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Ministry of Higher Education & Scientific Research
Directorate General for Scientific Research and Technological Development
Renewable Energy Development Center

Unit of Applied Research in Renewable Energies

7th International Symposium on New and Renewable Energies
October 15 - 16, 2025 Ghardaïa, Algeria

PROCEEDINGS

SIENR 2025

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Preface

Objectives of the symposium

The seventh international symposium on new and renewable energies, which will take place at the Unit of Applied Research in Renewable Energies "URAER Ghardaïa", affiliated with the Renewable Energy Development Center "CDER Algiers", aims to update attendees on the latest research developments in this technological field, highlighting their significance and application in the context of southern Algeria.

This scientific meeting, succeeding the great success of previous editions, intends to be a tradition to foster researchers from different research centers and laboratories in renewable energies, industrialists and decision-makers working in this field.

Topics

The main research topics to be discussed during this seventh symposium include:

- Photovoltaic Solar and Hybrid Systems
- Thermal Solar
- New Energies (Hydrogen, Fuel cell ...)
- Renewable Resources (Solar, Wind, Biomass ...)
- Energetic Efficiency and Environment

Symposium venue

The seventh International Symposium on New and Renewable Energies, SIENR25, will be held at the Applied Research Unit in Renewable Energies, approximately 20 kilometers from Ghardaïa.

Ghardaïa is located in the center of the northern part of the Algerian Sahara, about 600 km south of Algiers. Its geographical coordinates are 3° 40' East longitude and 32° 29' North latitude. This strategic geographical location makes Ghardaïa a crossroads connecting the High Plateaus to the Sahara region. It is well-known for its desert landscapes, palm groves, and traditional architecture, classified as a UNESCO World Heritage site. According to the most recent administrative delineation, it is bordered to the north by the Laghouat province, to the northeast by Djelfa, to the east by Ouargla, to the south by El Meniaa, and to the west by the El-Bayadh province.

Reception venues for the seminar event

Applied Research Unit for Renewable Energies

7th International Symposium on New and Renewable Energies SIENR25

October 15 - 16, 2021 Ghardaïa, Algeria

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Summary

Plenary conferences		
Conference title	**Speakers**	
Artificial Intelligence of Things (AIoT) for photovoltaic farms: Advancing smart monitoring and cyber-physical security		Prof. MELLIT Adel Faculty of Sciences and Technology, Jijel University, Algeria.
What role can renewable energy play in the oil and gas industry		Prof. HADJADJ Ahmed Faculty of Sciences and Technology, University of Adrar, Algeria.
Nanomaterials for Solid-state Hydrogen Storage: State of the art, Challenges and Perspectives		Prof. CHEKNANE Ali University Amar Telidji, Laghouat, Algeria.
The Energy Transition: Between Opportunities and Hidden Realities		Dr. DIAF Said Renewable Energy Development Center, CDER Algiers, Algeria.

Polymer encapsulant embedded with nanomaterials for photovoltaic module encapsulation process		Dr. AGROUI Kamel Semiconductors Technology for Energetic Research Center CRTSE, Algiers, Algeria
Main pathways for the emergence of passive and active energy solutions in building projects		Dr. BEKKOUCHE Sidi Mohammed El Amine Unit of Applied Research in Renewable Energies, URAER Ghardaïa
High-temperature materials for CSP Receivers: Experimental insights and material selection challenges		Pr. PAPURELLO Davide Politecnico di Torino Torino, Italia

Theme A

Photovoltaic Solar and Hybrid Systems

A Novel Distributed Two-Stage Photovoltaic Conversion Cascade Using a Single-Phase Five-Level I-Type NPC Inverter with Integrated Energy Storage

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Abstract

This work presents a new photovoltaic conversion architecture based on a five-level I-type single-phase inverter, powered by two photovoltaic generators through boost converters controlled by a fuzzy logic MPPT regulator. A Battery Energy Storage System (BESS) using lithium-ion batteries and a bidirectional Buck-Boost converter is integrated to ensure energy stability. Simulation results demonstrate the effectiveness of the fuzzy control in tracking the maximum power point under varying irradiation conditions. Vector control with redundant vectors applied to the inverter ensures proper regulation of the DC-link capacitor voltages. The overall system exhibits good adaptability to variations in both power generation and load, thus providing a robust solution for grid-connected or standalone solar applications.

Keywords: Five level NPC, Fuzzy MPPT, SVM, Redundant vectors

Performance Evaluation of P&O, improved Sliding Mode, and Fuzzy Logic MPPT Methods in PV Systems: A Comparative Study under uniform and non-uniform conditions

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Abstract

This paper presents a comprehensive comparative analysis of three Maximum Power Point Tracking (MPPT) algorithms Perturb and Observe (P&O), improved Sliding Mode Control (SMC), and Fuzzy Logic Control (FLC) applied to photovoltaic (PV) systems operating under both uniform irradiance and partial shading conditions. While uniform irradiance allows straightforward MPPT operation, variations caused by shading introduce nonlinearities in the power–voltage (P–V) characteristics that degrade performance and energy yield. The three MPPT techniques are implemented and evaluated in a simulated PV system using MATLAB/Simscape. Their performance is assessed using key metrics, including tracking efficiency, power losses (at the PV and load levels), and output power ripple. Results show that under uniform conditions, intelligent controllers (SMC and FLC) outperform conventional P&O by achieving faster convergence and improved output stability. Under partial shading, the disparity in algorithm performance becomes more pronounced, with FLC achieving the highest tracking accuracy (up to 99.8%), minimal ripple, and negligible power losses. The results reveal critical insights into the strengths and limitations of each method, providing guidance for optimal MPPT strategy selection in realworld solar energy applications.

Keywords: Photovoltaic (PV) systems, Maximum Power Point Tracking (MPPT), Partial shading, Uniform condition, Fuzzy Logic

Control (FLC), Sliding Mode Control (SMC), Perturb and Observe (P&O), Power ripple, Tracking efficiency, Power losses, MATLAB / Simscape.

