Smart Systems and Green Energy (2021) Vol. 3: 1-7
Clausius Scientific Press, Canada

DOI: 10.23977/ssge.2021.030101
ISSN 2523-904X

Analysis of the effect of Automatic gray water cleaner on the improvement of solar module power generation efficiency

Yi Wang[1, *], Qi Qi[1]

[1]*China Electric Power Research Institute, Beijin 100192, China*

*Corresponding author: gyedia@163.com

Keywords: Solar energy, automatic Automatic gray water cleaner, Power generation efficiency, Utilization hours.

Abstract: The solar energy industry has developed rapidly in recent years. Research on the improvement of power generation efficiency of solar modules is of great significance. The lower frame of the solar modules laid outdoors is prone to dust accumulation, which not only directly affects the power generation efficiency of the solar power station, but also generates hot spots due to local overheating, shortening the module life, and causing greater economic losses to the enterprise. In this paper, the power generation efficiency improvement effect of the Automatic gray water cleaner on the lower frame of the solar module is tested. The test data shows that the power generation efficiency of the module with the Automatic gray water cleaner on the lower frame has been improved.

1. Introduction

After rapid development in recent years, the installed capacity of solar power generation already has a considerable scale. There are many factors that affect the power generation efficiency of solar modules, including the cleanliness of the surface of the module, the service life, the temperature, the climate and altitude of the area, and the angle of inclination. When a solar power station is put into operation, the inclination of the modules and the local climate conditions have been determined. The cleanliness of the solar modules has the greatest impact on the power generation efficiency of the solar modules. In this paper, to solve the problem that the soot belt of the lower frame of the solar module has a great influence on the power generation efficiency of the solar module, the test is carried out by installing a Automatic gray water cleaner on the lower frame of the solar module.

2. The impact of dust on solar modules

As we all know, atmospheric particulate matter (PM) is one of the main pollutants that cause air pollution, especially fine particulate matter (PM2.5) has become the primary pollutant in most cities.

The most intuitive environmental manifestation of PM2.5 pollution is that the atmosphere is turbid, the color is yellow or orange, and the visibility is less than 10km. [1]

Figure 1: Photo of the dust belt on the lower frame of the solar module

The dust on the surface of solar modules mainly comes from the natural scattering of a large amount of air dust and rain water. As the module type, installation area and installation method are different, the dust accumulation of the module is also different. Under normal circumstances, the inclination of the distributed roof solar power plant components is small, and the metal frame is higher than the surface of the component, which is particularly easy to form an obvious dust accumulation zone on the lower frame of the component, as shown in Figure 1. Dust has three main effects on solar modules: temperature, corrosion and shading.

2.1 Temperature effect

Fouling has two main influences on the temperature of components. First of all, when the solar module has dust accumulation, the heat dissipation performance of the originally smooth module is reduced. Under the same irradiation and heat generation, the temperature of the module will be higher. Secondly, the surface of the module is unevenly distributed, and often more dust accumulates at the lower frame of the module, which forms a partial obstruction. The temperature of the module is significantly higher than other areas during power generation, forming a "hot spot", which is irreversible and will cause irreversible power generation modules Damage. As shown in Figure 2, hot spots have been formed on the lower frame of the module.

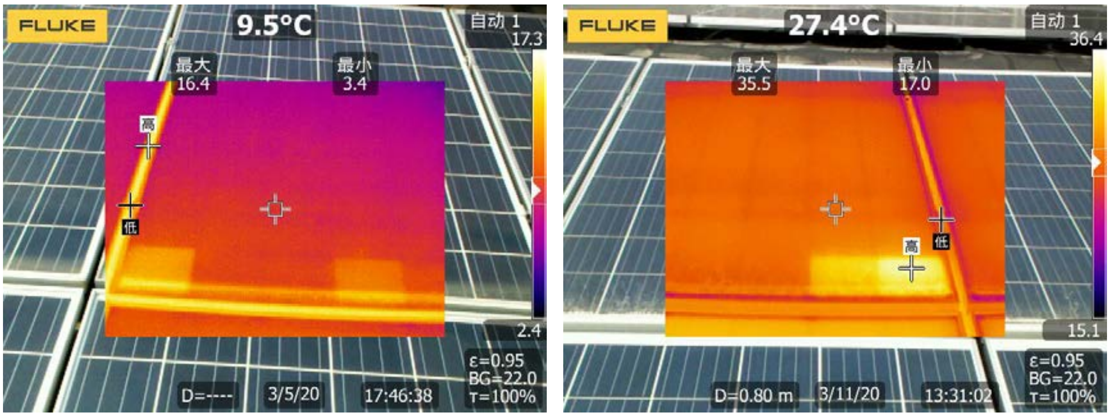

Figure 2: A picture of hot spots formed on the lower frame of the module

2.2 Corrosion effects

The chemical composition of rainwater generally includes K^{+}, Ca^{2+}, Na^{+}, Mg^{2+}, NH_4^{+}, Cl^{-}, F^{-}, SO_4^{-}, NO_3^{-}, and some organic matter [2]. Rainwater is acidic and alkaline, mostly acidic. After the rain is dried, dust is formed and adheres to the surface of the solar module. At the same time, the dry dust easily absorbs moisture in the air, so in most cases, there are varying degrees of water content in the dust. Solar panel panels are mostly made of glass, and the main components are SiO_2 and limestone. Both acidic and alkaline liquids can chemically react with the surface of the solar panel. Over time, a large number of small "pits" will be formed on the surface of the module. Small and many "pits" will refract and reflect part of the sunlight, which will reduce the power generation efficiency of solar modules. More serious is that once the component surface begins to form "pits", it will be easier to gather dust, and the "pits" are more likely to become larger and more numerous, forming a vicious circle.

