Bacterial Adhesion and Corrosion in Space Flight

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The International Space Station is a built environment that has been continuously inhabited since November 2000. Living with the crew are the microorganisms carried to the ISS as normal astronaut flora and by accidental introduction in supplies. These microorganisms have established biofilms in the water recycling system (WRS) that recycles urine and ambient humidity to provide drinking water to the ISS crew. Biofilms in the WRS can serve as a reservoir for opportunistic pathogens, including *Escherichia coli* and *Pseudomonas aeruginosa*, and can also induce clogs and corrosion damage on the stainless steel components. To investigate biofilm formation, silver disinfection susceptibility, and microbially induced corrosion in space flight, an experiment was launched to the ISS on SpaceX CRS-21 in December 2020 and returned to Earth on SpaceX CRS-21 and SpaceX Crew-1. To model biofouling in the WRS, mixed-species biofilms of *E. coli* and *P. aeruginosa* were cultured in artificial urine on 316L stainless steel using a specialized BioCell apparatus. Space flight-cultured biofilms in artificial urine show consistent morphology and coverage as ground-based controls, and there are indications that silver disinfection may be more effective in space flight than on Earth. Preliminary corrosion analysis data indicates that corrosion on 316L stainless steel is primarily driven by electrochemical changes, rather than by microbial induction, and may be more extensive in space flight than on Earth. Additionally, the inclusion of silver fluoride as a disinfectant may increase pitting corrosion on stainless steel. The presence of biofilms in space flight water filters is unavoidable and may pose significant risk to the inhabiting crew as a source of infection or by causing failure of the WRS. Characterizing the microbial response to silver disinfection in flight will allow for improved development of water recycling systems and disinfection protocols for long-term manned space flight missions.