Vapor hydrogen peroxide as alternative to dry heat microbial reduction

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The Jet Propulsion Laboratory, in conjunction with the NASA Planetary Protection Officer, has selected vapor phase hydrogen peroxide sterilization process for continued development as a NASA approved sterilization technique for spacecraft subsystems and systems. The goal is to include this technique, with appropriate specification, in NPG8020.12C as a low temperature complementary technique to the dry heat sterilization process. To meet microbial reduction requirements for all Mars in-situ life detection and sample return missions, various planetary spacecraft subsystems will have to be exposed to a qualified sterilization process. This process could be the elevated temperature dry heat sterilization process (˜115C for 40 hours) which was used to sterilize the Viking lander spacecraft. However, with utilization of highly sophisticated electronics and sensors in modern spacecraft, this process presents significant materials challenges and is thus undesirable to design engineers to achieve bioburden reduction. The objective of this work is to introduce vapor hydrogen peroxide (VHP) as an alternative to dry heat microbial reduction to meet planetary protection requirements. The VHP process is widely used by the medical industry to sterilize surgical instruments and biomedical devices, but high doses of VHP may degrade the performance of flight hardware, or compromise material compatibility. Our goal for this study is to determine the minimum VHP process conditions for planetary protection acceptable microbial reduction levels. A series of experiments were conducted to determine VHP process parameters that provided significant reductions in spore viability while allowing survival of sufficient spores for statistically significant enumeration. With this knowledge of D values, sensible margins can be applied in a planetary protection specification. The effects of VHP concentration, exposure duration, temperature, relative humidity, and material substrate on lethality of Geobacillus stearothermophilus will be discussed. Biological indicators were inoculated with more than 1 million Geobacillus stearothermophilus (ATCC 7953) spores on stainless steel coupons and packaged in Tyvek/Mylar pouches. For the tests on the effect of material substrates, the same inoculation procedure was employed on the selected material substrates. All exposures were conducted in a STERIS VHP MD2000 Series Sterilization System. The process involves a conditioning phase, injection of liquid hydrogen peroxide, a sterilization phase (in vacuum), and an aeration phase with HEPA-filtered air. The outcome of this study provided an optimization of test sterilizer process condi-

tions: VHP concentration, process duration, a process temperature range for which the worst case D value may be imposed, a process humidity range for which the worst case D value may be imposed, and robustness to selected spacecraft material substrates.

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