

## Nonhazardous Urine Pretreatment Method

**This method can be used as a means for safe urine storage on ships, planes, and recreational vehicles, or in conjunction with portable restrooms.**

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A method combines solid phase acidification with two non-toxic biocides to prevent ammonia volatilization and microbial proliferation. The safe, non-oxidizing biocide combination consists of a quaternary amine and a food preservative. This combination has exhibited excellent stabilization of both acidified and unacidified urine.

During pretreatment tests, composite urine collected from donors was challenged with a microorganism known to proliferate in urine, and then was processed using the nonhazardous urine pre-treatment method. The challenge microorganisms included *Escherichia coli*, a common gram-negative bacteria; *Enterococcus faecalis*, a ureolytic gram-positive bacteria; *Candida albicans*, a yeast commonly found in urine; and *Aspergillus niger*, a problematic mold that resists urine pre-treatment.

Urine processed in this manner remained microbially stable for over 57 days. Such effective urine stabilization

was achieved using non-toxic, non-oxidizing biocides at higher pH (3.6 to 5.8) than previous methods in use or projected for use aboard the International Space Station (ISS). ISS urine pretreatment methods employ strong oxidants including ozone and hexavalent chromium (Cr(VI)), a carcinogenic material, under very acidic conditions (pH = 1.8 to 2.4).

The method described here offers a much more benign chemical environment than previous pretreatment methods, and will lower equivalent system mass (ESM) by reducing containment volume and mass, system complexity, and crew time needed to handle pre-treatment chemicals. The biocides, being non-oxidizing, minimize the potential for chemical reactions with urine constituents to produce volatile, airborne contaminants such as cyanogen chloride. Additionally, the biocides are active under significantly less acidic conditions than

those used in the current system, thereby reducing the degree of required acidification.

A simple flow-through solid phase acidification (SPA) bed is employed to overcome the natural buffering capacity of urine, and to lower the pH to levels that fix ammoniacal nitrogen in the non-volatile and highly water soluble  $\text{NH}_4^+$  form. Citric acid, a highly soluble, solid tricarboxylic acid essential to cellular metabolism, and typically used as a food preservative, has also been shown to efficiently acidify urine in conjunction with non-oxidizing biocides to provide effective stabilization with respect to both microbial growth and ammonia volatilization.

*This work was done by James R. Akse and John T. Holtsnider of Umpqua Research Company for Johnson Space Center. For further information, contact the JSC Innovation Partnerships Office at (281) 483-3809. MSC-24520-1*