Performance Assessment of Single and Dual Axis Solar Tracking System

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Abstract

This work focuses on improving the performance of a single and two-axis solar tracking system, essential for maximizing the efficiency of photovoltaic panels. The main objective is to develop an optimized solution, capable of accurately tracking the sun's path throughout the day, thereby increasing energy production. To achieve this objective, a method combining the use of luminosity sensors and motors, controlled by an Arduino board, was implemented. The results obtained show a significant improvement in the alignment of the panels with the sun's rays, leading to a substantial increase in the energy captured. These improvements make a significant contribution to the optimization of solar systems, making this technology more viable for a wide range of sustainable energy applications.

Keywords: Solar tracking system, LDR sensor, single axis, dual axis, solar irradiation

Optimal Parameter Estimation for an Enhanced Self-Correcting Battery Model Based on Real Electric Vehicle Drive Cycle Profile

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Abstract

Lithium-ion batteries (LiBs) are the dominant energy storage solution for electric vehicles (EVs) due to their outstanding performance. However, accurately determining the ungiven parameters of LiB models from measured voltage and current data poses a highly nonlinear and multimodal optimization challenge. Precise estimation is critical for effective simulation, control, and evaluation of energy storage systems. Traditional methods often fail due to the problem's complexity, while metaheuristic algorithms (MAs) provide better solutions but require improvements to mitigate local optima entrapment and slow convergence. Recently, advanced MAs have been introduced to enhance these aspects, yet their application in battery parameter estimation remains underexplored. This paper evaluates four recently developed MAs—PID Search Algorithm (PSA), Spider Wasp Optimization (SWO), Triangulation Topology Aggregation Optimizer (TTAO), and Black Kite Algorithm (BKA)—for estimating parameters of an Enhanced Self-Correcting Battery Model. Using Urban Dynamometer Driving Schedule (UDDS) drive cycle data, these algorithms are assessed based on best fitness, average fitness, worst fitness, standard deviation (StD), average efficiency (Avg), and convergence speed. Results reveal that BKA is the most efficient and effective method among the tested approaches, whereas SWO performs poorly for this specific task.

Keywords: Enhanced Self-Correcting model, Metaheuristic Algorithms, Optimization, Li-ion battery, UDDS dataset

Study of GaAs betavoltaic cell using Monte Carlo Method

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Abstract

The process of generating power by incorporating a beta source into semiconductor junction devices is referred to as betavoltaic energy conversion. This study will use the Monte Carlo method to simulate the distribution of electron-hole pairs generated at each point in the cell under bombardment of Ni63 source for betavoltaic cells. The results of the Monte Carlo simulation will be used in the modelling and simulation of an n- GaAs/p-GaAs junction betavoltaic cell and their characteristics.

Keywords: Monte Carlo method, interaction, betavoltaic cell, generation EHP, GaAs

Hardware-in-the-Loop Implementation for Enhanced Energy Management in Grid-Connected PV Systems

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Abstract

This study presents an enhanced energy management strategy for grid-connected photovoltaic (PV)systems, focusing on optimizing active and reactive power exchange with the utility grid. Achieving this through a novel fractional-order proportionalintegral with variable proportional gain (VG-FOPI) controller. The controller's parameters are meticulously optimized using Particle Swarm Optimization (PSO)to ensure robust performance across diverse operating conditions.

The system, comprising a PV array connected to a singlephase inverter, was rigorously evaluated. We assessed the VG-FOPI controller's effectiveness under various disturbance scenarios and benchmarked its performance against traditional methods.

MATLAB/Simulink simulations were instrumental in initial validation, followed by crucial Hardware-in-the-Loop (HIL)validation to confirm real-time applicability and robustness. Our results demonstrate the VG-FOPI controller's significant superiority. We observed substantial improvements in transient response, including reduced overshoot and undershoot, and notably faster settling times.

Furthermore, the enhanced power quality, evidenced by a lower total harmonic distortion (THD) in grid-injected currents, highlights the controller's efficacy. These findings underscore the VG-FOPI controller as a robust and highly effective solution for optimizing energy exchange and improving power quality in grid-connected PV systems.

Keywords: Fractional-Order Proportional Integral, Controller, Grid-Connected Inverters, Active and Reactive Power Control, Grid-Connected PV System

Effective control and power flow management strategy for stand-alone wind system based on DFIG with storage

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Abstract

In this paper, an effective control is proposed to perform the operation of a Doubly Fed Induction Generator (DFIG) in a stand-alone application with battery storage. The proposed control technique integrates the Field Oriented Control (FOC) method to regulate the amplitude/frequency of the stator voltage and DC link voltage. A power management strategy is applied to manage the power flow in the system. A pitch control is used to adjust the turbine blade angle when the wind turbine operates in the third zone corresponding to wind gusts. The main objective is to supply AC loads with a constant voltage amplitude and frequency, while meeting the load's power demand, despite high wind speeds. The proposed stand-alone application is tested in MATLAB/Simulink environment. The obtained results show satisfactory performance. The AC load is supplied with a constant voltage, the wind turbine power is limited during wind gusts and the balance between generation and demand is achieved thanks to the power flow management strategy.

Keywords: Wind Turbine, Stand-alone operation, Doubly Fed induction generator, Energy management strategy, Pitch angle control, Field-Oriented Control

Experimental Evaluation of BLDC Motor Integration in Solar-Powered Water Pumping Systems

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Abstract

This study evaluates the performance of two photovoltaic (PV) generator configurations, 8Sx1P and 4Sx2P, integrated with Brushless Direct Current (BLDC) pumps for solar-powered water pumping systems under varying Total Manometric Head (HMT) conditions in a desert environment.

