Human Exploration of the Moon: Multi-stage lunar Dust Removal System

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ABSTRACT

International space exploration plans and scenarios are driven by the long-term goal to enable human exploration of Moon and Mars. To prepare for these ambitious goals, robotic and human space missions are required to gradually develop and demonstrate the enabling technologies and capabilities. In the frame of such scenario, the research program STEPS aims at developing technologies needed for the future exploration missions of the solar system. The pervasive presence of lunar dust could jeopardize the return of the man to the Moon, seriously affecting the health of future crews. It is therefore essential to design dust abatement systems that are reliable, reusable, and efficient. The present paper describes the design and manufacturing of a dust removal system developed as part of the Environmental Control and Life Support System of a manned rover for the exploration of the lunar surface near the South Pole. The Dust Removal System proposed has been designed to abate the amount of airborne dust present inside the pressurized volume of the rover due to the External Vehicular Activities of the crew. The proposed system consists of three dust-abatement stages arranged in succession in order to increase both the collection efficiency and the reliability of the whole system. The first stage, a cyclonic separator coupled with a magnetic collector, has been designed to remove the greater part of airborne particulates without the use of filters, through cyclonic and magnetic separation. Taking advantages of the peculiar electro-magnetic properties of the lunar regolith, due to abundant nano-phase metallic Fe, an electro-active filter second stage has been designed that ionizes and removes smaller-grained particulates. The last stage is a High Efficiency Particulate Air filter able to remove at least 99.97% of airborne particles larger than 0.3 micrometers in diameter. To test (on ground) the Dust Removal System, testing processes and procedures with the use of the enhanced lunar dust simulant are under investigation.

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