Microplastics from tyre wear particles – how to mitigate the problem?

Summary of ”Traffic microplastics” report in the FanpLESStic-SEA project

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Introduction

This document "Microplastics from tyre wear particles– how to mitigate the problem?" is a summary based on a report on the same topic (Traffic microplastics- How to mitigate the problem) being both outputs of Activity 3.1 *State-of the-art microplastic removal technologies* in the FanpLESStic-sea project, led by the Natural Resources Institute Finland (Luke) aiming to identify and validate state-of-the-art microplastic removal technologies and develop and refine new solutions.

The final report is available on Luke's website.

Microplastics from tyre wear particles – how to mitigate the problem?

The problem

Traffic microplastics, i.e. tyre and road wear particles, particles originate mainly from tyre rubber, but also from road markings and sometimes from polymer modified bitumen, which is used in the asphalt (Andersson-Sköld, 2020). Tyre wear particles have been identified as a major source of microplastics in the environment in Europe as well as in particular countries, such as Finland (Sundt et al. 2016, Eunomia & ICF 2018, Hann et al. 2018, Setälä and Suikkanen 2020). Among traffic microplastics particles, pure tyre wear particles exist in very low quantities in the environment, while most of tyre wear particles are associated with road material (Grigoratos & Martini, 2014). Other traffic related sources of traffic microplastics which are not related to tyre and road wear, such as crashed vehicles, littering and, wear from certain brake pads, are not addressed in this policy brief.

Today, the knowledge on traffic microplastics is limited, in particular on the presence, pathways and exposure effects on human health and the environment exposed to them. Despite this, several facts are to be pointed out: emissions from tyre and road wear are very high; the particles are likely to be persistent in the environment; and particles themselves, the hazardous substances in the particles or sorbed on their surfaces, may cause negative impacts on organisms (Andersson-Sköld et al. 2020).

Road traffic is expected to increase. Thus, at EU level, estimates suggest that passenger transport will increase by 42% by 2050, and freight transport by 60% (EC, 2019). Passenger car fleet is also becoming bigger, heavier and more powerful (i.e. sport utility vehicles). For instance, sales of sport utility vehicles have doubled in the last 10 years and now account for about 40% of all new cars in the global market according to the IEA (IEA 2019).

In addition, with increasing number of electric vehicles, more attention is to be paid to tyre wear. Electric cars can accelerate faster than many traditional cars, which may lead to increased tyre wear. Also, electric cars are today generally heavier than cars that run on liquid fuels or gas, due to the weight of the batteries. The heavier weight is another factor why electric vehicle is expected to release even more tyre related microplastics to the environment.

Traffic microplastics may end up in the aquatic or terrestrial environments through different pathways. These pathways include various transport and transformation processes influenced by different factors depending on local conditions making the overall picture very complex (Vogelsang et al. 2020). The pathways for traffic microplastics to end up in aquatic environments are through stormwater and air (Essel et al. 2015, Sundt et al. 2016, Kole et al. 2017).

Regulatory framework

There are not currently, to our knowledge, regulatory measures addressing the issue of traffic microplastics nationally, regionally nor at EU level.

In 2019, upon request from the European Commission, the European Chemicals Agency (ECHA) proposed an EU restriction on intentionally added microplastics in products and the restriction is to be adopted in 2021 or 2022, if agreed by the European Commission and EU member states (ECHA, 2021). However, this restriction concerns only primary microplastics and EU has planned to tackle the issue of plastic pollution more widely addressing both intentional and unintentional sources of microplastics. In relation to this, EU is preparing a consultation on measures to reduce microplastics pollution from secondary sources (including car tyres). It is to focus on labelling, standardization, certification, and regulatory measures for the main sources of these plastics. The public consultation for the initiative is planned for the third quarter of 2021 (EC 2021). Also, at EU level, there is no regulation on the minimum wear rate for tyres (Hann et al. 2018).

