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الْعِلْمَ دَرَجَات

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Abstract:

While, solar photovoltaic (PV) for clean electricity generation is promising, ensuring its optimum performance is crucial for sustainability. Accumulation of dust from the outdoor environment on the modules of PV system is natural, but dust becomes a major issue in the performance of PV systems in the Sahara region, like Libya, where the availability of high solar radiation. The considerable increase of installations in desert areas, it makes essential to assess the resistance of modules to sand and weather conditions in various areas of the country. This thesis will investigate the effect of dust on PV module performance. The important of this work came due to the transfer of large scale PV technology to the local area characterized by hot and dusty conditions for most seasons that is represents the main barrier to PV utilization. A fundamental understanding of how dust affects PV module performance is presented. However, further investigation on induced shading and losses of electrical PV module performance due to dust accumulation is conducted. A mathematical simulation model to justify the shape of the typical behavior of the electrical characteristics in the presence of shading on the tilted module surface is considered. The simulation results will be applied to develop a dust correction model for long term energy prediction for PV modules that is able to provide better energy prediction and possible variation in the PV module performance over long period of time. On the other hand, experimental investigation was carried out in order to study the effect of dust accumulation on PV module and to compare the results with that obtained from the simulation procedure. It is found that the degradation in power output from the module is related to the linear dependence of the current with the solar irradiance (light transmittance), since the open circuit voltage increases logarithmically with intensity which means that there is a small variation in PV module output voltage.

الخلاصة :

في حين أن الطاقة الشمسية الكهروضوئية (PV) لتوليد الكهرباء النظيفة واعدة ، فإن ضمان أدائها الأمثل أمر بالغ الأهمية لتحقيق الاستدامة. تراكم الغبار من البيئة الخارجية على وحدات النظام الكهروضوئي أمر طبيعي ، لكن الغبار يصبح مشكلة رئيسية في أداء الأنظمة الكهروضوئية في منطقة الصحراء ، مثل ليبيا ، حيث يتوفر إشعاع شمسي عالي. إن الزيادة الكبيرة في المنشآت في المناطق الصحراوية ، تجعل من الضروري تقييم مقاومة الوحدات للرمال والظروف الجوية في مناطق مختلفة من البلاد. ستبحث هذه الأطروحة في تأثير الغبار على أداء الوحدة الكهروضوئية. جاءت أهمية هذا العمل بسبب نقل تقنية الكهروضوئية على نطاق واسع إلى المنطقة المحلية التي تتميز بظروف حارة ومغبرة لمعظم المواسم والتي تمثل العائق الرئيسي أمام استخدام الطاقة الكهروضوئية. يتم تقديم فهم أساسي لكيفية تأثير الغبار على أداء الوحدة الكهروضوئية. ومع ذلك ، يتم إجراء مزيد من التحقيق حول التظليل المستحث وفقدان أداء الوحدة الكهروضوئية بسبب تراكم الغبار. يُنظر في نموذج محاكاة رياضي لتبرير شكل السلوك النموذجي للخصائص الكهربائية في وجود التظليل على سطح الوحدة المائلة. سيتم تطبيق نتائج المحاكاة لتطوير نموذج تصحيح الغبار للتنبؤ بالطاقة على المدى الطويل للوحدات الكهروضوئية القادرة على توفير تنبؤ أفضل للطاقة والتباين المحتمل في أداء الوحدة الكهروضوئية على مدى فترة طويلة من الزمن. من ناحية أخرى ، تم إجراء تحقيق تجريبي لدراسة تأثير تراكم الغبار على الوحدة الكهروضوئية ومقارنة النتائج مع تلك التي تم الحصول عليها من إجراء المحاكاة. لقد وجد أن التدهور في خرج الطاقة من الوحدة يرتبط بالاعتماد الخطي للتيار مع الإشعاع الشمسي (نفاذية الضوء) ، نظرًا لأن جهد الدائرة المفتوحة يزداد لوغاريتميًا مع الشدة مما يعني أن هناك اختلافًا بسيطًا في الوحدة الكهروضوئية انتاج التيار الكهربائي

