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CONCEPTUAL DESIGN OF A MEDICAL GRADE OXYGEN DELIVERY SYSTEM FOR SPACE MISSION AND ITS MARKET ANALYSIS

Abstract

The International Space Station Health Maintenance System provides life support to ensure the safety of astronauts including the delivery of medical grade oxygen during planned and emergency operations. NASA flight rules that oxygen concentration of the flight shall not exceed 30% under any circumstances. As a result, there is a risk that the delivery of medical grade oxygen on ISS may lead to the maximum oxygen concentration level being exceeded. This issue might also negatively affect the future exploration missions or commercial crew program where smaller vehicles such as Orion are expected to be used.

In this context, this paper proposes a conceptual design of an oxygen delivery system which can administer medical oxygen without raising the oxygen level above the safe cabin limit. The proposed system removes oxygen from exhaled air and maintains the space station oxygen level within acceptable limits. The system consists of two major components, an oxygen mask and an exhale air reservoir bag. The mask is airtight, soft-cushioned and has low breathing resistance with one inlet and one valve-operated outlet. The reservoir bag is a flexible bag internally coated with an oxygen absorbing chemical which temporarily holds the exhaled air and chemisorbs the oxygen. The bag inlet is connected to the outlet of the mask, and the bag outlet is fitted with an electrically operated valve activated by a Zirconium oxygen sensor. The oxygen sensor measures the oxygen percentage of the air inside the reservoir bag. As soon the oxygen percentage falls below 30%, the bag outlet valve will activate and release the gases to the room. A cationic multi-metallic crystalline cobalt complexes for the reservoir bag coating which can absorb oxygen almost instantly and reversibly is under consideration.

The proposed system will address an identified limitation of the U.S. ISS module and so may have significant commercial application for space tourists, space tourism companies and the commercial companies interested in LEO commercialization. It may also have commercial non-space applications such as in hospital hyperbaric treatment chambers, submarine simulators, diving, decompression chambers. To reflect this, the paper includes not only a schematic system design but also the outcome of market analysis for both space-based and non-space based applications of the proposed system.