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Settling velocity of marine microplastic particles: laboratory tests

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An assessment of the settling velocity of different classes of microplastic particles (< 5 mm) is crucial for the prediction of their transport and fate. The Reynolds numbers for the settling microplastic particles is usually outside the Stokes range (Re « 1), but still far from fully developed turbulent flow (Re >105). Even for such transitional regime, the settling velocity of the particles that could be treated as more or less smooth spheres can be predicted with high accuracy by relationships available in publications. This is not the case for the non-spherical particles like fibres or flakes. There are quite a large number of quasi-theoretical or semi-empirical approaches that take into account the shape and roughness of the particles, usually in the applications to transport of natural sediments. Some engineering formulas for the settling velocity are also developed which have simpler structure along with high degree of accuracy on the set of experimental data. For marine microplastic particles, the absence of relationship between the settling velocity and the properties of the particle requires testing on the samples of marine microplastics. Besides small fragments of rigid plastic (granules, microbeads), there are also fibres and thin plastic sheets (flakes) with some degree of flexibility. The applicability of available formulae to thin and/or flexible plastic particles again requires verification by experiments.

The set of laboratory experiments on settling of microplastic particles of various shapes and excess densities in homogeneous water is reported. The particles were collected in water column, bottom sediments and on the beaches of the South-Eastern Baltic. The experiments demonstrate not just different regimes of motion but different manner of the sinking of spheres, flakes and fibres. The very definition of the "settling velocity" has a specific meaning for every kind of a particle shape. The results of test measurements are compared with predictions by several published semi-empirical formulae. We conclude that there are several new questions to discuss in this regard: (i) proper definition of the meaning of "settling velocity" for complicated motion of particles of different shape classes, (ii) usage of formulae calibrated for particles in the density range characteristic for plastics (not natural sands, etc.).

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