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NUMERICAL ANALYSIS OF THE VENTILATION IN A MOON HABITAT LABORATORY MODULE

Abstract

Human spaceflight demands systems that provide a livable environment for humans i.e. habitats for long duration missions on other planets. This challenge involves the design of several subsystems of the life support system according to comfort criteria, including air management and ventilation of supply air. The main goals of the ventilation system are to ensure a comfortable room climate with fresh air while being able to remove waste heat of the habitat's systems. In this project a ventilation design for a habitat laboratory is created. The ventilation flow's performance in different configurations and boundary conditions is evaluated via numerical simulation using OpenFOAM 6 with the buoyantBoussinesqPimpleFoam solver for an incompressible transient turbulent flow with heat transfer. The design of MaMBA, the Moon and Mars Base Analog, is used as an example geometry, consisting of an octadecagonal room with racks in alternating heights and stairs as obstacles. The maximum heat load (8.8 kW) produced by scientific instruments, habitat systems and humans inside the room is modelled. Since testing of a cooling system with the room ventilation being the only cooling loop does not provide an acceptable solution, a secondary cooling loop is proposed. It absorbs the heat of the electrical devices like the scientific instruments, that are located inside the racks, and releases heated air at the rack's bottom in the direction of the room's exhaust vents. Comfort criteria according to literature values are set to ensure a good mixing of the supply and ambient air with a low probability of drafts. In combination with the secondary rack ventilation, the cooling loops can fulfil most of the comfort criteria. It can be shown that a secondary cooling loop for the rack system at maximum heat load is required and should therefore be integrated in the design of the habitat's ventilation system as a minimum configuration.