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Assessing the potential of surrogate EPS to mimic natural biofilm mechanical properties

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Biofilms growing on benthic sediments may increase the resistance towards erosion considerably by the sticky nature of extracellular polymeric substances (EPS). The EPS is a biopolymer which is secreted by the microorganisms inhabiting the biofilm matrix and may be regarded as natural glue. However, laboratory studies on the biostabilization effect mediated by biofilms are often hampered by the unavailability of “environmental” flumes in which light intensities, water temperature and nutrient content can be controlled.

To allow investigations on biostabilization in “traditional” flume settings the use of surrogate materials is studied. Another advantage of using appropriate surrogates is the potential to reduce the experimental time, as compared to cultivating natural biofilms, the surrogates can readily be designed to mimic biofilms at different growth stages. Furthermore, the use of surrogates which are expected to have more homogeneous mechanical properties could facilitate fundamental studies to improve our knowledge on biostabilization.

Even though a number of studies have already utilized EPS surrogates it is not clear how to mix them to correctly mimic natural EPS mechanical properties. In this study the adhesiveness (a measure of stickiness) on the surface of several EPS surrogates (e.g. Xanthan Gum, sodium alginate) is measured. These surrogates which are originally used in the food industry as rheology modifiers are mixed by adding water to a powder at a desired concentration (C). The measured surface adhesion of different surrogates at different concentrations ranged from 0.5 to 6.7 N/m^2, which is well in line with values found for laboratory cultured biofilms. We found that the surrogate characteristics differed largely especially in regard to a) the response of the adhesiveness to increased concentrations (powder to water) and b) in their rheological characteristics. A seemingly promising surrogate for the use in biostabilization studies is Xanthan Gum (XG) which can be easily mixed to achieve natural-like adhesion values. A comparison of XG characteristics to natural biofilms cultivated under different environmental conditions and at different seasons will be provided at the conference along with more details on the different surrogates.

These findings will help designing laboratory experiments on biofilm-stabilization by providing a first guideline for adequately mixing the surrogates to enable e.g. investigations on fundamental aspects of biostabilization or speeding up experiments with long cultivation times.