Novel approaches for enhanced antimicrobial treatment of problematic industrial biofilms

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Most microbes in nature live in biofilm communities. Problematic biofilms cause biocorrosion (also known as microbiologically influenced corrosion) and biofouling, leading to tremendous economic losses in many industrial sectors such as the oil and gas industry, water utilities and the power generation industry. Sessile cells in biofilms are notoriously difficult to treat. They employ various defense mechanisms such as diffusional barriers, lowered metabolic rates, formation of persister cells, upregulation of resistance genes and efflux pumps, to fend off antimicrobial attacks. The repeated applications of an antimicrobial system will eventually lead to antimicrobial resistance, thus requiring dosage escalation. This causes financial, environmental and operational sustainability problems. Thus, more effective antimicrobial applications are needed to treat problematic biofilms. This presentation discusses two newly developed approaches to enhance existing antimicrobials that achieve better efficacies with lower dosages. One approach uses D-amino acids as biofilm dispersal agents and the other adopts sea anemone surface protein inspired synthetic anti-biofilm peptides. D-amino acids are known to govern bacterial cell wall remodeling. They are found to disperse bacterial biofilms although the exact mechanism is not known. Sea anemones secrete anti-biofilm proteins to keep their surfaces clean. Novel peptides mimicking the active sites of the proteins have been synthesized for biofilm treatment. For recalcitrant industrial biofilms, both D-amino acids and the peptides require an antimicrobial stress. Although these anti-biofilm agents are non-biocidal by themselves, they exhibit excellent enhancements of several antimicrobials at low concentrations in both biofilm prevention and biofilm removal lab tests against the *Desulfovibrio vulgaris* biofilm and several recalcitrant field biofilm consortia on carbon steel and stainless steel. The enhancements not only achieve better efficacies, but also reduce antimicrobial dosages considerably.