

Study on ECLSS and Micro Ecosystem Aimed at The Optimal Design of Closed Ecological Life Support Systems

*Takuma Terao, Tomofumi Hirotsaki¹, Masato Sakurai²

1.Space Systems Development Corporation, 2.Japan Aerospace Exploration Agency

We must produce the environment we can survive in order to live in space. Can be it possible is ECLSS (Environmental Control and Life Support System). ECLSS remove carbon dioxide and the hazardous substances generated from the human body and equipment and control oxygen concentration and humidity etc. In ground 400km ISS (International Space Station), ECLSS has created an environment that enables the activities of about six people. In the current ISS, assumes the supply of goods from the earth and they are reusing a portion of the material. Now, the system that can reuse full materials has not been developed. In recent years the manned space activity on Moon or Mars is expected, finally the development of high rate material regeneration ECLSS is desired. Aimed at the study of the complete materials circulation, Biosphere 2 and CEEF (Closed Ecology Experiment Facilities) as artificial closed ecosystem, were built. Both required a vast land and processing equipment for living of several people. Although the part of regeneration equipment of ECLSS on ISS is relatively compact, just then considering full regeneration of materials, the system becomes extremely complex and difficult.

If we can look with a macro view, the Earth is the largest closed ecosystem operated with the energy from the sun. Materials within the Earth is circulated and innumerable life exist together. They withstand to so many kinds of disturbance, but there are also species going extinct, and they has been co-exist in a much longer period than our life span. Moreover, change of number of individuals caused by disturbance goes to converge or vibration as if something control. Natural ecosystems are very stable in many aspects. The variety of factors of the self-standing stability has been studied. However, the method of incorporating it to the specific system is not clear. It is one of the dream for ECLSS developers to put a self-standing stability on ECLSS.

We carry out the two directions of approach of analysis of realistic ECLSS analysis and ecosystem function in order to propose what factor makes the ECLSS with completely material circulation (CELSS: Closed Ecological Life Support Systems). In ECLSS analysis, we simulate ECLSS with current technologies and investigate what technology can be a bottleneck and high sensitivity factors in the system by multi evaluation items. At the same time we study similarities between the actual trouble in ECLSS and disturbance in real ecosystem. In the ecosystem analysis, modeling a minimal ecosystem "microcosm", analyze mechanisms of a restoring force to a disturbance in the system. Then, we consider how self-standing stability of natural ecosystems can be applied to a specific artificial system. The final goal is to apply the self-standing stabilizing function found out from the ecosystem analysis to CELSS. At the same time we propose a system having a high stability and current technical problems for the system. Progress of our present study, we have reached only the analysis of each approach. In this presentation, we make their introductions.

Keywords: Life support system, Closed system, Ecosystems, Microcosm