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Impact of dust ingredient on photovoltaic performance: An experimental study

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ABSTRACT

Different building materials such as sand, cement, and gypsum are transported and stored poorly in Iraq (open-air), so large amounts of them fly into the air and form part of the dust. In this study, collected amounts of dust deposited for three months studied in a controlled manner. The components of the accumulated dust were examined and found that the largest part of it (more than 50%) is silicon oxides (sand), the rest of which represent most significant part of the components of cement and gypsum. In this study, the accumulation of building materials (sand, ordinary cement, egg cement, gypsum, and industrial gypsum) studied on the power output of a photovoltaic module (PV). The effect of periodic cleaning and its duration on the lost power of the PV were also studied.

The study results showed that the accumulation of these materials, even in small quantities on PV reduces the transmittance and reduces the resulting power because it prevents the arrival of solar irradiation to the PV. The accumulation of natural and white cement followed by sand and gypsum gave the most considerable loss of energy produced. The studied module cleaned without using any liquids so as not to react with the tested building materials. Natural cement is the most difficult of these materials in dry cleaning due to its particles' small size. The industrial gypsum causes the most substantial power reduction when accumulates in more than 25 g/m^2. When studying the material's ability to adhere to the surface of the dry PV module, the industrial gypsum showed a high degree of adhesion followed by sand compared with the other studied materials. Three methods to prevent the dew water from being connected to the building material were studied, which is to clean the PV daily at the evening, cover the PV with plastic cover from evening until early morning, and turn the PV in the evening to face the ground. The first method limited in effectiveness, while the other two methods were effective in reducing dust accumulation damage and preventing its interaction with dew.

1. Introduction

Over the past decade, photovoltaic (PV) technologies have grown exponentially and have contributed more than 59 GW of power generation around the world in 2015 (Al-Waeli et al., 2019). The intensity of solar irradiation in the Middle East and North Africa (MENA) region is one of the largest in the world as most of its countries located in or near the solar belt (Krarti and Ihm, 2016; Parajuli et al., 2016). Iraq is close to this belt and shares with its country's high solar irradiation throughout the year enough to obtain the electrical power of PV (Kazem and Chaichan, 2012). This country is one of the wealthiest countries in the world in term of oil and gas and one of the largest exporters of crude oil and began since 2017 to export large shipments of natural gas. The delay in the use of PV technology in addition to the fact that the harsh climatic conditions that characterize the Middle East with high temperatures and levels of dust (Pollution) (Chaichan and Kazem, 2018). Iraq, after the vast desertification resulting from two decades of drought, a source of dust to neighboring countries (Kazem et al., 2014). So, the investigation of the behavior of PV cells in the dusty areas of Iraq has not ceased to develop practical solutions to increase reliance on them instead of fossil fuels that cause environmental pollution (Al-Maamary et al., 2017).

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