Decomposition of plastics in real conditions at river mouths

Dr. Annegret Potthoff, Dr. Kathrin Baumgarten, Dipl.-Ing. Johanna Sonnenberg

Reducing plastic discharge into the sea

The discharge of plastic waste from inland areas via rivers into the sea is the main cause of increasing plastics concentrations in many of the world's oceans. If other measures to prevent plastic emission are not effective, the separation of macroplastics before they reach the river mouth can contribute to the reduction of plastic input.

To design such treatment systems, the plastic load needs to be quantified. Additionally, information on its distribution on the water surface, in the water body, and in the sediment is important. Particle size, shape and density are the determining parameters for this.

Time-dependent properties of plastics

As plastic waste is being transported from its source to the river mouth, the material undergoes constant changes, which any model needs to take into account: the mechanical energy of the water and contact with the sediment accelerate the decomposition of macro- into microplastics. The growth of biofilm influences, among other things, the density. Because of this, plastics that previously floated near the surface may then sink. Previous studies on biofilm formation focused on the (specific) composition of the biofilm, not on the kinetics of mass increase.

Quantifying biofilm growth

In order to close this gap, Fraunhofer IKTS in Rostock is investigating the behavior of plastics in water bodies under real and permanently monitored conditions. Plastic plates are fixed in the Warnow, near the river mouth, and the change of surface and bulk of the material is analyzed at regular intervals while additionally monitoring temperature, pH value, salinity and other parameters of the water.

Polyethylene terephthalate as a case study

Polyethylene terephthalate (PET), a typical plastic that is discharged into rivers as waste in the form of bottles, was deposited for 8 weeks during winter and 8 weeks during summer. The influence of solar radiation was taken into account by fixing the samples at different depths below the water surface. In addition to the increase in mass due to biofilm growth, the change in polymer properties was analyzed using spectroscopic methods and contact angle measurements.

During the same period, a 50-fold increase in mass was detected during summer compared with winter, with the biofilm growth being stronger near the surface than near the sediment.

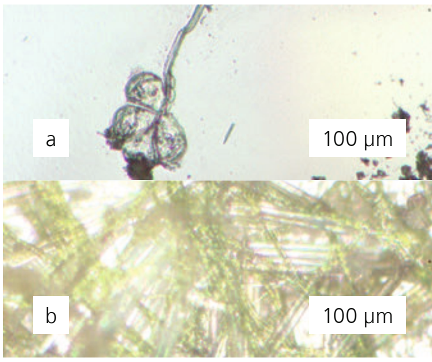
With the available experimental set-up, plastics and other materials can be tested for their durability under real and constantly monitored conditions.

We would like to thank the German Federal Ministry of Economics and Climate Protection BMWK for the project funding of "DeMARC" (grant no. 03SX556B).

Supported by: Federal Ministry for Economic Affairs and Climate Action on the basis of a decision by the German Bundestag

Underwater robot for photo documentation (source: Fraunhofer IGD).

Sample holder at the beginning of depositing.



Microscopic image of the biofilm in winter after two (a) and eight weeks (b) near the water surface.

PET samples after 8 weeks near the water surface (winter/summer).