An overview of the Closed Ecology Experiment Facilities (CEEF) and carbon circulation in the CEEF

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In order to conduct experiments on the behavior of gaseous radioactive materials, which are discharged in extremely small quantities from Rokkasho Nuclear Fuel Reprocessing Plant, in the ecosystem, Closed Ecology Experiment Facilities (CEEF) were constructed in Institute for Environmental Sciences located in Rokkasho village in 1994-1999. The CEEF is composed of Closed Plant Experiment Facility (CPEF), Closed Animal and Habitation Experiment Facility (CAHEF) and Closed Geo-Hydrosphere Experiment Facility (CGHEF). Each of these Facilities has material circulation system (MCS), which has function of air revitalization (control of O2, CO2 and trace contaminant gas), water recycle and waste processing (recovery of CO2 and minerals). Processing technology mainly used in the MCS is physical/chemical one.

Two humans known as eco-nauts inhabited the CEEF, living and working in the Plant Module (PM) of the CPEF and Animal and the Habitation Module (AHM) of the CAHEF for a week three times in 2005. On a fresh weight basis, 82% of their food was supplied from 23 crops including rice and soybean etc., cultivated and harvested in the PM, in the 2nd and 3rd experiments. For the goats, the animals held in the experiments, all of their feed, consisting of rice straws, soybean plant leaves, and peanut shells and peanut plant leaves, was produced in the PM in the 2nd and 3rd experiments. The O2 produced in the PM by photosynthesis of the crops was separated by the O2 separator using molecular sheaves, then accumulated, transferred, and supplied to the AHM atmosphere. The CO2 produced in the AHM by respiration of the humans and animals was separated by the CO2 separator using solid amine, then accumulated, transferred, and supplied to the PM atmosphere. The amount of O2 consumed in the AHM was 46-51% of that produced in the PM, and the amount of CO2 produced in the AHM was 43-56% of that consumed in the PM. The surplus of O2 and the shortage of CO2 came from that almost part of waste was not processed in these habitation experiments. The estimated amount of carbon taken by the eco-nauts was 64-92% of that in the harvested edible part of the crops. The estimated amount of carbon taken by the goats was 36-53% of that in the harvested inedible part of the crops. One week was not enough time for determination of gas exchange especially for humans and animals, because fluctuation of their gas exchange was quite high. The amount of transpired water collected as condensate was 818-938 L d-1, and it was recycled as a part of new nutrient solution. The amount of waste nutrient solution discharged from the PM was 1,421-1,644 L d-1. The waste nutrient solution was processed through a filtration system using ultra-micro filters and reverse osmosis (RO) filters. Concentrations of nutritional ions in the processed solution were determined, the depleted ions were added back, and the nutrient solution was regenerated. Average amounts of water used in the AHM (L d-1) were determined as follows: drinking by humans (filtrated water), 1.5; cooking etc. (filtrated water other than for drinking), 14.3; drinking by goats, 3.8; showering (hot water), 13.2; showering (cold water), 0.1; washing of hand and face and brushing teeth, 4.1; washing of dishes, dish clothes and towels, 36.4; and washing of animal holding tools, 0.3. The waste water was processed by a RO purification system and recycled for toilet flushing and animal pens washing. A circulation experiment for water was started in 2006 and a circulation experiment for waste materials is planned for 2007. In 2006, a single duration of the air circulation experiments was two weeks, although the human habitants were changed after one week.

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