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WATER RECOVERY SYSTEMS BASED ON PHYSICAL/CHEMICAL PROCESSES INTENDED FOR SPACE STATIONS

Abstract

Water recovery systems installed on Salut, Mir and international (ISS) space stations are based on physical/chemical processes. The systems use hydrodynamic, chemical and heat/mass transfer processes in single-phase and two-phase gas/liquid media. In the last case special methods for processes have to be used in space flight under microgravity conditions. The processes selected depend on the trace contaminant content in the feed liquid and the requirements for the water recovered. For low-contaminant liquids, for instance, humidity condensate from the cabin atmosphere and greenhouse condensate the best method for the removal of dissolved contaminants is the use of sorption/catalytic and ion-exchange processes. The principle of complete water purification to distilled grade followed by potable water conditioning with salt, microelement and pretreatment chemicals addition is employed. At present all the processes are conducted in the operational system at temperature and pressure maintained in the space station's crew module with power consumption for recovery equal to 2 W-hr per liter of water produced. For urine containing large amount of dissolved salts the distillation method accompanied by sorption/catalytic purification is applied. On space station Mir the low-temperature membrane distillation method was used as the most simple and reliable method in microgravity. This method provided the required process temperature (not higher than 45) due to liquid evaporation from the membrane surface to the vapor/gas media. On ISS the more advanced and less power intensive method of vacuum distillation with a heat pump will be used. Hygiene water (medium-contaminated) processing is provided by preliminary membrane filtration (ultra filtration and reverse osmosis) with ion-exchange post-treatment. One of the principal moments is the absence of microbial contamination of the recovered water. For these purposes the water is pretreated with ionic silver and pasteurization. In general, the combination of physical/chemical processes is the most reliable water production method with the required quality and minimal power consumption. The paper analyzes water recovery systems for orbital space stations and provides recommendations for water recovery system design for promising space missions.