2.3 Occlusion

Dust particles will block, absorb and reflect sunlight on the surface of the module, thereby greatly reducing the irradiance of the module power generation unit, which directly affects the power generation efficiency of the module. Under the same conditions, the output power of the cleaning module is generally at least 15% higher than that of the dust accumulation module, and the more the dust accumulation, the more the output power of the module decreases. [3] In addition, according to the horizontal and vertical blocking of the lower frame of the cleaning module, it is found that when the lower frame of the horizontal cleaning module is completely blocked, the power generation efficiency of the module will be reduced by 20-30%. When the lower frame of the vertical cleaning module is completely blocked, the power generation efficiency of the module will be reduced by as much as 50-60%. It can be seen that the occlusion of the lower frame of the module has a great influence on the power generation efficiency of the module.

Dust has a comprehensive effect on the temperature, corrosion, and shielding of solar modules, which will greatly reduce the power generation efficiency and cause economic losses to enterprises.

3. Introduction to Grey Water Cleaner

3.1 Structure and working principle of grey water cleaner

The Automatic gray water cleaner is formed outside of a C-shaped, aluminum alloy material, including siphon nets, diversion grooves, drainage holes and a fixed card. The Automatic gray water cleaner is shown in Figure 3.

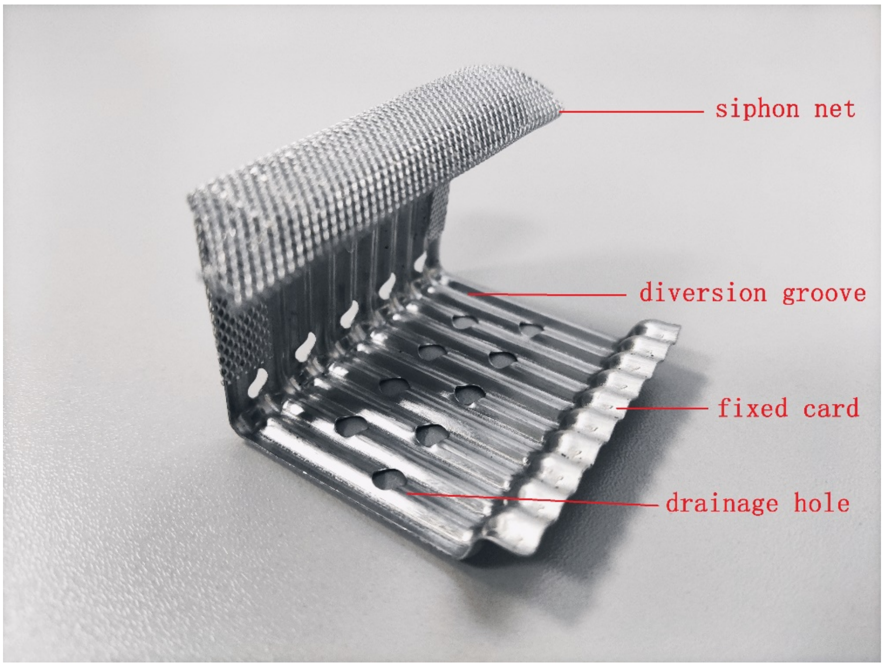

Figure 3: Grey water cleaner

The Automatic gray water cleaner is installed at the lowest lower frame of the solar modules laid at an oblique angle. When there is a certain amount of water on the surface of the module, the accumulation of water at the lower frame of the module is the most. When the stagnant water contacts the Automatic gray water cleaner, under the combined action of the surface tension of the water and the siphon net of the Automatic gray water cleaner, the Automatic gray water cleaner can automatically divert the gray water out of the surface of the solar module to achieve the effect of removing dust from the solar module. .

3.2 Applicable scenarios and methods of use

The grey water cleaner is mainly suitable for solar modules with aluminum alloy frame. The closer the angle of installation of the components is to the level, the better the effect of removing the dust zone. Field test data shows that the cleaning effect is ideal when installed on components with an inclination angle of less than 10 degrees. When rainfall, heavy dew, or water washing, the gray water remover will automatically lead out the gray water to achieve the purpose of quickly and effectively removing the dust.

4. Analysis of the effect of gray water remover

This paper selects a distributed solar power station in the suburbs of East China city for experiment. The basic situation of the solar power station is: the SG50KTL inverter produced by Sungrow, polycrystalline solar modules, and the average inclination angle of the modules is 2.86 degrees.