TABLE OF CONTENTS

LISTOF TABLES

LIST OF FIGURES

Nomenclature

PV	Photovoltaic	Λ	Wavelength
J_{sc}	Short circuit current density	$ESTI$	Institute for energy and transport
$c\text{-}Si$	Crystalline silicon	Q_{ext}	Extinction efficiency
$CIGS$	Copper-Indium-Gallium-Diselenide	A	Ratio of the particle size to the wavelength of the incidence Irradiation
$CdTe$	Cadmium Telluride	Q_{sca}	Scattering efficiency
$a\text{-}Si$	Amorphous silicon	a_n	Mie coefficients
E	Spectral irradiance	b_n	Mie coefficients
AM	Air mass	M	Refractive index
h	Solar elevation	m''	Imaginary part of the refractive Index
G	Irradiance	μ_1	Fraction of the magnetic permeability of the sphere to the magnetic permeability of the ambient medium
SR	Spectral response	X	Size of the particle
I_{sc}	Short circuit current	A	Radius of the sphere
I_o	Diode saturation current	Q_{abs}	Absorbance efficiency
n	Diode ideality factor	$T_{Transmittance}$	Transmittance
q	Electron charge	D	Particle diameter
K	Boltzmann constant	XRD	X-Ray Diffraction
T	Temperature of the device in Kelvin	A_t	Integral of the spectral transmittance data at specific dust Concentration
V_j	Voltage across the diode junction	$SMARTS$	Simple model of the atmospheric radiative transfer of sunshine
I_{ph}	Photocurrent	$S3DM$	Spatial 3 dimension model
R_s	Series resistance	Y_s	Array yield
R_{sh}	Shunt resistance	E_{total}	Total energy for the PV module
I	Current drown by the load	E_λ	Photon energy
V	Voltage across the load	H	Planck's constant
P_{mpp}	Maximum power point	C	Speed of light
V_m	Voltage at the maximumpower point	I_D	Current at the diode

I_m	Current at the maximum power point	R_{in}	Input resistances
FF	Fill factor	*TCO*	Transparent conductive oxide
STC	Standard testing condition	*Hor*	Horizontal
η	Efficiency	V_{BD}	Voltage across the back diode
A	Area of the module	I_{BD}	Back diode saturation current
V_{oc}	Open circuit voltage	*N*	Dust particles concentration
$R_{s,Lat\text{-}TCO}$	TCO lateral resistance	h_a	Height of measured wind from the surface
$R_{s,Lat\text{-}Al}$	Back contact lateral resistance	V_s	Dust particle velocity
R_{se}	Series resistance representing bulk resistivity of the semiconductor material, without the contribution of the contact layers resistivity.	*D*	Turbulent diffusivity
R_b	Terminals resistance	Θ	Surface tilt angle
VL	Voltage limited	*W'*	Fluctuation in the vertical wind Speed
CL	Current limited	A_{ats}	Atmospheric condition,
Vert	Vertical	K_{vk}	Von Kerman constant
KISR	Kuwait Institute for Scientific Research	*Uy*	Wind velocity vertical components
DCA	Directorate of Civil Aviation	U'_y	Wind friction velocity
EPA	Environment Public Authorities	*G*	Acceleration due to gravity
DNI	Direct normal irradiance	*P*	Particle density
GHI	Global horizontal irradiance	μ	Air dynamic viscosity
CREST	Centre for renewable energy systems technology	*D*	Dust particle diameter
H	Haze	*C*	Cunningham correction
M	Mist	K_{sp}	particle nonsphericity
R	Rain	A_d	Attachment coefficient
S	Suspended dust	D_{Dust}	Dust accumulation
RD	Raised dust	C_f	Cleaning correction factor

DS	Dust storm	R_{min}	Minimum rain cleaning threshold
RH	Relative humidity	R_{max}	Maximum rain cleaning threshold
PC	Personal computer	R_c	Rain correction factor
U	Uncertainty	*DST*	Dust spectral transmittance at specific dust density
SD	Standard deviation	I_1, V_1	Coordinates of points on the measured I-V characteristic
μc/a-Si	Micromorph	I_2, V_2	Coordinates of the corresponding points on the corrected I-V curve
T_a	Ambient temperature and	G_1	Irradiance as measured with the reference device
T_m	Averaged module temperature	G_2	Target irradiance for the corrected I-V characteristic
PVSR	PV soiling ratio	T_1	Measured temperature of the test specimen
WS	Wind speed	*K'*	Temperature coefficient of the internal series resistance R'_S
T_2	Target temperature of the test specimen	V_{OC1}	Open circuit voltage at test conditions
WD thetest	Winddirection	R'_S	Internal series resistance of specimen
J	Dustfluxrate	*YOV*	Optimized daily yield deviation desired for the optimisationprocess

α_{rel}, β_{rel} Relative current and voltage temperature coefficients of the test specimen measured at 1000 W/m^2. They are related to short circuit current and open circuit voltage atSTC

α Irradiance correction factor for open circuit voltage which is linked with the diode thermal voltage of the pn junction and the number of cells serially connected in themodule

CF Cleaning frequeny