The experimental analysis focuses on key parameters such as solar irradiance, PV voltage and current, cell temperature, water flow rate, pump power consumption, and the efficiency of Maximum Power Point Tracking (MPPT) algorithms. Results demonstrate that the 8Sx1P configuration consistently outperforms the 4Sx2P configuration, achieving higher water flow rates, improved MPPT efficiency, and greater energy utilization across all HMT values (1 m, 15 m, and 25 m). The 4Sx2P configuration, however, suffers from insufficient operating voltage, limiting MPPT activation and reducing system performance, particularly at higher HMTs and elevated temperatures. The integration of BLDC pumps further enhances system efficiency, offering superior reliability, energy savings, and adaptability to fluctuating solar input compared to traditional Alternating Current (AC) or brushed DC pumps. However, challenges such as the complexity of control electronics and the dependency on high-quality MPPT algorithms highlight the need for advanced control strategies, including sensorless vector control and artificial intelligence-based approaches, to optimize BLDC pump performance in dynamic operating conditions. These findings underscore the importance of ensuring adequate voltage levels and selecting appropriate pump technology to achieve optimal energy conversion and system reliability. The results highlight the 8Sx1P configuration combined with BLDC pumps as the most suitable solution for high-efficiency solar water pumping applications, particularly in challenging climatic conditions.

Keywords: Solar water pumping, PV generator configurations, BLDC pumps, MPPT, Total Manometric Head.

Advanced Network Voltage Control for Grid-Connected PV Systems Using Smart PV Inverter Capabilities

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Abstract

Photovoltaic systems connected to low voltage distribution networks (LVDN) can cause voltage violations. Despite the many advantages of grid-connected photovoltaic systems (GCPV), such as lower production costs and higher efficiency, their impact on voltage levels frequently needs a determination of penetration limits. To avoid grid reinforcements, distribution network operators must develop new control mechanisms that will support the current and future adoption of PV systems at a reasonable cost. Advanced control methods, such as volt watt control (VWC), Volt Var control (VVC), and their combination (VWC-VVC), can mitigate voltage violations by absorbing or injecting reactive power or by injecting curtailed active power. This work focuses on examining the use of inverters in critical PV systems that experience significant voltage fluctuations due to high PV penetration. Real measurement data from a GCPV system located in Centre De Développement Des Énergies Renouvelables (CDER) are used to validate the proposed simulation methodology. The study shows how PV inverters may be effectively used to integrate PV systems into LVDN. It also evaluates the use of advanced VWC and VVC functionalities and the improvements in voltage management achieved through the combined VWC-VVC approach.

Keywords: Advanced Control capabilities; Grid-connected PV system; Network voltage control; Smart PV inverters; Voltage violations

Experimental Implementation of an Advanced Solar Charge Controller for Photovoltaic Systems with Battery State-of-Health Dynamic Tracking and Adaptive Compensation

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Abstract

The increasing reliance on photovoltaic (PV) energy systems necessitates efficient battery management to ensure reliability and longevity, particularly in off-grid applications. This paper presents the experimental implementation of an advanced solar charge controller designed for real-time battery State-of-Health (SoH) dynamic tracking and adaptive compensation. The proposed system continuously monitors key battery parameters, including voltage, current, and temperature, to estimate SoH and adaptively mitigate degradation effects such as overcharging, deep discharges, and thermal stress. A microcontroller-based control unit is integrated with sensor technology and programmed using MicroC Integrated Development Environment (IDE) to execute precise control actions. The charge controller employs a Working Zone and Temperature Tracking (WZTT) methodology, enabling dynamic SoH estimation and adaptive threshold regulation. The system's performance is evaluated through simulations and experimental validation, demonstrating its correctness and effectiveness in optimizing battery charging cycles and enhancing PV system efficiency. Results confirm that the proposed controller significantly improves energy management, extends battery lifespan, and ensures stable operation under dynamic and uncertain environmental conditions. Finally, this work contributes to the advancement of intelligent charge regulation strategies for PV-based energy storage systems, paving the way for more resilient and adaptive renewable energy solutions.

Keywords: Photovoltaic Systems; Solar Charge Controller; Battery State-of-Health (SoH) Monitoring; Working Zone and Temperature Tracking (WZTT); Adaptive Compensation.

Hybrid MPPT - Simple boost control of Z source inverter integrated in standalone PV systems

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Abstract

This study gives a hybrid strategy control of standalone system based on Z source inverter and powered by photovoltaic generators and electrochemical batteries. In off grid application, the most challenge is obtain voltage stability with a higher power quality in all really conditions (meteorological conditions, load variations). The Z-source inverter (ZSI) provides an alternative solution for the conventional voltage source inverter (VSI) by eliminating de DC/DC converter, and replace it by LC network design, this solution reduce the switching power number, losses and cost. In this work, a combined P&O MPPT technique and simple boost control strategy will be integrated in the Z sourec inverter to elaborate the shoot through situations. Many simulation results expose clearly in different situations the reliability and the robustness of the proposed control.

Keywords: Photovoltaic, MPPT, Z source inverter, simple boost control, battery, standalone system.

Using SILVACO TCAD to enhance the In0.62Ga0.38N Solar Cell by adding a BSF layer

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Abstract

In this work, the p-InGaN/n-InGaN/n+-InN based solar cell structure has been studied numerically by SILVACO-TCAD simulator software. by introducing a highly doped InN layer as a back surface field (BSF) in the structure between the absorber layer and the back contact layer. the effects of thickness and acceptor density of the absorber layer, the buffer layer and the BSF layer, on the open-circuit voltage, short-circuit current, fill factor, and efficiency, as well as on the quantum efficiency, of the solar cell have been investigated. From these studies the performance has an improved PCE of 24.43% with a JSC of 38.05 mA/cm2 and VOC of 0.821 V, with a quantum efficiency of over 78.32% in the wavelengths of 300–900 nm by the addition of InN BSF layer

Keywords: GaN, III-V, SILVACO, Solar Cells, 2D simulation

Performance Enhancement of Solar Modules in Arid Climates: Dust Mitigation Strategies in Ghardaïa, Algeria

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Abstract

This study explores how different dust reduction and cleaning methods affect the performance of monocrystalline silicon solar modules in the harsh desert conditions of Ghardaia, Algeria. Six identical solar modules with maximum power point tracking (MPPT) technology were tested to compare three cleaning techniques: water cleaning, cloth cleaning, and a mixture of water and sodium bicarbonate. The water-sodium bicarbonate solution proved highly effective, improving cleaning efficiency by 75% over 10 days. This significant improvement is due to the solution's ability to thoroughly remove dust and dirt that can reduce solar panel performance. The study highlights the importance of choosing the right cleaning methods and scheduling them properly to boost energy output, lower maintenance costs, and ensure reliable solar energy production in dry and dusty environments.

