into low-, medium- and high- molecular weight compounds. Preliminary results are presented in Figure 4.