Finally, the EU's 'Sustainable and Smart Mobility Strategy' aiming at reducing transport related greenhouse gas (GHG) emissions by at least 90% by 2050 compared to 1990 is to be pointed out. However, a carbon neutral transportation system is to be considered in conjunction with other traffic related contamination, such as tyre and road wear particles.

Practical solutions to mitigate the problem

In general, the presence of tyre and road wear particles in the environment can be reduced through preventive and removal methods. The most efficient way is through preventive methods influencing the factors that affect tyre and road wear (Sundt et al. 2016). These are related to proper use of tyres, driving behavior (eco-driving), and the characteristics of the tyres (more durable, in terms of tyre wear) as well as road surfaces (optimizing road surface to be smoother without affecting required traffic safety conditions). However, preventive methods need to be supported by removal methods and therefore, appropriate technologies are needed (Sundt et al. 2016). Removal methods are related to improved sewers, road cleaning, stormwater treatment and for example treatment of urban dust and snow (Winquist et al. 2021).

Preventive methods

Preventive measures to reduce traffic microplastics emissions can be divided into proper use of tyres, driving behavior and tyre characteristics (Table 1). An optimal tyre pressure is also to consider as well as the steering angles of the tyres, i.e. wheel alignment, which should be checked regularly, e.g. once a year (Firestone 2019).

Table 1. factors affecting tyre wear, and examples of good practices addressing them.

Factor		Good practices	How to implement them
Proper use of tyres	Tyre pressure	Regular checking, varies also depending on the load	Education for drivers
	Wheel alignment	Regular checking once a year, occasionally more often if needed	Education for drivers, yearly inspections obligatory
Driving behaviour	Fast acceleration and heavy braking, high cornering speeds	Smoothly driving, tyre wear comparable to fuel consumption	Education for drivers, fuel consumption/tyre wear meter
Tyre characteristics	Summer tyres, non-studded winter tyres, studded tyres	Proper selection of tyres according to weather conditions and driving needs	Local guidelines for tyre selection, public awareness raising campaigns
	Tyre properties	Product development: chemical composition and pattern of the tyre tread	EU regulation for tyre wear, subsidies for eco-tyres (analogy with subsidies for electric vehicles)

Drivers can influence the tyre wear with their driving behavior. Sundt et al. (2016) estimated that by avoiding unnecessary rough driving there would be a potential to reduce the tyre wear particle generation by 10 %. Electric cars can accelerate faster than many traditional cars, which may lead to increased tyre wear if this performance is used. An initiative for a tyre wear meter, “Ecometer”, was proposed during the DEEP Microplastic Challenge 2019, an event organized as part of the FanpLESStic-sea project. The idea was to combine the tyre wear with driving-related factors in a similar manner than in a fuel consumption meter.

Currently, the EU tyre label focuses on three elements: fuel efficiency, wet grip and external rolling noise (Viegand Maagøe 2016). The aim is to guide both the manufacturers and customers towards more fuel-efficient tyres, as well as safe and quiet tyres. However, there is no regulation on the minimum wear rate for tyres (Hann et al. 2018). Despite the lack of regulation, there are forerunners among tyre manufactures who have identified the problem with traffic microplastics originating from tyre wear. Thus, one example could be a new eco-design which combines low rolling resistance with decreased tyre wear and fuel consumption. Test drives in Nordic countries and Russia shows 35% decreased tyre wear compared to previous model, which accounts to ca. 10,000 km depending on driving behavior (Tuulilasi 2020). Moreover, the product development has focused on the environmental sustainability of the materials as 100% biobased resin is used in the rubber blend of the tyre tread.

In Nordic conditions with seasonal variation, tyre characteristics vary also between winter and summer tyres. Thus, it is important to select the right tyres according to weather conditions. No winter tyres, not even non-studded ones, should be used during the summer – their performance is not appropriate for high temperature and their wear rate may be very high. For milder winter conditions, non-studded tyres are a better option than studded ones.