Keywords:

Improving natural ventilation for photovoltaic panels mounted in rows and on stairs using a double-pass airflow system

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Abstract

This numerical study aims to improve the natural ventilation of photovoltaic panels installed in rows and on stairwells using a dual airflow system. A comparative analysis was performed between two configurations, configuration (A) installed in rows, and (Configuration (B)) installed in stairwells. Numerical simulations of turbulent natural convection were performed for different Rayleigh numbers (Ra) at a fixed duct spacing (S). The numerical model was validated against existing experimental data, showing strong agreement with published results. Current results indicate that the configuration (Config (B)) installed in the stairs has a better heat transfer rate compared to the concept (Config(A)) by approximately 27%. The correlation of the mean Nusselt number versus the modified Rayleigh number for the two configurations is presented and discussed.

Keywords: Finite volume method; Hybrid PV/T system; Heat transfer enhancement; Single-pass; Double-pass; Passive cooling; turbulent Natural ventilation

Modeling and simulation flexible graphene/Si Schottky junction solar cells

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Abstract

Schottky junction solar cells (SJSC) that use transparent electrodes (TE) are becoming increasingly important in photovoltaic (PV) applications because of the structural flexibility they offer. Indium tin oxide (ITO), known for its high electrical conductivity and outstanding transparency, dominates the market with a resistivity ranging from 30 to 80 Ω/sq and a visible light transmittance of 90%. However, the high indium content in ITO leads to increased costs, prompting research into alternative materials for the photovoltaic (PV) sector. Graphene, renowned for its exceptional properties, is being explored in this context as a candidate material for fexible graphene/Si Schottky junction solar cell (FG/Si SC). This article proposes a simulation model using artificial neural networks (ANN), the behavior of the FG/Si SC was interpreted using the ANN-model, allowing us to determine its profile parameters, highlighting optimal values for silicon substrate doping and thickness, as well as graphen's number of layer and work function. After fixing the profile parameters of our FG/Si SC, J-V curve simulations were conducted for the various structures, spotlighting the quality parameters of each structure: short-circuit current density (JSC), open-circuit voltage (VOC), fill factor (FF), and efficiency (η). We identified an optimal structure with the quality parameters set at: (JSC, VOC, FF, η) = (23.02 mA/cm², 0.50

V, 51.09%, 5.88%). These findings underscore the potential of FG/Si SC as a promising contender in the field of flexible solar cell.

Keywords: Graphene, n-Si solar cells, Schottky junction, ANN-model.

Performance Enhancement of Solar Systems for Hybrid Energy Storage Integration

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Abstract

This paper presents an integrated hybrid approach that combines fuzzy logic-based Maximum Power Point Tracking (MPPT) with a battery-supercapacitor hybrid energy storage system (HESS) to enhance the performance of photovoltaic (PV) systems. The proposed method not only improves overall energy efficiency but also contributes to extending the operational lifespan of the storage components. By optimizing both power extraction and energy distribution, the system achieves greater adaptability, reliability, and responsiveness under varying environmental conditions. The incorporation of fuzzy logic control within the hybrid storage framework marks a significant advancement in renewable energy systems, delivering a more sustainable and effective solution for real-world solar applications. This strategy strengthens the reliability and energy management capabilities of solar installations.

Keywords: Photovoltaic system, Fuzzy logic control, Energy management, Hybrid energy storage system

Enhancing PV Performance in Desert Regions through Replaceable Transparent Protective Films

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Abstract

The Algerian Sahara is one of the most promising regions for solar power plants because of their geographical position and area. Nevertheless, these installations are still plagued by the chronic problem of dust and dirt accumulation on solar panels, which affects energy efficiency and increases maintenance costs leading to considerable annual financial losses.

This study proposes a solution based on a plastic film that acts as a barrier against the deposition of particles, covering the surface of solar panels. Technical evaluation of the light transmission of these plastic films and their resistance to desert conditions and temperatures, which produced significant results on performance with respect to these two factors. An economic analysis has also been performed resulting from applying this solution to one of Algeria’s hypothetical photovoltaic (PV) plants.

Keywords: Economic analysis, Protective Films, PV Performance

Comparative Analysis of Hybrid Forecasting Models for Energy Consumption Based on Signal Decomposition

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Abstract

For effective energy management and the integration of renewable energy sources, accurate electricity consumption forecasts are crucial. Three machine learning models—Artificial Neural Network (ANN), Extreme Learning Machine (ELM), and Random Forest (RF) — as well as three signal decomposition methods—Wavelet Transform (WT), Wavelet Packet Decomposition (WPD), and Swarm Decomposition (SD)—are compared in this study. The models are validated using actual electricity usage data from a Mediterranean city in Turkey under two scenarios: raw inputs and decomposed inputs. The results demonstrate that hybrid models consistently outperform standalone ones. In particular, SD-based ANN and ELM models achieved the best performance, with R^2 above 95.5% and nRMSE around 3.1%, compared to raw models with R^2 near 83% and nRMSE above 8%. These findings highlight the importance of signal preprocessing and confirm that decomposition, especially SD, significantly enhances forecasting accuracy and stability. This study advances the development of reliable and flexible forecasting tools for energy planning in regions with variable climatic conditions.

Keywords: Forecasting Energy Consumption – Hybrid Models – Signal Preprocessing

Sizing of a hybrid energy system based on a fuel cell and a generator to power a home in southern Algeria

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Abstract

This study analyzes the energy needs of a typical home and determines hybrid system specifications, including fuel cell capacity, gas generator output and energy storage capabilities. Computer simulations are carried out to evaluate the performance of the system under different conditions, to optimize its design and to correctly size the components. The sizing of fuel cells and generators is crucial to ensure their proper operation and energy efficiency in various use cases, particularly for providing electricity in isolated areas or during power outages. We have chosen a stationary application for these systems. The energy needs are primarily electricity and heating/air conditioning. Both sources will be able to meet these needs continuously, i.e., day and night, winter and summer. The results demonstrate the feasibility and relevance of powering a home with a hybrid system based on a fuel cell and a generator. This home is fully powered. This is a promising solution for remote locations.

