National Biofilms Innovation Centre

Case Study

USING SYNTHETIC MATERIALS TO MODEL MARINE BIOFILMS

Supporting the next generation of scientific leaders

Marine biofilms can cause up to an 11% increase in ship shaft power which has environmental and economic consequences. As biofilms are heterogeneous and adaptable, rigid models are often used as a benchmark for studying biofilm associated drag; however, these models neglect natural biofilm behaviour, such as viscoelasticity which could lead to under-estimations in drag penalty. Understanding how biofilms properties interact with one another and with fluid flow, and how these interactions influence drag can further research on strategies for managing and preventing biofilm presence can be used to inform the shipping industry of more efficient biofilm targets.

An NBIC-funded Proof of Concept (POC) project between the University of Southampton and AkzoNobel investigated the use of synthetic materials to model marine biofilms. Alexandra Snowdon was part of the AkzoNobel team working on the POC. She then went on to study as an NBIC BITE student, with the results of the POC project forming the basis of her PhD.

Her research focused on marine biofilm physico-mechanics and the effects these have on ship-drag using artificial and real-life systems. By using imaging techniques in conjunction with a flow cell the group were able to capture biofilm physico-mechanical properties in-situ in real time whilst measuring drag. It was concluded that marine biofilms are viscoelastic, that viscoelasticity plays a significant role in drag production and that it shares complex interactions with biofilm structure.

It was also shown that an elastomeric sandpaper model system produced up to a 52% increase in drag when compared to rigid counterparts; the model also simulated drag curves and relationships between physico-mechanical properties like that observed for naturally grown marine biofilms. As a result, it is believed that the synthetic system proposed is a more appropriate substitute for modelling viscoelastic biofilms and highlights how systems that only capture rigid roughness could be underestimating drag.

Microscope image taken of a marine biofilm grown on a static circular coupon (4 cm dia.) in Hartlepool Marina. Algal components can be seen in red, diatom chains in orange and to the bottom right an animal can be seen. Image by Alexandra Snowdon.

Alexandra has recently completed her PhD and two academic papers have already been published and acted as milestones for the project. The first was on developing the artificial biofilm system to demonstrate how softer and deformable materials could better mimic marine biofilm properties than rigid ones; the second was on studying the rheological properties of marine biofilms to demonstrate marine biofilm viscoelasticity and the relationship this has with structure. Dr Jennifer Longyear from AkzoNobel said,

“Alex’s work forms a strong foundation for expanded quantitative analysis of the contribution of biofilm mechanics to marine biofilm fouling hydrodynamic drag properties. Her work is an exciting development as this research topic is challenging to approach experimentally. We have adopted Alex’s methodologies and anticipate future work will lead to further insight regarding ship slime drag”.

Since completing her PhD, Alexandra has started working as a Statistical Data Scientist at the Office for National Statistics.

Alexandra Snowdon

Alexandra Snowdon has recently completed an industrial-sponsored PhD with the University of Southampton and AkzoNobel. Her research involved studying marine biofilm physico-mechanics and the effects these have on ship-drag using artificial and real-life systems. Alexandra’s supervisors from the University of Southampton were Paul Stoodley, Julian Wharton and Simon Dennington and from AkzoNobel, Jennifer Longyear.