Janik DS: Recycled Water. In Austin FH and Maio DA (Eds): Journal of the Citizen Ambassador Program Aerospace Medicine Delegation to the Soviet Union April 1-18, 1990 (Citizen Ambassador Program, Washington DC, 1991).

DELEGATE: Daniel Janik
LEADER: Frank Austin

APPROX TIME: 45 min incl translation
EQUIP NEEDED: Slide projector

TITLE: RECYCLED WATER

ABSTRACT

Life support is a key technology, and water recycling the major constraint for long duration, manned space exploration.

Four areas are especially critical: 1) Definition of recycled water requirements for human, animal, plant and combined spacecraft users; 2) Development of an effective and safe terminal treatment; 3) Control of microbes within closely-recycled water systems; and 4) Contribution and interactions of biological participants within a small artificial biosphere such as a spacecraft or extraterrestrial habitat.

Problems defining recycled water requirements include development of organic, microbial and disinfectant-product(s) sampling, identification, quantification and health effects testing.

A new approach to product water sampling which is under investigation utilizes positive pressure, low deadspace, inert materials construction to more correctly capture volatile, soluble and reactive organics while minimizing back contamination.

New methods more for analyzing and identifying volatile, soluble, iodo-, metalo- and reactive organics are under investigation.

Biomedical effects of recycled spacecraft water contaminants, starting with those which are purposefully added (e.g. iodine disinfectant), are being re-examined emphasizing 24-hour, chronic exposure. Chronic disease, uncompensated/recompensated dysequilibrium or equilibrium at either a new or "normal" state, and interspecies effects are of special interest. Such effects are being concurrently re-evaluated at the organismal, neuro-hormonal-circulatory, organ, tissue and target cell level in humans, animals, plants and combinations thereof. Such effects are simultaneously being redefined from the classical clinical illness model to include subtle biochemical and neurophysiological changes in exposed organisms which might mimic, enhance, diminish or alter the effects of microgravity and the closed environment on a test subject user.

Current terminal water treatments utilize primarily surface-active, ion-exchange and/or filtration processes to remove recalcitrant organics. Each, however, contributes to unit and system microbial contamination in about inverse proportion to organic removal efficiency. Conversely, while a current objective is to produce and maintain product water "sterility" (0 microbial colony forming units per 100 milliliters of water), microbes

appear to enhance, and may even be necessary for effective organic removal. Research emphasis is therefore being directed towards investigating biologically-enhanced physical-chemical terminal water treatment, e.g. bacterially-coated, granular activated carbon suspension treatment or higher plant treatment with recovery of plant transpiration water. Other research areas include development of novel methods for identifying low-nutrient stressed, "environmental" microbes, low-nutrient microbial culturing, and inline microbial quantification. Special emphasis is being placed on conditional pathogens and on microbes capable of sharing genetic material with human commensals which have been commonly found in terrestrial recirculating water systems. Such organisms include the ubiquitous pseudomonads.

The use of higher plants for water reclamation, close-recycling and as surrogates for human test subjects in water recycling experiments are being aggressively explored through development of a variety of testbeds. For example, an inexpensive, plant transpiration water recovery system testbed with few and small contaminant sinks, is being developed. A larger, more complex and expensive testbed utilizing inert constructions materials is similarly being constructed for high fidelity water recovery experiments. Small-scale, spaceflight-adapable testbeds to capture reclaimed and recycled plant transpirate in space are also in development. At the other end of the spectrum, a large-scale plant transpiration water recovery project utilizing a 100 foot diameter biodome is also under design for use as a lunar/Mars-base engineering and scientific testbed.

Substantial work remains to be done at virtually all levels of research, design, development, testing and certification in order to produce a safe and efficient water recyling system to support long duration, human space exploration. In recognition of the magnitude of this requirement, the University of Alabama Consortium for Space Life Sciences has undertaken the establishment of a national Center for Life Support and an international Institute for Advanced Studies in Life Support.

REFERENCES

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