Qualitative and quantitative analysis of mixtures of microplastics in the presence of calcium carbonate by pyrolysis-GC/MS

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J. Anal. Appl. Pyrol. 157 (2021) 10518

Abstract:

Environmental pollution by microplastics (MPs) has attracted much attention due to possible risks of MPs to human health, and fast and reliable analytical methods are required for identification and quantification of MPs in various matrices. Pyrolysis-gas chromatography/mass spectrometry (Py-GC/MS) has advantageous characteristics in that both identification and mass quantification can be easily done by chromatographic separation in combination with mass spectral analysis. Environmental MP samples usually contain several types of polymers and the pyrolysis of mixed polymer particles may cause a secondary reaction between pyrolyzates from different polymers. In this study, effect of the usage of calcium carbonate ($CaCO_3$) as a catalyst on pyrolytic behavior of polymers was examined to obtain catalytic conversion of reactive pyrolyzates to stable compounds. $CaCO_3$ was also utilized as a diluent for insoluble PE and PP powders to assure weighing easiness by forming a homogenous mixture. First, a reference material was prepared to make calibration curves by mixing twelve different types of standard polymers, selected to reflect common polymers in the global production. Identification and quantification of polymers in mixed polymer samples were validated by using model polymer mixtures, after storing Py-GC/MS data of twelve polymers with a given sample amount in a software named as F-Search MPs. Results exceeding the limit of quantitation combined with the high probability of a library match as confirmed by the software, provided assurance of the presence of the identified polymer in the model polymer mixtures. The quantitated values for the model polymer mixtures were compared with the compounded amount. The recovery varied depending on the polymer type, and especially short recovery (ca. 60–70 %) was recognized for PC in the sample from Solution A (SA) and excess recovery (ca. 175 %) for PET in the sample from Solution B (SB). Finally, the developed method was applied to the analysis of ground mixtures of isolated environmental MP particle samples and quick identification and quantification of each polymer in the MP samples were attained.

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Frontier Labs Products used:

IQ-Mill 2070, Eco-cup LF, EGA/Py-3030D, AS-1020E, UA$^+$-50, UA$^+$-5, Vent-free GC/MS adapter, MFS-2015E, UADTM-2.5 N, F-Search MPs