



Analysis of Forward Osmosis Filtration on Synthetic Urine Substitute

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Introduction

Life support is one of the most crucial system that supports manned spaceflight. These systems almost exclusively rely on mechanical filtration for water processing. This creates a large power draw, limiting the available power for other systems. This draw stems from the large pumps used for filtering water for the crew to use for both consumption and sanitation. To facilitate future long-term missions, passive Forward Osmosis (FO) filtration could be used to support necessary life support systems. To test the quality of the water filtered using this method, a urea-based urine substitute will be synthesized and tested using multiple methodologies to determine the Urea content in the filtered water solution.



Forward Osmosis

Forward Osmosis (FO) is a form of filtration that uses the natural properties of concentration gradients to perform liquid filtration without the need for any powered systems. The system is split into two chambers by a semi-permeable membrane. Contaminated water is filled into one chamber of the system, while a high concentrated osmotic agent is filled into the adjoining chamber of the system. The concentration gradient between the solutions along the membrane causes the water to pass through the membrane to the solution of higher concentration. This transfer dilutes the osmotic agent, while leaving behind the contaminants. The result of this process is a solution requiring only tertiary treatment to bring it to a safe potable water quality.

Experiment

This experiment will be testing the quality of filtration of a Forward Osmosis system on a simulated urine sample. The results show whether FO is a viable method of filtering out Urea and Urea nitrogen from an aqueous solution. The findings could be used to provide both an example of FO successfully being used in simulated human waste processing, as well as providing a methodology to do quality assurance testing on future FO based water processing systems.

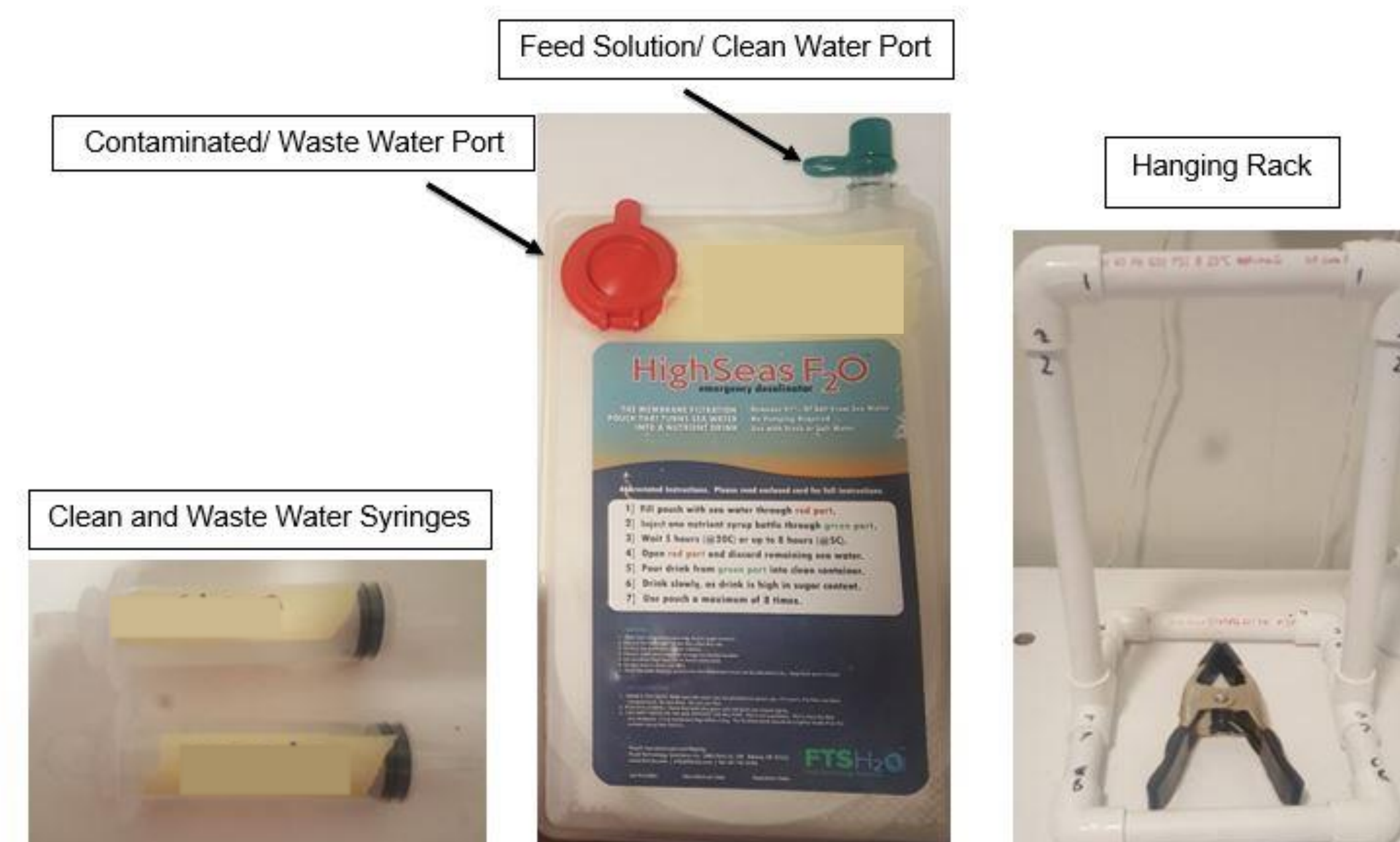


Figure 1: Materials for Experiment

Methods and Materials

Three different methodologies will be utilized so that the results can be self-validated. Spectrometry and H nuclear magnetic resonance will be used to test for Urea in the post-filtration samples.

The mass spectrometry methods will use chemical reagents to treat the samples so that the Urea will be detectable. The other methodology will be H nuclear magnetic resonance. This method will utilize an NMR spectrometer housed in the COAS chemistry laboratory to test for Hydrogen nuclei in the samples. This method will also use a standard curve to compare results against.

Goal of Results

This experiment will provide a basis of testing the quality of Forward Osmosis based water processing systems. This will allow future processing systems that utilize this technology to be able to adequately test the outbound quality of water.

This experiment will also establish a methodology for high fidelity urea testing in water. This experiment has the possibility to establish an expected Urea rejection standard for future improvement in water filtration technology.



Figure 2: Vernier Laboratory Spectrometer

Current Status

As the research was ongoing when the current world health crisis started, the results of this experiment are unfinished. Preparations are currently being made to continue the experiment in the fall under the COAS chemistry program.

The limited experimentation and preparations done before it was halted had yielded promising prospects for a successful experiment.

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