4.1 Test method

The solar modules with the same physical conditions in the same power station are selected as the research and comparison objects. The number of components to install the Automatic gray water cleaner is 4440, with a capacity of 1.2432MW. There are 12,344 pieces of components without the Automatic gray water cleaner, with a capacity of 3.45632MW.

The testers installed 8,880 grey water cleaners on the lower frame of 4440 modules, with an average of 2 installed on each module. The test period is 80 days.

4.2 Grey water cleaner test results

The test found that after the rain, the dust accumulation of the components installed with the gray water cleaner was significantly less than that of the components without the gray water cleaner. The contrast of the soot belt near the lower frame of the solar module is obvious, as shown in Figure 4.

Figure 4: Comparison diagram of component dust accumulation

4.3 Effect analysis

A comparative analysis was made on the utilization hours of solar modules with and without the Automatic gray water cleaner.

4.3.1 Data analysis of power generation utilization hours.

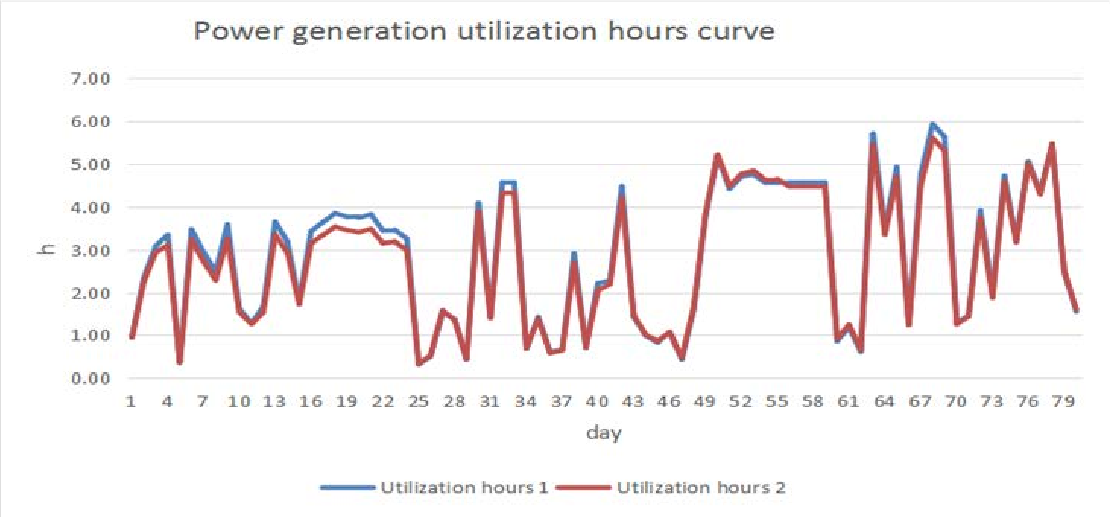

Figure 5: Power generation utilization hours comparison curve

It can be seen from the comparison curve of power utilization hours (as shown in Figure 5). Utilization hours 1 represents the components with the gray water cleaner installed, and Utilization hours 2 represents the components without the gray water cleaner. The overall power generation efficiency of the components with the Automatic gray water cleaner installed is slightly higher than that of the components without the Automatic gray water cleaner.

4.3.2 Percentage curve of power generation utilization hours increase (As shown in Figure 6)

Figure 6: Power generation increase percentage curve

In the 80 days of the test period, 55 days of the power generation efficiency of modules with

Automatic gray water cleaners were higher than those without Automatic gray water cleaners, accounting for 68.75%. The highest single-day increase in power generation efficiency is 10.68%.

During the test period, the total power generation capacity of the Automatic gray water cleaner components installed was 285513.7kWh, and the total power generation utilization hours was 228.37h. The total power generation without the Automatic gray water cleaner components is 765153kWh, and the total power generation utilization hours are 221.383h. The total power generation hours are increased by 6.987h, an increase of 3.156%.

5. Conclusion

The dust accumulation of solar modules will not only directly affect the power generation, but also cause direct economic losses to enterprises. Moreover, over time, the components will generate heat and cause hot spot damage, which will shorten the service life of the components. The test results show that by installing a Automatic gray water cleaner on the lower frame of the solar module with a relatively small inclination angle of the module, it can increase the power generation efficiency of the module and bring direct economic benefits to the enterprise. This article only provides a valuable reference scheme for improving the power generation efficiency of distributed rooftop solar power stations.

References

[1] ZHANG Jin, XUE Caifeng, etc.Discussion about the harm of PM2.5 and its control process and experience in China[J].ENVIRONMENT AND SUSTAINABLE DEVELOPMENT, 2021, 1: 109-114.

[2] LUO Xuan, LI Jun, etc.Advances in Research on the Chemical Composition of Precipitation and Its Source in China [J]. EARTH AND ENVIRONMENT, Vol.41. NO.5, 2013: 566-574.

[3] ZHANG Feng, BAI Jian-bo, etc.Effects of Airborne Dust Deposition on PV Module Surface on Its Power Generation Performance [J]. East China Electric Power, Vol.41 No.2 Feb.2013: 364-366.