



Aromatic hydrocarbons in a controlled ecological life support system during a 4-person-180-day integrated experiment

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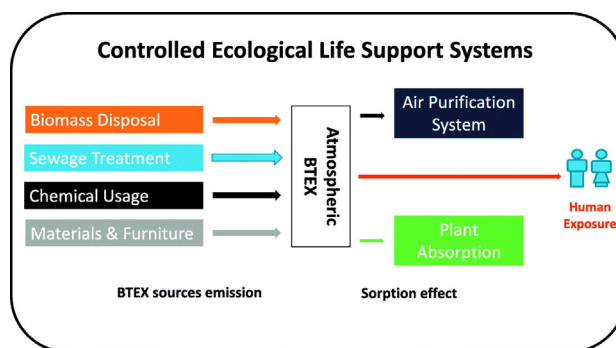
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HIGHLIGHTS

- BTEX were monitored in a 4-person-180-day experiment inside an artificial ecosystem.
- The concentrations of BEX experienced exponential decays while toluene's fluctuated.
- Using low-emitting materials/furniture may help lowering BTEX concentration levels.
- CELSS is suitable for humans' long-term living, free of health risks from BTEX.

GRAPHICAL ABSTRACT



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ABSTRACT

Indoor air quality is vital to the health and comfort of people who live inside a controlled ecological life support system (CELSS) built for long-term space explorations. Here we measured aromatic hydrocarbons to assess their sources and health risks during a 4-person-180-day integrated experiment inside a CELSS with four cabins for growing crops, vegetables and fruits and other two cabins for working, accommodations and resources management. During the experiment, the average concentrations of benzene, ethylbenzene, *m,p*-xylenes and *o*-xylene were found to decrease exponentially from 7.91 ± 3.72 , 37.2 ± 35.2 , 100.8 ± 111.7 and $46.8 \pm 44.1 \mu\text{g}/\text{m}^3$ to 0.39 ± 0.34 , 1.4 ± 0.5 , 2.8 ± 0.7 and $2.1 \pm 0.9 \mu\text{g}/\text{m}^3$, with half-lives of 25.3, 44.8, 44.7 and 69.3 days, respectively. Toluene to benzene ratios indicated emission from construction materials or furniture to be a dominant source for toluene, and concentrations of toluene fluctuated during the experiment largely due to the changing sorption by growing plants. The cancer and no-cancer risks based on exposure pattern of the crews were insignificant in the end of the experiment. This study also suggested that using low-emitting materials/furniture, growing plants and purifying air actively would all help to lower hazardous air pollutants inside CELSS. Broadly, the results would benefit not only the development of safe and comfort life support systems for space exploration but also the understanding of interactions between human and the total environment in closed systems.

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1. Introduction

Controlled ecological life support system (CELSS) is an artificial closed ecosystem built for long-term space exploration which provides

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The concentrations of aromatic hydrocarbons have been previously determined in controlled ecological environment within durations of 10 days inside closed ecology experiment facilities (Tani et al., 2002) and 33 days inside a CELSS (Guo et al., 2015). However, the emission and variation of these aromatic hydrocarbons inside CELSS were not fully understood. In this study, we collected air samples during the 4-person-180-day integrated experiment inside a CELSS, and measured BTEX for their trends inside the CELSS, their possible emission sources and their health risks as well. The study aimed to provide valuable information for better air quality management inside CELSS to lower crews' personal exposure to hazardous air pollutants like BTEX.

During the 180-day CELSS experiment, air samples were collected every 30 days in each cabin. Sampling inlet (8 mm I.D.) of polytetrafluoroethylene was obligated in advance outside of each

Fig. 1. Six cabins in 4-person-180-day CELSS experimental platform.

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