

Water Recovery and Urine Collection in the Russian Orbital Segment of the International Space Station (Mission 1 Through Mission 17)

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ABSTRACT

The paper summarizes the experience gained with the ISS water management system during the missions ISS-1 through ISS-17 (since November 2, 2000, through October 23, 2008). The water supply sources and structure, consumption and supply balance and balance specifics at various phases of space station operation are reviewed. The performance data of the system for water recovery from humidity condensate SRV-K and urine feed and pretreatment system SPK-U in the Russian orbital segment are presented. The key role of water recovery on board the ISS and the need to supplement the station's water supply hardware with a system for water reclamation from urine SRV-U is emphasized. The prospects of regenerative water supply system development are considered.

INTRODUCTION

With the International Space Station (ISS) earth orbital flight for eight years wide experience in crew life support, in particular, potable and service water supply has been obtained. Water is supplied

through deliveries from earth and it is recovered from humidity condensate on board the station. During the first phase of the ISS flight, no water reclamation from urine is performed (only urine collection and pretreatment) therefore the SRV-K system plays a key role for water recovery onboard the ISS. The relation between the water recovered and the total amount of water required (consumed) is on average 0.45 to 0.55.

Depending on crew's individuality and water consumption the distribution between crew humidity condensate and crew urine has varied. This has resulted in an increase in the consumption of water supplies and in an increase of the amount of water delivered to the station. If a system for water reclamation from urine was available on board the ISS, the amount of water delivered would be practically constant. The construction and performance data of the water supply systems during the previous period of their functioning aboard the ISS have been reported at the ICES conferences [1]. This paper summarizes the eight years experience gained and makes recommendations regarding updates of promising water supply systems.

ISS WATER MANAGEMENT

Fig.1 is an ISS water supply schematic. Water is currently supplied to the crew of the international space station by the Zvezda Russian service module's systems, namely the system for water recovery from humidity condensate SRV-K and water supplies system SVO-ZV. The water sources are humidity condensate and water delivered from earth by Progress resupply crafts or transferred from Shuttles. In 2008 water was experimentally delivered by European ATV craft. Humidity condensate is processed to potable water grades in the SRV-K system. The condensate is fed to the SRV-K from the service module's air conditioning system. The condensate in the U.S. Lab. module is collected in CWC tanks and transferred to the service module for processing in the SRV-K system. For this purpose the SRV-K system is incorporated with the condensate feed unit CFU (since April 2002). The water produced in Shuttle's fuel cells with iodine added is

processed and transferred to the station by the U.S. side. CWC tanks filled with potable water (with organic calcium and magnesium salts /formates/) and service water (with 0.5 mg/L silver ions) are transferred from the Shuttle to the SM and are an integral part of the supplies system SVO-ZV. Progress resupply crafts deliver specially processed tap water containing 0.5 mg/L of silver ions either in the Rodnik system's tanks or in EDV tanks.

The water is stored in the Rodnik system's tanks or in the system SVO-ZV. Potable water is consumed directly from SVO-ZV or the SRV-K system's potable water container is filled with it. Service water from CWC tanks is used as flush water in the urine feed and pretreatment system SPK-U. For oxygen generation by electrolysis either service water or water from the Rodnik system is used after being passed through water purifying facilities including a pumping unit, multifiltration bed (the same as in SRV-K), EDV for processed water and hoses.

