Lunar Dust Contamination Effects on Lunar Base Thermal Control Systems

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ABSTRACT

Many studies have been conducted to develop a thermal control system that can operate under the extreme thermal environments found on the lunar surface. While these proposed heat rejection systems use different methods to reject heat, each system contains a similar component, a thermal radiator system. These studies have always considered pristine thermal control system components and have overlooked the possible deleterious effects of lunar dust contamination. Since lunar dust has a high emissivity and absorptivity (greater than 0.9) and is opaque, dust accumulation on a surface should radically alter its optical properties and therefore alter its thermal response compared to ideal conditions. In addition, the non-specular nature of the dust particles will alter the performance of systems that employ specular surfaces to enhance heat rejection.

To date, few studies have examined the effect of dust deposition on thermal control system components. These studies only focused on a single heat rejection or photovoltaic system. These studies did show that lunar dust accumulations alter the optical properties of any lunar base hardware, which in turn affects component temperatures, and heat rejection. Therefore, a new study was conducted to determine the effect of lunar dust contamination on heat rejection systems.

For this study, a previously developed dust deposition model was incorporated into the Thermal Synthesizer System (TSS) model. This modeling scheme incorporates the original method of predicting dust accumulation due to vehicle landings by assuming that the thin dust layer can be treated as a semitransparent surface slightly above and in thermal contact with the pristine surface. The results of this study showed that even small amounts of dust deposits can radically alter the performance of the heat rejection systems. Furthermore, this study indicates that heat rejection systems be either located far from any landings sites or be protected from dust producing mechanisms.