UV-C Decontamination of Aerosolized and Surface Bound Single Spores and Bioclusters

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Background

The benefits of the germicidal effect of UV lights was demonstrated in an early study reporting a reduced number of cases of influenza infection in a veteran's hospital equipped with UV-C producing bulbs compared to nearby non-irradiated hospital rooms. Since then, several additional studies have shown reduction of bacterial spores and vegetative cells due to upper room air UV. These findings indicate that UV light can contribute to the control of contagious disease in an environment outside of the controlled confines of a laboratory (CDC 1994).

Recent laboratory studies evaluating the kill effect of UV-C were conducted with single spores or close to single spore sizes on surfaces and in the air. However, by neglecting multi-spore clusters, little is known about the decay of potentially equally hazardous larger clusters such as those belonging to aerosols released by sneezing and coughing and other aerosols generated by crude or sophisticated methods. Larger particles consisting of multiple layers of spores are of particular concern due to the potential for the outer layers of spores forming a sacrificial protective sheathing around an inner core of viable and infectious pathogens. Therefore, only a fraction of the incident radiation is expected to reach spores in the center of a multi-layer cluster.

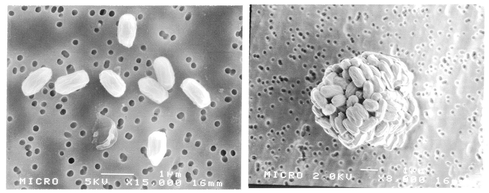

Figure. SEM Picture of Single Spore BG and clustered BG generated by the IJAG

Surface Exposure

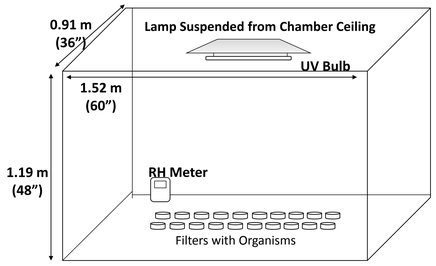

Figure. Surface Exposure Chamber

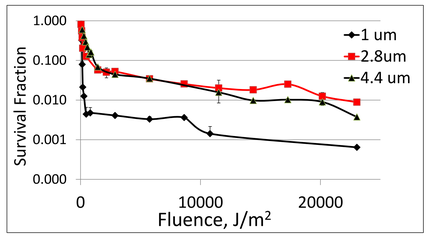

Figure. Kill Curve for the Surface Exposure.

Table. The values for the two stage decay curve for spores on surface. k_1 = first stage rate constant (m^2/J),

	k_1
Single Spores	0.012
2.8 µm Clusters	0.008
4.4 µm Clusters	0.003

Aerosol Exposure

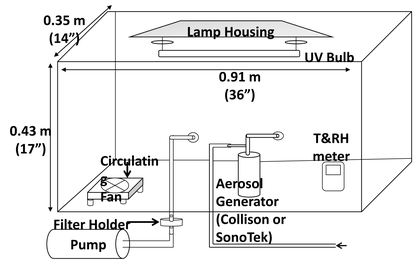

Figure. Aerosol Exposure Chamber

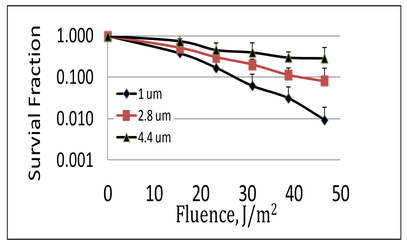

Figure. Kill Curve for the Aerosol Exposure

Table . The values for the multihit target model for the aerosol exposure. k = rate constant and n=multitarget exponent.

	n	k
Single Spores	2.82	0.12
2.8 µm Clusters	1.61	0.06
4.4 µm Clusters	1.43	0.04

Conclusion

	D_{90} values for Surface J/m^2	D_{90} values for Aerosol J/m^2
Single Spores	138	27
2.8 µm clusters	725	42
4.4 µm clusters	1128	86-94

In conclusion, this study evaluated the effect of UV-C irradiation on monodispersed spore cluster particles with mean diameters of 2.8 µm and 4.4 µm as well as single spores of *Bacillus atrophaeus* subspecies *globigii* (BG) on fixed surfaces and as aerosol. The results demonstrate that the decay rate of spores is dependent upon the overall particle size in which they reside; both fixed to surfaces and as an aerosol. Our results demonstrate that the rate of decay of a potentially infections particles is dependent upon the overall size of the cluster, and the physical state of the spores (surface bound or aerosolized), with other obvious variables such as spectrum of light, intensity of irradiation, organism and strain used, and the use of a well characterized particle size distribution.

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