Water Consumption in PV Panel Cleaning

When PV panels were first installed commercially, panel manufacturers suggested that rainfall was sufficient enough to maintain panel generation efficiency. This worked for installations with enough annual rainfall but in those areas where it was inadequate or where rainfall alone did not remove contaminants, power generation quickly degraded and return on investment was compromised. To overcome the inefficiencies of the rainwater-only regime, many panel operators now use local water supplies and treated water, such as distilled, deionized (DI) or reverse osmosis (RO) water, when necessary. The incremental costs of drawing from local sources or using treatment processes are important to the management of water costs in maintaining the economic viability and environmental stewardship of a PV operation.

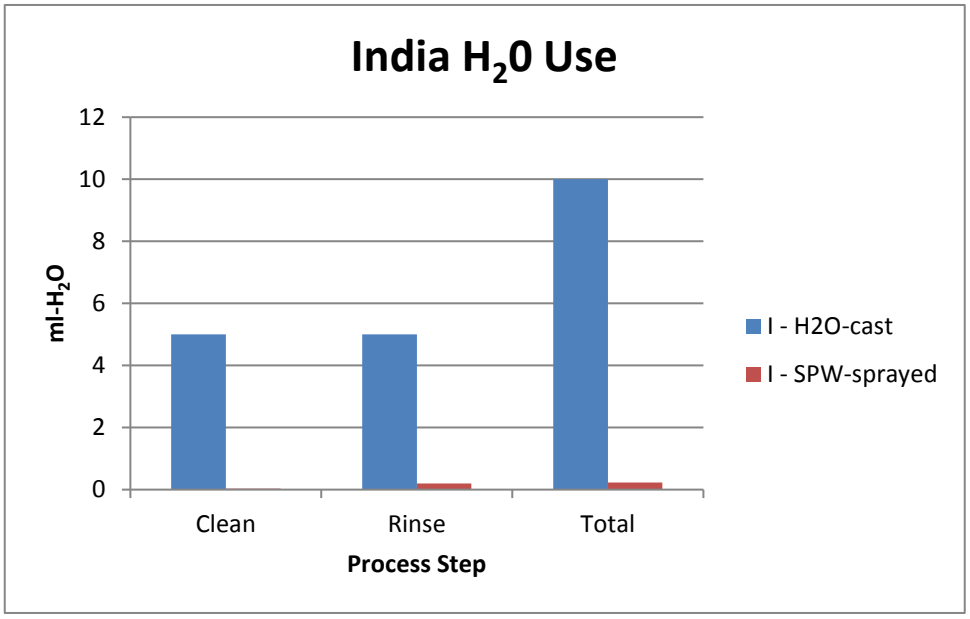
There are a number of ways to lower water costs in PV cleaning; i.) Reduce or eliminate water treatment, ii.) Recycle wash and rinse water, or iii.) Use less water in general for cleaning operations. Treatment is used to remove impurities from the water to minimize streaking and spotting of the panel's protective glass. Recycling can be used to both re-treat panel wash water and to reduce the total amount of water used. Using less water in the cleaning process is the easiest and least costly way of controlling PV cleaning water consumption. This final cost control method; Reduced Water Use, is the subject of this paper.

Water Consumption Tests—American Polywater has quantified water use in a number of PV installations around the world. In all comparisons, American Polywater's Solar Panel Wash™ (SPW) reduced water use significantly. There are three basic steps in cleaning PV panels: Soaking/cleaning, scrubbing and rinsing. Water is always consumed in the soaking and rinsing steps. When special cleaning equipment is employed, water can also be consumed in the scrubbing step. In the tests described below, water is either cast, e.g., thrown from large plastic cups/pails and/or hosed, or sprayed onto the surface of the protective glass in the soaking and rinsing steps. These comparison tests measured the amount of water used in the soaking and rinsing steps using only water vs those same steps using an H_2O/SPW mix in a 25:1 ratio.

