

Water and biofilms

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All water on earth is surrounded by interfaces – they can be solid-liquid in the case of sediments, or reservoirs, pipes, reactors in technical systems, they can be liquid-liquid in the case of oil spills or gaseous-liquid in the case of the very thin layer at the air-water interface. Microorganisms have a tendency to accumulate at such interfaces, form aggregates such as films, slimes and even provide new interfaces by generation of flocs. All these aggregates are embraced by a somewhat loose definition as “biofilms” and have a few very important features in common: the organisms can establish long-term interactions as microconsortia, create gradients in oxygen concentration, pH-value, redox potential and, thus, high heterogeneity which in change allows for high biodiversity. Co-existence of aerobic and anaerobic organisms in small scale is possible, and pathogens can invade, establish and accumulate and be protected in biofilms. Their matrix of extracellular polymeric substances stabilizes the structure, keeps microconsortia together and prevents leaching of extracellular enzymes which are used for utilization of particulate nutrients. In biofilms, aspects of multicellular behaviour of microorganisms can be observed, even to the extent of differentiated intercellular communication with “division of labour” among biofilm organisms. Biofilms are involved in the global cycles of all elements, they have provided the oxygen to the atmosphere and act as “global cleaning company” when performing biodegradation. Water quality is tightly connected to biofilms as carriers of self-purification processes as well as the base of biological water treatment. However, if they occur at the wrong time and location, they can cause considerable problems, e.g., in biofouling of ship hulls, heat exchangers, drinking water pipes and reservoirs, or in membrane processes. Furthermore, they interact with their abiotic support, causing microbially influenced corrosion of metals or weathering of mineral materials. Understanding the biofilm mode of life is crucial for employing and enhancing their desirable effects and for avoiding or mitigating their unwanted effects. In general, wherever water is available and the environment is not sterile, biofilms have to be expected. The vast majority of microorganisms on earth have organized their life in biofilms and represent both the oldest and most successful form of life on this planet – ultimately sustainable and robust.