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TEMPERATURE PROFILE THROUGH THE THICKNESS OF A DOME HABITAT STRUCTURE ON THE LUNAR SURFACE

Abstract

Human habitation on the moon has been a target of scientists and engineers for a long time now. However, it is challenging due to several extreme and hazardous environmental conditions. Extreme temperature conditions are one of them. Therefore, it is imperative to understand the thermal behavior of the lunar habitat structure. This paper presents the analytical study of the surface temperature and temperature through wall thickness of the concrete dome habitat structure on the lunar surface at the equatorial line. The study also includes the structural self-shadowing effect. The study found that the surface temperature can vary from around 90 K during the nighttime to 425 K during the daytime.

The external surface temperature and the temperature through thickness were determined using the three dimensional thermodynamics energy balance equation. The explicit finite difference method was implemented to discretize the equation. The direct solar radiation, lunar albedo were taken as the heat sources whereas non-blackbody radiation, and habitat albedo were taken as heat sinks during the study. The exterior surface temperature (time varying) and the ambient air temperature (constant of 293.15 K) were taken as the two boundary conditions to determine the temperature through wall thickness. The analysis was conducted using the intial temperature condition of the dome structure to be 293.15 K. While the maximum temperature of 425 K is observed in the base element of the dome at either around sunrise or sunset time, the minimum temperature ranges from 90 K to 110 K during the night time. The results from this study should help to determine the structural stresses and deflections caused by the extreme lunar environment temperature fluctuation and the heat regulation for habitability.

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