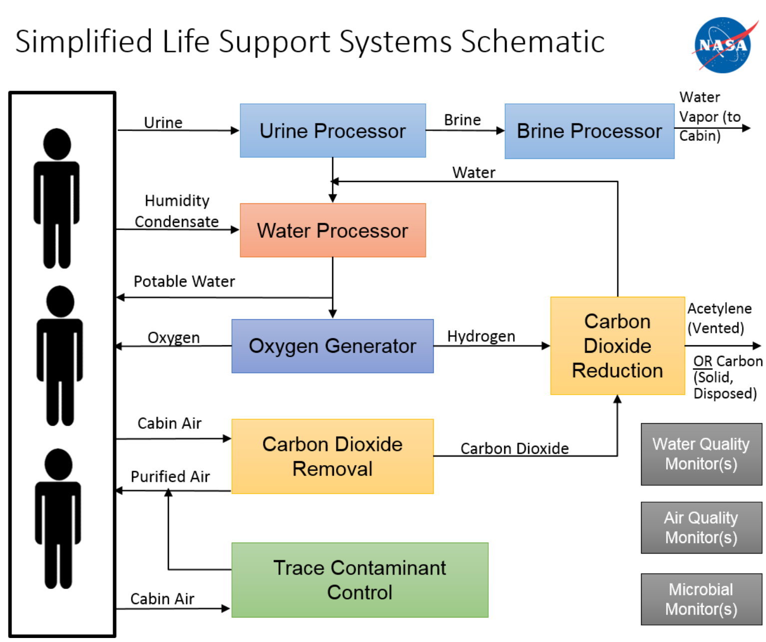
International Space Station

With the exception of the supply runs made every so often, the International Space Station is nearly a closed system orbiting the Earth at approximately 4.76 miles per second, or about 17,136 mph, at an altitude of about 240 miles (science.nationalgeographic.com). The opportunity for fresh food is few and far between while the opportunity for fresh water is next to never. One of the greatest dilemmas from human space travel arises from the basic human need for hydration. The amount of water needed to sustain a single human for one day is about 1.9 liters, according to the Mayo clinic. Extrapolated across a 6 month mission, this could be about 350 liters which would have a mass of 350 kg. Cutting down weight is one of the more important aspects of space travel. More weight equates to more fuel being expended which leads to even more weight, ultimately accruing a much higher mission cost. The best viable option for reducing weight and increasing efficiency is to reclaim and reuse the wastewater from the spacecraft, base, or the occupants.

Currently, the International Space Station (ISS) employs a life support system which utilizes a water reclamation system. The life support systems on the ISS have been in development for over forty years and consists of managing the air, food, and water, as well as monitoring atmospheric pressure, waste management, and fire detection and suppression (NASA.gov). These many features all make up three components of the life support systems which are environmental monitoring, atmosphere management, and water management. The environmental monitoring is for observing and controlling the temperature, pressure, and humidity within the ISS to allow it to remain hospitable and comfortable for the astronauts and equipment (NASA.gov). The atmosphere management component is for monitoring the air, removing carbon dioxide, producing oxygen, and removing particles and volatile gases. The final component is the water management section which recycles wastewater for reuse as potable and the production of oxygen, and stores and distributes the potable water. All three components are vital for the continued safety and success of the missions, however, the water management is the main focus here. The water management process takes the urine into a urine processor and



Life support systems schematic for waste, air, and water courtesy of NASA.

outputs brine to the brine processor for water vapor into the cabin. The urine processor also outputs water to the water processor. The water processor will take water from the humidity condensate, the urine processor, and the carbon dioxide reduction to create reuse for potable water, water for the oxygen generator. A schematic for this process is shown to the right.

Although the technology of the life support system has been functioning for a long period of time, in recent years, NASA has detected a buildup of various organic compounds within the ISS system. These organic compounds consist of dimethylsilanediol, ethanol, Isopropanol, trimethylsilanol, 2-butanone, methanol, and acetone (Wallace, et al 2014). The most concerning of this group based on quantity are dimethylsilanediol, ethanol, and methanol (Wallace, et al 2014). Initially, the National Aeronautics and Space Administration (NASA) used a monitoring system to observe the levels of Total Organic Carbon (TOC) (Ramanathan, James, & McCoy, 2012). NASA initially planned on keeping the TOC levels to below 3mg/L, however, the readings were shown to be encroaching on that upper limit (Ramanathan, James, & McCoy, 2012). At these levels, the danger could arise from a possible toxicity of the potable water for the crew. Being in such a hostile and secluded environment on the ISS, any sort of sickness can prove quite dangerous. NASA then began designing a solution to remove the contaminants from the water supply to avoid furthering the TOC levels. They have designed a solution to filter the dimethylsilanediol from the environment of the ISS by replacing the Multifiltration Beds within the filter, however, not much progress has been gained on methanol and ethanol (Rector et al, 2014).

Methanol is an organic chemical compound which contains one carbon, one oxygen, and four hydrogens (Methanol). Similarly, ethanol contains two carbons, one oxygen, and six hydrogens (Ethanol). Unwanted methanol and ethanol in the environment can create a dangerous atmosphere from this volatile compound. Both of these chemicals can be lethal when consumed in high doses or quantities. While the doses found in the ISS are in the parts per million, it is far safer to eliminate them, than to allow them to build up over time. Currently, the ISS does not have a feasible solution for filtering methanol and ethanol from the recycled water. One of the difficulties comes from the microgravity effects experienced on the ISS. Water is the cause of many problems in space since Earth lays within the habitable zone which allows for temperatures to reach liquid water ranges. Outside of Earth, there is not much opportunity in the way of liquid water much less potable water.

The general public struggles to see the benefits of technological advances of outer space for terrestrial applications. In fact, many of the technologies developed for space are currently being used throughout the world. The life support systems currently being designed and utilized in space applications can be highly beneficial and vital to the survival of people in underprivileged, impoverished areas. Regions that struggle with fresh water such as draught stricken or war torn geographical zones would find great value in a water recycling, decentralized system. Whether it is developed for micro gravity of the space shuttle, it can be slightly modified to best serve the region. The reliability and versatility of the products designed for the harsh constraints of space would translate well when introduced into a terrestrial model of application.

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