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THE ATMOSPHERIC REGENERATION AND REGULATION IN 4-CREW AND 180-DAY CONTROLLED ECOLOGICAL LIFE SUPPORT SYSTEM (CELSS) INTEGRATION EXPERIMENT

Abstract

To create a suitable atmospheric environment that satisfied the normal growth of plants and the health needs of crew in a Controlled Ecological Life Support System (CELSS), a kind of atmospheric regeneration subsystem, which was composed of several functional modules, such as temperature and humidity control, CO2 removal, electrolysis oxygen generation, solid waste treatment, atmospheric purification and microbe control, was constructed. And a series of control strategies were established to maintain the atmospheric concentration balance, which contained plant batch cultivation, physical-chemical regenerative equipment control, solid-waste treatment equipment control, cabin ventilation, etc. The experiment was consist of two phases: the first 40-day metabolism-simulation stage when there was no crew but 4 equivalents of respiratory metabolism was loaded onto the system, and the following 180-day manned stage when 4 crew members lived in. During the simulation stage, the physical-chemical generation ways were dominated for the CO2 removal and O2 generation because the plants batch cultivation were started and the biological regeneration ability was relatively weak. While the operation time of physical-chemical regenerative devices was reduced gradually until the devices completely stopped with the gradual increase of plant metabolic ability, the way of atmosphere regeneration in the closed system was transformed from physical-chemical regeneration to biological regeneration in the late simulation stage. About 60 days later in the manned stage, when the rate of plant metabolism was higher than that of the crew group and plant inedible parts were gradually produced, operation way of the solid-waste high-temperature oxidation device was intermittently started to maintain the balance of O2 and CO2 by strengthening the recycle of carbon from plant straw to CO2. Furthermore, the atmospheric concentration of different cabins, such as plant cabin and crew living cabin, was regulated through cabin ventilation. During the experiment, the atmospheric purification module was continuous running to keep the concentration of trace contaminants safety. In

this CELSS integrated experiment, 100% oxygen supply was achieved through biological regeneration during the whole manned stage without the gas leakage of system being taken into account. And the environmental parameters were controlled in normal range to meet the needs of person and plants.