Keywords: Hybrid, Fuel cell, Generator, Home, Sizing

Application of Sliding Mode and SVM-Based Robust Control to DFIGs in Wind Power Systems

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Abstract

This work focuses on the study of a wind energy conversion system employing a doubly-fed induction generator (DFIG) operating at variable speed. The rotor-side control is achieved using two power converters, while the stator remains directly connected to the grid. To implement an effective control strategy, a thorough understanding of the mathematical models governing each system component is essential. For this purpose, a complete modeling of the system has been carried out. The study also explores the application of space vector modulation combined with sliding mode control (SM-SVM) and variable structure control to the DFIG. By merging the high performance of space vector modulation in pulse-width modulation with the robustness of sliding mode control in the face of uncertainties and disturbances, the SM-SVM approach enhances overall control performance. This was evident in the precise regulation of both active and reactive stator powers, as well as in the control's robustness to variations in the machine's parameters.

Keywords: Wind energy, DFIG, sliding mode, SVM.

Control of Magnetic Induction Intensity and Optimization below Overhead High Voltage Electric Power Transmission Lines

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Abstract

A growing amount of electric networks systems in our surroundings, implemented to meet the demand for electricity, are raising public apprehensions regarding potential health effects. Consequently, assessing the human exposure to line frequency electromagnetic fields is crucial. To gain a comprehensive understanding of the electric and magnetic fields around overhead transmission lines, it is necessary to give both the magnitude and phase angle of the magnetic field intensity. This paper analyzes double circuit 400kV three-phase overhead transmission lines are tested to note the lateral profile of magnetic fields distribution at a height of 1m above the ground, covering various situations including single circuit line, double circuit line with the same phase arrangement, and optimized double circuit line featuring transposed phases, following examine the effect of different heights of the double circuit line in similar phase arrangement on the deviation of magnetic field rates at the specified point of interest in the surface space.

Keywords: Power line systems, magnetic induction, arranging phase conductors, optimization, double circuit line

Hybrid Forecasting of Photovoltaic Production: A Comparative Study of Short- and Medium-Term Horizons with Signal Decomposition

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Abstract

This paper presents a comparative study of hybrid models for short- and medium-term forecasting of solar photovoltaic (PV) energy production using real-world data from the Adrar power plant in Algeria (2018–2020, hourly resolution). To improve model accuracy, three signal decomposition techniques Wavelet Packet Decomposition (WPD), Variational Mode Decomposition (VMD), and CEEMDAN were applied prior to prediction. These decomposed signals were fed into three predictive models: Extreme Learning Machine (ELM), Least Squares Boosting (LSBoost), and Long Short-Term Memory (LSTM). Forecasting was performed for three-time horizons (H+1, H+3, H+6). Evaluation based on RMSE, nRMSE, and R^2 showed that the ELM-VMD model achieved the best performance across all horizons, with an nRMSE of 7.89% at H+6. The results highlight the effectiveness of hybrid decomposition-learning frameworks for PV forecasting in arid climates.

Keywords:

Theme B

Thermal Solar

Experimental Investigation of a Box Solar Cooker: Enhancing Performance through Optimized Glass Cover Positioning

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Abstract

This experimental study investigates a novel design for a solar box cooker that optimizes the positioning and distance of dual-glass covers to enhance thermal performance and sustainability. The first glass cover, positioned 1 cm above the absorber plate, minimizes convective heat loss and maximizes heat transfer, while the second cover, located 15–40 cm above, provides additional insulation. Comparative testing of an unmodified cooker (Cooker 1) and the modified design (Cooker 2) demonstrates significant performance improvements. Notable outcomes include a 41.64% increase in thermal efficiency, a 240.7 W/m²°C enhancement in heat transfer coefficient, and a 5.68 W/m²°C reduction in heat loss coefficient. This design reduces cooking time by 27.77% and achieves a cooking power of 49.44 W while maintaining a cost-effective production value of just $75. By addressing critical challenges such as energy efficiency, affordability, and accessibility, this design bridges the gap between high-performance solar cooking technologies and practical applications in underserved communities. The findings underscore the potential of simple, scalable innovations to drive sustainable development and energy equity worldwide.

Keywords: Modified solar cooker; Experimental test; Thermal performance; Heat transfer; Glass cover

Thermal behavior of mortar incorporated with natural and textile fibers

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Abstract

This study seeks to assess the thermal efficiency of mortars in the construction sector by incorporating human hair and textile fibers. The objective is to achieve enhanced energy efficiency. The investigation involves substituting sand with fractions ranging from 10% to 50% in volume. The evaluation encompasses both thermal conductivity measurements and an examination of the mechanical properties after 28 days of curing.

Keywords: Mortar; Buildings; Energy efficiecy; Waste; fibers Composites.

Forced Convection Study in a Solar Collector Tube for Water Desalination Preheating

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Abstract

Enhancing the thermal and fluid dynamic performance of parabolic trough collectors is a critical objective in the field of renewable energy. The incorporation of baffles within the flow channel offers an effective means to intensify heat transfer, increase the convective heat transfer coefficient, maximize thermal energy recovery, and reduce overall energy consumption. In this study, we present the results of a numerical investigation focused on the thermal and hydrodynamic behavior of turbulent forced convection within a baffled tube of a parabolic trough collector, designed for solar distillation applications.

Keywords: heat exchanger; baffles; energy consumption

Evaluate the impact of the optimum inclination for the installation of thermophotovoltaic modules

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Abstract

To maximize the thermoelectric production of photovoltaic and thermal power plants, the modules must be optimally oriented in order to capture maximum solar radiation. Indeed, the perfect orientation of the sun is of great importance.

In this article, we examine the impact of the optimal inclination of south-oriented photovoltaic modules on energy production in arid and semi-arid regions, taking the example of the Ghardaïa region. By focusing on improving the capture of solar radiation and increasing energy production, this study aims to provide valuable data to improve the efficiency of combined photovoltaic and thermal power plants through an optimal inclination installation.

