Phase 2 Project Summary

Firm: Creare Incorporated
Contract Number: NNJ08JA53C
Project Title: Efficient Long-Life Biocidal Condenser

Identification and Significance of Innovation:

Crewed spacecraft on long-duration exploration missions require active environmental control and life support systems (ECLSS) that are extremely reliable. A critical function of the ECLSS is control of humidity in the cabin atmosphere, which is typically accomplished using a condensing heat exchanger (CHX). The condensing surfaces in the CHX are a very attractive environment for growth of bacteria and fungi. To prevent growth of microbes on the condenser surfaces while enabling efficient performance, the CHX needs a coating that is both antimicrobial and hydrophilic.

We have developed a zeolite coating for the CHX that prevents growth of microbes, has excellent wetting properties, adheres extremely well to the CHX surfaces, and is much more stable than other types of coatings. We developed a process to coat prototypical heat exchanger structures with the zeolite, then load the zeolite with silver ions. The ions diffuse from the zeolite gradually over time and prevent growth of microbes on the condensing surfaces.

Technical Objectives and Work Plan:

We developed a process to produce thin layers of crystalline zeolite on prototypical materials and prototypical plate-fin heat exchanger structures. We produced numerous test coupons and measured the coating's physical and antimicrobial performance after exposures of up to five months in laboratory conditions that simulated operation in a CHX. We developed new methods to test the antimicrobial performance of the coating using growth media that simulated the environment in a CHX. We applied the coating to prototypical sections of a heat exchanger core to demonstrate that the coating could be applied to complex internal core structures following fabrication of the CHX.

Technical Accomplishments:

The crystalline zeolite can be applied to prototypical materials and structures, and it is simple to add silver ions to the coating. The coating adheres extremely well to heat exchanger surfaces fabricated from prototypical materials. Wetting properties of a clean surface are excellent after five months of exposure. The wetting properties of contaminated surfaces can be restored using simple cleaning techniques. The coating demonstrated powerful biocidal action after soaking for five months in DI water: greater than 6 log reduction in both gram positive and gram negative bacteria and greater than 4 log reduction in fungus.

The zeolite coating is superior to alternative coatings in its short-term stability, powerful antimicrobial action, and wetting properties. However, additional work is still needed to understand coating chemistry, to quantify the sensitivity of the silver ions to sodium ions present in condensate, and demonstrate improved coating stability for long-term operation.

NASA Application(s):

The coating will be useful to NASA for condensing heat exchangers in crewed spacecraft built for future exploration missions, lunar outposts, planetary bases, manned rovers, and space stations.

Non-NASA Commercial Application(s):

The coating process is inexpensive and can be used for a wide range of terrestrial heat exchangers. Commercial applications for the coating include condensing heat exchangers for terrestrial air conditioners and HVAC systems, water recovery systems for fuel reformers and fuel cell power systems, and heat exchanger/reactors for compact fuel reforming and other chemical process systems.

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