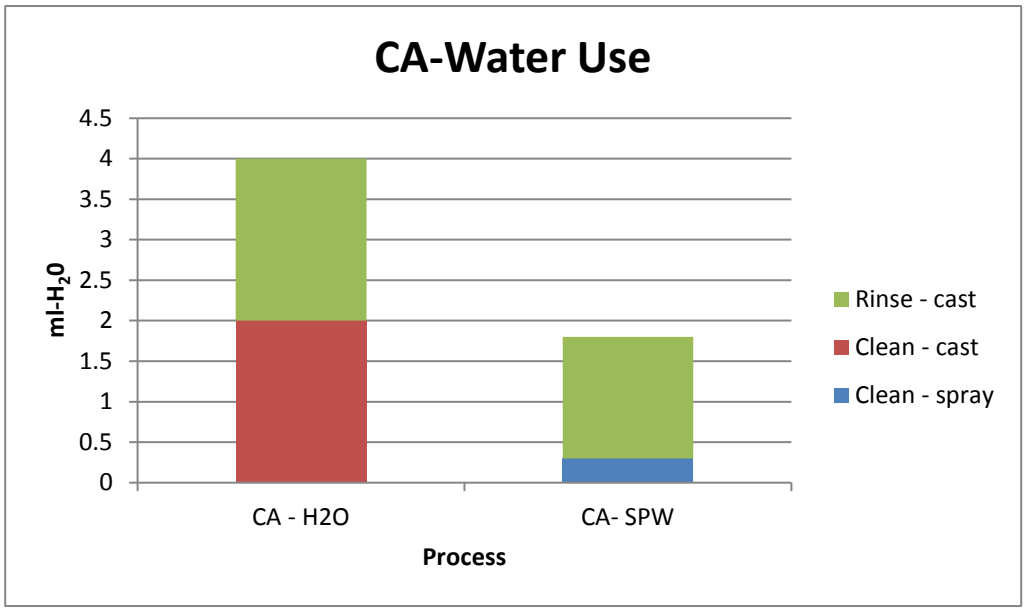
Water cast onto the panel with a hose

Water sprayed onto the panel

India Test—For example, in an H_2O consumption test done in India, it was determined that over 10 L of water were used to clean and rinse a panel using only untreated local water. In both soaking/cleaning and rinsing steps, the H_2O was cast onto the panels. In comparison, when both soaking and rinse water were sprayed on to the panel, only 230 ml of water/SPW mixture was used. This translates to more than 40 times more water consumed when panels are cleaned with water alone. (See graph below.)



Central American Test—In another comparison test done in Central America, it was estimated that 3.5 L of water were needed for soaking and rinsing each panel when water only was used. (See graph below.) Using the H_2O/SPW mix, only 30 mL were needed in the soaking stage. In the rinse stage, where H_2O only was used instead of the SPW mixture, another 1.5 L of water were used. This translates into a total of 1.53 L of total H_2O used per panel, or a reduction of 56.3% from using water alone for both wash and rinse. It is believed that the reduction could have been greater had the H_2O/SPW mixture been used in the rinse stage.



Analysis—As can be seen in the table below, there are significant differences in the amount of water used in these two scenarios. But, in both cases, SPW reduced total water consumption. How and where these reductions were realized are discussed below:

H_2O Comparison

Location	H_2O-Clean (litres/panel)	H_2O-Rinse (litres/panel)	H_2O Total (litres/panel)	H_2O Reduction %
India - H_2O Only	5.0	5.0	10.0	
India - SPW Mix	0.03	0.2	0.23	97.7%
C.A. - H_2O Only	1.5	2.0	3.5	
C.A. - SPW Mix	0.03	1.5 (H_2O)	1.53	56.3%

- Differences in cleaning procedures—Water consumption is most affected when only water is used in both the soaking/cleaning and rinse stages. The surface-tension-reducing properties of SPW help to form a thin, continuous H_2O /SPW sheet across the entire panel. This property is called wetting. Because of its high surface tension, water alone will tend to form droplets on the surface of the glass and will not wet completely. More water is required to completely wet the panel when the H_2O/SPW mix is not used.

  A cleaning procedure change that results in significantly lower water consumption is the use of the H_2O/SPW mix in both the cleaning and rinsing steps. More water was used when only H_2O was used to rinse in Central America than when the H_2O/SPW mixture was used in India. This shows that the cleaning procedure employed can dramatically impact water use.

- H_2O Spraying vs. Casting—In both H_2O Only cleaning scenarios described above, water was cast onto the panel's surface. Spraying was used in the case of the application of the H_2O/SPW mix in both instances. Spraying resulted in lower water use as a spray pattern covers more of the panel's surface area with less water. This is evident in the table above. The H_2O Rinse column shows that the water used in the Indian SPW Mix-Rinse scenario was 87% lower when sprayed onto the panel than when rinse water was cast onto the panel. Compare gray cells in the table above for a comparison of Indian and Central American rinsing scenarios.

  Water application methods result in different levels of water consumption during PV panel cleaning. Sprayed water in both cleaning and rinsing stages uses significantly less water than when water is cast onto the panel.

- Time of Day—Panel cleaning in the early morning or evening will result in lower water use than when cleaning is done during the heat of day. When the sun is high in the sky and the panels are at their peak power generation capacity, the heat generated by the panels causes wash and rinse water to evaporate quickly. More water is required as a result.

  In addition to higher water use, cleaning panels during periods of peak solar irradiance can result in micro-cracks or fissures in the panel's protective glass. These are caused by the large temperature gradient created between the hot glass surface and the lower temperature water. These micro-cracks not only compromise the protection of the underlying solar cells but also interfere with incoming sunlight, which can reduce overall power generation.

Conclusion—Water consumption in PV panel cleaning operations can be a major operating cost over the lifetime of a solar panel installation. Control of water use is a key element to the economic viability and environmental stewardship of many PV installations. There are a number of strategies that can be used to control water consumption costs. This paper reviewed one of these strategies: water use reduction. Water consumption can be reduced significantly with the use of Solar Panel Wash™ (SPW) from American Polywater Corporation. SPW helps to lower water consumption as it allows for the formation of a thin, continuous sheet of water on the PV panel's protective glass. Less water is used to wet the panel completely than would be required if water were used alone. SPW is easily sprayed on the glass in both cleaning and rinsing steps of the cleaning process to further reduce water consumption. When panels are cleaned during early morning hours or after dark, further reductions in consumption are possible due to slower water evaporation.

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