This work aims to evaluate the energy benefit (gain) related to the determination of the optimal inclination angle of south-oriented photovoltaic modules in an alternative energy system. It is also necessary to install a solar tracker, to follow the solar path at any time. The energy gain compared to altitude varies between 6.49%, as a minimum, and 71.24%, as a maximum.

Keywords: Thermoelectric, photovoltaic, thermal, optimal inclination, energy gain.

Numerical Analysis of Multi-Glass Collector Effects on Flow Behavior in Small Solar Chimney

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Abstract

This study conducts numerical simulations to investigate the effect of a multi-glass collector on flow behavior inside a solar chimney power plant. We analyze cases with single-, double-, and triple-glass collectors combined with collector inclinations (15°, 30°, and 45°). A 2D axisymmetric turbulent model is adopted. The momentum and energy equations are solved using the finite volume method and the SIMPLE algorithm. The standard k-ε model is employed, with second-order upwind scheme used for convective term discretization. The model is validated against experimental data from Maia et al. (2009). Results indicate that a 45° collector inclination with single glass represents the optimal configuration, improving mass flow rate by approximately 22% compared to the baseline case (without inclination).

Keywords: Solar chimney; collector inclination; multi-glass collector; CFD simulation

Design and Performance Evaluation of a Forced Convection Solar Dryer for Fig Dehydration

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Abstract

Figs (Ficus carica), due to their high moisture content and perishability, require effective drying methods for preservation and storage. Traditional open sun drying, while cost-effective, suffers from major drawbacks such as long drying durations, microbial contamination, weather dependency, and poor product quality. This paper presents the design and implementation of a cost-efficient, forced convection solar dryer specifically developed for fig dehydration. The dryer features a black-painted metal chamber to maximize solar absorption, frontal air inlet vents for natural air intake, and a rear-mounted exhaust fan to maintain steady airflow. The system was experimentally tested in Pune, India, under varying ambient conditions. Observations were recorded for drying temperature, moisture removal, and weight reduction across specific time intervals. Compared to traditional drying, the proposed dryer demonstrated significantly reduced drying time, improved color retention, and enhanced product hygiene. Energy consumption was minimal, with the fan operating on solar-generated or battery-supported power. The results validate the efficiency of the forced convection mechanism in improving drying uniformity and minimizing energy costs. This system provides a sustainable and scalable solution for small and medium-scale fig processing units, contributing to improved post-harvest management and reduced wastage.

Keywords: Solar drying, forced convection, fig dehydration, post-harvest preservation, moisture removal, black metal chamber, agricultural drying system.

A socio-economic approach to agricultural drying activities in the Ghardaïa region of the Sahara

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Abstract

This study aims to analyse the socio-economic profile of agri-food producers and dryers in the Ghardaïa region of the Sahara, where agriculture is a fundamental pillar of rural livelihoods. Although agricultural drying is a relatively modest source of income and employment, it plays a significant role for smallholders and marginalised farmers, particularly among the most economically disadvantaged in the population. A stratified random sampling method was adopted to select producer-dryers from different areas of the region. Primary data were collected using structured interviews and pre-tested questionnaires administered during individual interviews. A total of 240 producer-dryers were surveyed in the study area. Statistical analysis of the data reveals that the majority of producer-dryers are women (76.7%), elderly (52.5%) and illiterate (63.4%). Around 64.1% have a farm of less than two hectares, and 61.6% are considered small farmers, cultivating less than one acre of farmland. Most respondents are engaged in subsistence farming, a field in which many have over 15 years' experience.

Keywords: Agricultural drying sector, Saharan agro-ecological zones, Local and cross-border trade dynamics, Subsistence farming, Socio-economic profile.

Numerical Study Of The Hot Airflow In A Mixed Solar Dryer

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Abstract

A numerical study on solar drying using a mixed solar dryer was carried out, aiming to make a new contribution to research on solar drying systems. The main objective was to optimize the heat transfer mechanisms to identify the most efficient design for a mixed solar dryer. The study focused on the air circulation within the greenhouse and around the drying trays, varying both the air velocity and the spacing between trays. This analysis helped determine the optimal number of trays and the ideal air velocity for efficient solar drying. We studied four different geometric configurations were for air velocities of V = 1, 2, and 3 m/s.

Keywords: Solar drying; mixed solar dryer; numerical study; air circulation

Experimental Study on the Effect of Thermoelectric Cooling Position on the Performance of a Basin-Type Solar Still

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Abstract

This study investigates the effect of thermoelectric cooling placement and operation on the performance of a basin-type solar still. A solar still was designed and fabricated for experimental testing under the meteorological conditions of Khemis Miliana. The focus was on analyzing the impact of the Peltier module's position on the glass cover—upper, middle, and lower—while maintaining a fixed intermittent cooling cycle of 3 minutes every 30 minutes. Results showed that the position of the cooling system significantly affects the freshwater production. The highest yield was achieved when the cooling system was placed in the upper position of the glass cover, with a daily production of 2.9 L/day, compared to 2.36 L/day and 2.15 L/day for the middle and lower positions, respectively. These findings highlight the importance of optimal cooling system placement in enhancing the condensation process and improving the overall efficiency of solar stills.

Keywords: Basin solar still, glass cover cooling, solar distillation, thermoelectric cooling

Heat Transfer Enhancement in Solar Air Heaters Using Porous Ribs

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Abstract

Solar air heaters (SAHs) suffer from inherently low thermal efficiency due to poor convective heat transfer between the absorber plate and airflow. This study numerically investigates a novel passive enhancement technique: integrating periodically placed porous ribs on the absorber plate. A comprehensive computational fluid dynamics (CFD) analysis was conducted using ANSYS Fluent to model turbulent flow (Reynolds number range: 3000 ≤ Re ≤ 12000) and heat transfer within a rectangular SAH duct. The finite volume method (FVM) solved the governing equations, employing the validated RNG k-ε turbulence model and the Darcy-Brinkman-Forchheimer model for the porous rib regions. The computational domain, adapted from established literature, included entrance, test, and exit sections.

