

IAF SPACE EXPLORATION SYMPOSIUM (A3)
Interactive Presentations - IAF SPACE EXPLORATION SYMPOSIUM (IP)

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OVERVIEW OF THE LUNAR IN SITU RESOURCE UTILIZATION TECHNIQUES FOR FUTURE
LUNAR MISSIONS

Abstract

Along with the rapid development of space technology, extraterrestrial exploration has gradually tended to further-distanced and longer-termed planet exploration. As the first step of an attempt for humans to build a perpetual planet base, building a lunar base by in situ resource utilization (ISRU) will drastically reduce the reliance of supplies from Earth. Lunar resources including mineral resources, water/ice resources, volatiles, and solar energy will contribute to the establishment of a lunar base for long-term life support and scientific exploration missions, although we must consider the challenges from high vacuum, low gravity, extreme temperature conditions, etc. This article provides a comprehensive review of the past developing processes of ISRU and the latest progress of several ISRU technologies, including in situ water access, in situ oxygen production, in situ construction and manufacture, in situ energy utilization, and in situ life support and plant cultivation on the Moon. Despite being able to provide some material and energy supplies for lunar base construction and scientific exploration, the ISRU technologies need continuous validation and upgrade to satisfy the higher requirements from further lunar exploration missions. Nowadays, China's lunar exploration project has completed the 3 steps strategy of "orbiting, landing, and sample return", and the future lunar exploration program will focus on establishing a permanent lunar station and carrying out long-term lunar surface scientific activities. The lunar ISRU technologies will play key roles in in situ replenishment of survival matters, in situ construction of lunar habitats, and in situ acquirement of energy in future lunar exploration missions. Thus a 3-step development plan for China's lunar ISRU technologies in the next decade is proposed, which consists of providing technological solutions, conducting technical verification on payloads, and carrying out in situ experiments, with the ultimate aim of establishing a permanent lunar station and carrying out long-term lunar surface scientific activities. The overview of ISRU techniques and our suggestions will provide potential guidance for future lunar exploration missions of China and other countries.