HUMAN SPACEFLIGHT SYMPOSIUM (B3)
Astronaut Training, Accommodation, and Operations in Space (5)

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THERMODYNAMIC CHALLENGES OF COOKING FOOD ON MARS

Abstract

Cooking food is a relatively easy process on Earth. Water boils at 100C, enough to sterilize potential bacterial contaminants, brew tea or coffee, cook rice, potatoes, noodles or boil eggs. However, the boiling point of water is a strong function of atmospheric pressure. At higher altitudes, for example where the atmospheric pressure is lower than at sea level water boils at temperatures below 100C. At some extreme terrestrial environments (Himalayas), the boiling point falls below the necessary temperature to boil eggs. While rare on the surface of Earth, low atmospheric pressures are common on other planets such as Mars. With an average of 6 mbars at the surface, Mars has an atmospheric pressure less than 1% of that on Earth. In addition, Mars has only roughly one third of Earth's gravity. Currently, blueprints are being laid out on how to explore and colonize Mars in the coming decades. While some habitat designs assume 1 bar internal pressure with terrestrial air composition, others suggest to rely on lower pressures and higher oxygen contents, up to the extreme of 200 mbar and almost 100% oxygen. However, such low pressures raise the question of how early settlers will prepare their food: Blatantly spoken, will they be able to eat well-boiled eggs for breakfast? What is the minimum pressure for boiling eggs on Mars? And does gravity play an important role in cooking of food on Mars? We will address these questions based on basic thermodynamics and compare the results to state-of-the-art Mars habitat designs. In addition, we will use the experience of altitude cooking at the Hawaii Space Exploration Analog and Simulation site for long-term simulated missions to Mars and discuss some practical challenges encountered by the crews there. Finally, we will present a recommendation for habitat pressures from a food preparation standpoint: What is the minimum pressure necessary for cooking on Mars?