Variable Frequency Operation of Electrodynamic Screens for Removing Dust Particles over a Wide Size Range to Maintain High Reflectivity of Solar Mirrors

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***Abstract*— Fine particle deposition on mirrors used in Concentrated Solar Power systems such as parabolic mirrors and Fresnel lenses used in Concentrated Photovoltaic (CPV) arrays is a major source of power loss. Electrodynamic screens (EDS) integrated on the solar mirrors can be used for removing dust layer deposited on the optical surface of solar collectors, thus maintaining high reflection and transmission efficiency. EDS consist of rows of parallel electrodes deposited on a dielectric substrate and encapsulated with a thin uniform dielectric film. The EDS electrodes are powered by three-phase, low current (< 1mA/m^2), square wave high voltage pulses (+1kV) to generate an alternating electric field between the electrodes and a traveling wave across the electrodes. The electric field repels dust particles, which gains their electrostatic charge through dielectrophoretic and triboelectric charging processes. The traveling wave sweeps the particles away from the mirror surface. Electrostatic force modeling and experimental studies show that removal of dust particles in a given size range depends upon the electrode geometry and the frequency of three-phase pulses used for electrode activation. We report here the design, construction and evaluation of a three-phase pulsed high voltage power supply for efficient operation of EDS that can be programmed to vary frequency from 2 to 200 Hz with different duty cycles and sweeping frequency modes. Experimental data on dust particle removal in different size ranges will be reported to demonstrate the feasibility of restoration of specular reflection efficiency of the solar mirrors integrated with EDS. Of particular interest is on sub-5 µm dia. particles, as previous studies show that particles in this size range cause significant scattering losses and are difficult to remove because of their relatively strong adhesion forces on the surface. Our goal is to maximize the dust removal efficiency of EDS by using different frequency sweeping patterns with several electrode geometries for its applications to self-cleaning solar mirrors.**