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Assessment of Water Droplet Evaporation Mechanisms on Solar Panel Surfaces

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Periodic cleaning of solar panels is of vital importance to reduce electrical output losses caused by dust on the panel surfaces. Prediction of water requirements for cleaning solar panels requires a detailed study, especially for places such as Nevada where water scarcity is of significant concern. A major loss of water during panel cleaning has been attributed to evaporation, however little information is available to help solar facilities predict this loss, and by extension plan for future water needs. As a part of the NEXUS project, a quasi-steady state model to simulate the evaporation of water droplets from tilted surfaces is being developed. The model includes physical phenomena such as vapor diffusion in the gas domain, evaporative cooling of the interface, as well as buoyancy-driven convective flow in both the liquid and gas domains associated with the tilted solar panels. This model is being developed to depict a real scenario of evaporation in an open environment, with a special emphasis on conditions that can be expected in the arid Nevada climate. Specifically, evaporative behavior of pure water and water with dust particles will be compared on flat horizontal and flat tilted surfaces. Concurrently with the modeling, experimental data (e.g., evaporation rates and contact angles) are being collected for several different flat surfaces, including materials common to solar panels. Once the quasi-steady state modeling is complete, the model may be extended to depict the transient nature of evaporation and may be combined with the membrane distillation model also under development to better predict heat and cleaning water available for that process. At the completion of this project, it is expected that we will have an experimentally validated, first principles model that will provide solar energy producers with an excellent tool for predicting a facility's evaporative water losses from panel cleaning.

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