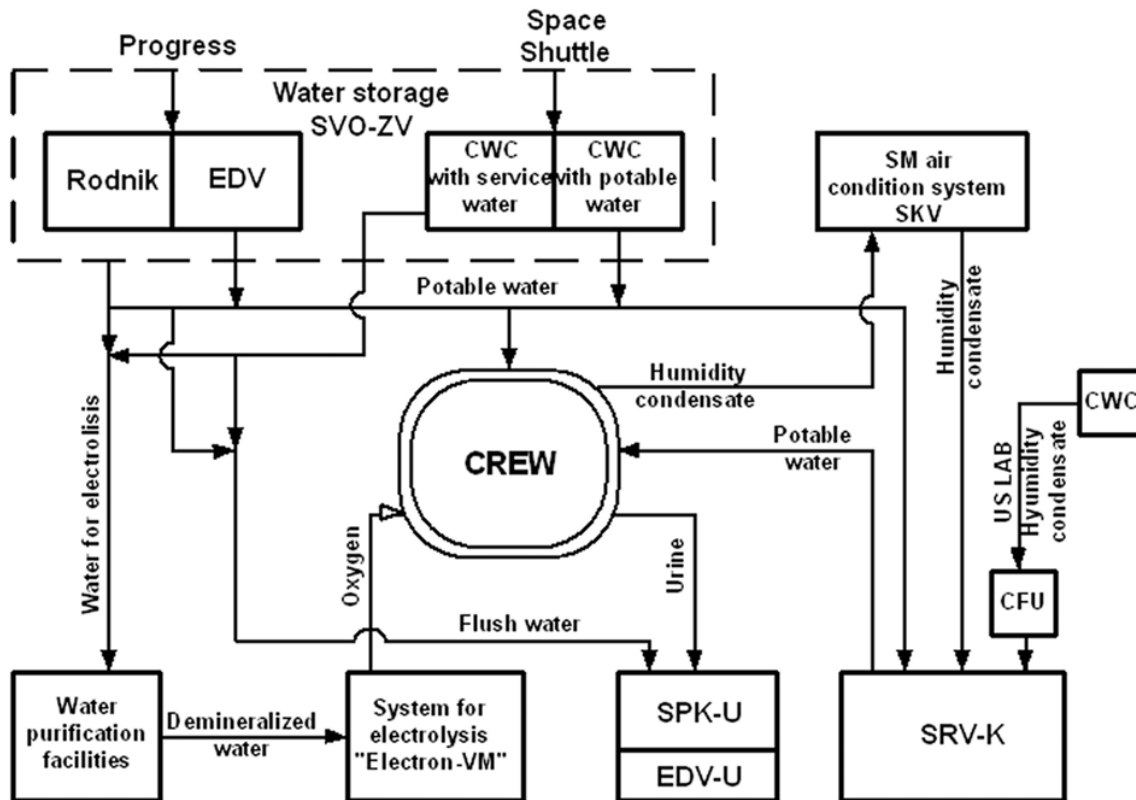


Fig.1. ISS WATER SUPPLY SCHEMATIC

Table 1.

ISS water supply and consumption during ISS-1 through ISS-11 missions from 11.02.00 through 23.10.08 (2913 days, 8028 man.days)

Water source and specified purpose	Water feed / water consumption, liters	Part of feed water, %
1. Water recovered from humidity condensate in SRV-K system for drinking and food preparation	10952	44.3
2. The consumption of water delivered to the station	13768	55.7
3. The consumption of recovered and delivered water	24720	100

Table 2.

Averaged water supply and demand for one crewmember for ISS-1 – ISS-17

Demand for water, L/man.day		Water supply, L/man.day	
Drinking and personal hygiene	2.15	Recovered by SRV-K from humidity condensate (total amount of condensate 1.5 L)	1.40
Water contained in food	0.50		
Flush water	0.30	Water contained in food	0.50
Oxygen generation	0.65	Water from supplies:	
(the system for water electrolysis did not work the whole period of flight)		Drinking and food	0.75
		Flush water	0.30
		Oxygen generation	0.65
Total	3.60	Total	3.60

Table 1 presents the station's water supply and consumption during ISS-1 through ISS-17 missions. Table 2 gives the averaged water balance per cosmonaut per day over the entire time period considered for the station in flight.

The total water consumption on the station amounted to 24720 liters over the time period mentioned above including 10952 liters of water recovered from humidity condensate, i.e. 44.3% of the total amount of water used and 63.9% of potable water. In addition, 13194 liters of urine with flush