The primary objectives were to quantify the impact of porous ribs on heat transfer and fluid flow characteristics compared to both smooth ducts and conventional solid ribs, and to optimize key geometric parameters: relative rib height (e/D), relative rib pitch (P/e), and rib porosity. Results demonstrate that porous ribs significantly enhance thermal performance. where, The porous ribs increase the average Nusselt number (Nu), indicative of convective heat transfer, by 20% to 50% across the studied Re range compared to conventional SAHs. Crucially, the porous ribs also lead to a reduction in friction factor compared to configurations likely to induce similar Nu gains with solid ribs. Peak thermal performance was also achieved at specific ratios, where the relative roughness height e/D = 0.055 and the

relative slope P/e = 0.05 (at Re = 8000, Nu increased by ~48.5% compared to the smooth channel). Also, heat transfer (Nu) decreases with increasing rib porosity (i.e., decreasing solids fraction), indicating an ideal equilibrium near low porosity values.
This work conclusively demonstrates that strategically designed porous ribs offer a highly effective solution for augmenting heat transfer in SAHs while mitigating the friction penalty often associated with solid turbulators. The identified optimal geometric parameters provide valuable design guidelines for developing more efficient solar air heating systems.

Keywords: Porous Ribs; Solar Air Heater; Heat Transfer Enhancement; Thermo-hydraulic Performance

Enhancing thermal performance of a solar air heater using finned glazing

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Abstract

In this work, the natural convection in the air gap of an inclined solar collector contains partitions attached to its glazing has been studied numerically. The temperatures of the two horizontal walls are constants and different. The two vertical walls are supposed adiabatic. The equations of the problem are solved with the finite volume method, using of the Fluent software. The necessary objective is to study the influence of the partitions (length and number) on the natural convection in the air gap of the solar collector. The obtained results indicate that the presence of the partitions has important influence on the heat transfer with the decreasing of heat losses with natural convection, so improving of the solar collector efficiency. In this study, it reached that the number of partitions must be higher than 10, and their optimal length is Lp=0.4. The presence of the partitions with the optimal values reduces the heat losses by natural convection with 46 %.

Keywords: thermal solar collector, partitions, FLUENT, natural convection, thermal radiation, efficiency.

Experimental study of the effect of perforated fins on the improvement of PCM melting processes

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Abstract

The experimental study analyzes the effect of the volume concentration of aluminum on the melting of Paraffin in a rectangular thermal cavity heated on both sides and perfectly insulated. The positions of the solid-liquid interfaces and the PCM's temperature evolution were noted and used to determine the liquid fractions and heat transfer behavior. The results obtained show that the addition of 1.2, 2.4, and 4.8% aluminum concentration accelerate the melting rate by 4, 12, and 29%, and improves thermal storage by 3, 5.2 and 9.6%.

Keywords: PCM, melting rate, aluminum, temperature

Relationship between geometric shapes of hollow bricks and their thermal efficiency

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Abstract

Air cavities play a crucial role in energy efficiency. Well-designed air cavities serve as an insulating barrier and minimize thermal bridges. The investigation aims to explore several aspects, including the impact of the number of cavities and their geometric shapes on thermal resistance. The calculation guidelines have been established by the standards outlined in the Algerian Regulatory Technical Document DTR.C3-4. The number of test cases for a hollow brick in a vertical position will consist of 12 configurations, all with the same external dimensions of 20 cm × 15 cm × 30 cm. The goal is to prioritize the design of air cavities within the hollow bricks to improve their thermal efficiency. The internal structure and the number of cavities significantly impact thermal resistance. Cavity columns are typically better suited for hollow bricks, as they enhance load distribution and offer superior thermal and compressive resistance, crucial for masonry structures. The cavity lines can be utilized, although they generally offer reduced strength and stability. Furthermore, the multiple cross walls in hollow bricks might create thermal bridges, which can enhance heat transfer between the sides of the brick.

Keywords: temperature air cavities; geometric shapes; hollow bricks; electrical analogies; thermal resistance; energy needs.

Study of the Thermal Behavior of a Workplace in an Arid Region: Case Study

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Abstract

This research focuses on the investigation and experimental thermal analysis of a workplace, and finally on the validation of the data recorded during the experimental period. The equations of the energy balance have been reproduced for each part of the material. The resulting system of equations is solved by the implicit finite difference method and the Gauss algorithm coupled with an iterative procedure. The heat transfer coefficients by convection and by radiation depend on the temperatures of the media considered. The analysis of the results obtained shows that the thermal conductivity of the heavy concrete and brick used in the construction of this place, as well as the climatic conditions, directly contribute to the increase in internal temperature. After comparing the numerical results with the experimental results for the two selected days, May 10th, 2024, and May 18th, 2024, we found a very satisfactory convergence between the results, with an error rate not exceeding 4%. This study made it possible to conclude that the materials used in residential construction, with the absence of thermal insulation, contributed significantly to the increase in the indoor temperature of public buildings. This leads to an uncontrolled consumption of electricity in this desert region.

Keywords: Experimental analysis; Method of finite differences; Thermal conductivity; Physical analysis; Building materials; Desert areas; Internal temperature.

Investigation of a novel solar chimney concept

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Abstract

Solar energy is a clean energy by excellence. In addition, it can ensure an energy independence. Production of electricity through solar systems, in large or small scale, is a viable alternative especially for deserted regions where access to electricity is difficult. Solar chimney power plant (SCPP) is one of the concepts in renewable energy technology that converts the thermal energy of solar radiation into kinetic energy of an in-flowing air. The present study aims especially to investigate a novel concept, which consists of a horizontal solar chimney power plant with an adapted collector entrance, named sloped collector entrance SCPP (SCESCPP). Accordingly, the effect of the collector entrance shape (slope, sloping distance) is examined. A numerical investigation is carried out using a 2D axisymmetric chimney model. The model was first validated using experimental results. The influence on air thermo-hydrodynamic behavior of this system is comprehensively studied to enhance the understanding and deepen the analysis in order to improve the performance of the SCPP. The results indicate that the new collector entrance design influences the system performance in a significant manner. It is shown that the best performing configuration (sloping distance of 0.8) produces an available power reaching 16.36 % more than that for zero slope collector roof at same conditions.

Keywords: Solar chimney; sloped collector entrance; natural convection; solar energy.