Removal technologies

Existing methods for the removal of microplastic-containing road runoff particles are usually based on sedimentation, especially for larger and higher density particles. Filtration and adsorption are also important mechanisms especially for finer particles (Vogelsang et al. 2020, Andersson-Sköld et al. 2020). Urban and highway stormwater runoff are direct pathways for land based solid particles including microplastics and other traffic-borne particles into freshwaters. The traditional management practice for stormwater in urban areas has been to channel it in underground stormwater networks to the nearest waterbody without any treatment.

Stormwater management methods for separate sewer systems include roadside gully pots and various nature-based solutions (Vogelsang et al. 2020). Nature-based solutions, so-called sustainable drainage systems in urban areas include infiltration chamber systems and dry swales (Vogelsang et al. 2020). Data on the efficiency of these stormwater treatment methods for removal of tyre associated microplastic particles is lacking. However, there are novel results on microplastic removal efficiency of microplastics from stormwater runoff using a concrete-based filtration system with two comparative fine filtration media (sand and biochar, Pankkonen 2020).

In urban areas with a combined sewer system, stormwater runoffs end up in local wastewater treatment plants (WWTPs), which can, according to many recent studies, remove up to 99% of the microplastics in the influent during the primary and secondary treatment processes (Simon et al. 2018, Sun et al. 2019). However, no data on the removal efficiency of WWTPs for road traffic associated microplastics has yet been published (Vogelsang et al. 2020).

Street cleaning is also used to reduce the amounts of dust and pollutants in urban air. Street sweeping has been shown to collect considerable amounts of tyre and bitumen microplastic particles. Therefore e.g. weekly street sweeping might prevent transport of these microplastics via stormwater out in the environment (Järlskog et al. 2020).

Key conclusions

The knowledge regarding the effectiveness and cost-effectiveness of various measures concerning the restriction of microplastics from road traffic is very deficient, however, certain measures can be justified based on the positive side effects. These could be summarized as follows:

- Preventive methods are cost-effective and most of them are not dependent on further technology development. Thus, preventing or reducing the formation of tyre and road wear particles is the preferred approach when addressing traffic microplastics, followed by stopping or decreasing their spread to the environment.
- Simple preventive methods are related to the use of tyres (regular checking of tyre pressure and wheel alignment), driving behavior (avoiding fast acceleration and heavy braking), and tyre characteristics (non-studded instead of studded tyres, “eco-tyres” with better wear resistance). In addition to decreasing microplastics emissions from tyre wear, these measures provide other benefits such as improved air quality in cities and safety in traffic and decreased noise pollution, fuel consumption and greenhouse gas emissions.
- Awareness raising through a more comprehensive education for drivers and campaigns on the traffic microplastic issue in general. Fuel consumption meters could be recommended as part of instrumentation in the car. In addition to guiding the drivers towards more economic driving, they would also lengthen the lifetime of tyres and decrease the tyre wear.
- Supportive policies for the implementation of various measures are needed. Tyre pressure is easy to check by particulars, but wheel alignment must be checked by professionals. Because it is an extra cost and not required, it is often overlooked. However, proper wheel alignment is critical regarding tyre wear and thus yearly inspections are encouraged (Lutsey et al. 2006).
- Tyre labels to include a standardized wear rate marking.
- Positive and negative incentives for both “eco-tyres” and electric vehicles to improve the technology development and market penetration of tyres, which wear less and contain less hazardous compounds.
- Further research to develop both environmentally friendly and cost-effective microplastic removal methods related to traffic microplastics, as well as on effective preventive measures.
- Further development and harmonization of sampling, sample preparation and analytical methods for tyre and road wear particles to better evaluate and understand the problem.
- Traffic related contamination such as tyre and road wear particles, noise to be considered together with a carbon neutral transportation system towards a sustainable transport system.

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