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Realistic evaluation of tire wear particle emissions and their driving factors on different road types

TIAGO DE OLIVEIRA[1], BOGDAN MURESAN PASLARU[1], SOPHIE RICORDEL[1], LAURENCE LUMIÈRE[1], LAURENCE POIRIER[2] AND JOHNNY GASPERI[1]

[1]Université Gustave Eiffel

[2]Université de Nantes

Presenting Author: tiago.de-oliveira@univ-eiffel.fr

During its use, a tire undergoes significant physical stresses, including abrasion, related to driving conditions. In turn, tire abrasion emits particles called Tire Wear Particles (TWP). Considering their polymeric composition, TWP are considered as microplastics, which are widely distributed in the soil, sediment, and road samples around highway or urban areas, confirming environmental contamination [1].

To provide knowledge regarding the sources and fate of TWP in the environment, TWP emissions under various realistic conditions have to be better examined and factors driving these emissions better assessed. Hence, this study evaluates TWP emissions of a fully instrumented vehicle driving five emblematic road types: rural, suburban, highway, beltway, and urban. Speed, distance and vehicle dynamic factors were recorded for each track. For the first time, the emissions were collected on filters with different cut-off thresholds from 0.39 to 10 µm resulting in seven fractions that were analyzed by pyrolysis coupled with gas chromatography-mass spectrometry. Analyzes targeted the polymeric content of tires, namely, styrene-butadiene-rubber (SBR). The derived emission data were then correlated with corresponding driving conditions and vehicle variables.

The measurements taken over the five routes show similar distributions for SBR-based TWP emissions by number, with maxima in the sub-micron fraction (< 0.39 µm). This is much smaller than expected and confirms the ability of TWP to widely impregnate the atmosphere around roads and, consecutively, more distant environmental compartments. Upon applying a SBR-to-TWP conversion factor derived by quantifying SBR of the instrumented tire, sub-micron TWP emissions were the highest for highway (with 2.8 ± 0.8 mg/g of collected particle) followed by suburban, urban, beltway and rural routes. An analysis of variables finally indicated that neither the distance travelled nor the driving time are major determinants. Instead, speed (variations), vertical and lateral tire constrains, traffic fluidity exhibited significant correlations with TWP emission ($r > 0.81$, $p < 0.1$).

[1] Goßmann, I., Halbach, M., Scholz-Böttcher, B.M., 2021. Car and truck tire wear particles in complex environmental samples – A quantitative comparison with “traditional” microplastic polymer mass loads. Science of The Total Environment 773, 145667. https://doi.org/10.1016/j.scitotenv.2021.145667