Experimental Investigation of Vapor Condensation and Removal in a Box Solar Cooker Using a Pressure Cooker Integrated with a Flexible Pipe

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Abstract

Solar cookers represent an environmentally friendly and sustainable technology for carrying out cooking processes, as they harness solar energy—a clean, renewable, and abundant energy source—as their primary input. This research focuses on evaluating the impact of vapor condensation on the glass cover of a box-type solar cooker, a factor that can significantly influence the thermal performance of the system. The experimental investigation involved a series of controlled trials, including stagnation and sensible heat tests, conducted under two main configurations: one using a conventional simple pot and the other employing a pressure cooker integrated with a flexible pipe specifically designed to release steam externally. In the case of the simple pot, it was observed that vapor condensed on the inner surface of the glass cover, which in turn caused a gradual decline in the absorber plate's temperature due to reduced solar transmittance and thermal losses. Conversely, when the pressure cooker was used in conjunction with the flexible pipe, the steam was effectively vented out of the cooker system, thereby eliminating condensation on the glass cover. As a result, the absorber temperature remained stable and unaffected. The experimental data further revealed that the thermal performance parameters, namely the figures of merit F1 and F2 were 0.11 m²·°C/W and 0.427, respectively. These findings highlight the effectiveness of incorporating a flexible pipe with a pressure cooker in mitigating vapor condensation issues, and they provide valuable insights into optimizing solar box cooker design for enhanced thermal efficiency and more reliable cooking performance.

Keywords: solar box cooker; pressure cooker; flexible pipe; thermal performance.

A CFD based simulation for determining the optimum position of a roof-top solar chimney for building ventilation

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Abstract

In this study, a passive ventilation which is extensively used in sustainable building designs was numerically investigated. A CFD based approach for determining the optimum position of a roof-top solar chimney to ensure thermal comfort in a scaled spaceroom.
The solar chimney drew ambient air through the inlet windows; the air flow circulates inside the space and leaving through the outlet of the solar chimney. This study focuses on determining the effect of the exhaust chimney positions on the inside air temperature, the air flow field structures, and the ventilation capacity is reported in terms of air changes per hour (ACH) that the chimney can produce under different conditions.

Keywords: Solar chimney, position; air changes per hour

Experimental Characterization of a Natural Sugar Alternative (Erythritol) for Latent Heat Storage in Solar Cookers, using the T-History Method

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Abstract

Phase change materials (PCMs) effectively store thermal energy in solar cookers, enhancing their efficiency after sunset and during cloudy conditions. To choose the appropriate PCM requires determining its thermophysical properties. These properties are typically characterized in specialized laboratories using costly equipment, such as Differential Scanning Calorimetry (DSC). In this work, we present an experimental characterization of a natural sugar alternative (Erythritol), obtained to be used as a phase change material for latent heat storage in a solar cooker developed by the Research Unit for Renewable Energies in the Saharan Region in Adrar. The variation of PCM enthalpy was measured as a function of temperature using the T-history method, which allows the determination of the thermophysical properties of phase change materials. For this purpose, a test platform was created using locally available means in the laboratory of the Thermal Transformations Department of the Research Unit for Renewable Energies in the Saharan Region in Adrar, where experiments were conducted according to a simple experimental protocol using cylindrical copper capsules for erythritol samples and oil (TORADA TC46) as a reference material, in addition to the laboratory oven (Memmert INE 400). The experimental data processing resulted in obtaining thermophysical properties that are consistent with those of pure erythritol as reported in specialized references, where the latent heat of fusion reached 341 kJ/kg and the melting point reached 118 °C, proving the suitability of the natural sugar alternative (erythritol) for use as a phase change material for latent heat storage in the solar cooker.

Keywords: Phase Change Material (PCM), Thermal Characterization, T-History Method, Erythritol, Thermophysical Properties, Latent Heat Energy Storage in Solar Cooker.

Themes C, D and E

New Energies

Renewable Resources

Energetic efficiency and environment

Study of the Electrostatic Response of barriers with a Self-Cleaning Surface

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Abstract

As part of our study, we investigated the behavior of various types of insulating materials that can be used in the manufacturing of high-voltage insulators, particularly those employed in energy transmission networks operating under harsh environmental conditions. These insulators are critical components that ensure the safety and reliability of the power grid by preventing leakage currents and electrically isolating transmission lines from supporting structures, even in environments frequently exposed to humidity, pollution, and extreme weather.

To thoroughly assess their performance, we conducted both experimental and numerical analyses. The experimental tests were carried out at the High Voltage Laboratory of the University of Bejaia, where the insulators were subjected to different voltage levels, and their dielectric strength and electrical discharge behavior were observed. In parallel, we used COMSOL Multiphysics 6.1 simulation software to model the insulators and analyze the distribution of electric fields and potentials in the surrounding regions.

This combined approach allowed us to obtain a comprehensive understanding of the insulators' performance under realistic operating conditions.

Keywords: High voltage insulator, water droplets, pollution, COMSOL Multiphysics Electric field lines, electrical discharge

Optimization of factors affecting biogas production and valorization of compost using dairy wastewater

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Abstract

The study was conducted at Bechar University and focuses on production of biogas as an alternative energy by using dairy wastewater of Igli milk factory. The optimization of the factors affected the anaerobic digestion gave the following results : pH = 7.5, temperature (T= 38°C) and moisture content 90%. The application of these parameters conducted to an excellent production of the biogas. The experiments were carried out in two digesters and daily gas yield from milk waste was monitored for 70 days and the total volume of gas production was found to be 25,472 L.

The measurement of the percentages of the essentials nutriments needed for the biomethanization gave the values of 48.28%, 75.65 mg / kg P and 5.56% for the total organic carbon, phosphorus and nitrogen, respectively. The biogas formed is flammable, so very rich in methane.

The compost was then evaluated as a fertilizer for wheat and barley in clumps filled with soil and sand separately. The planting gave a good result as heights of 17 cm and 4 cm were recorded for wheat with and without compost. For barley, heights of 16.5 cm and 1 cm were obtained. For planting in sand, the height of barley without compost was 20.5 cm with a yellow-green color and 14.5 cm with compost and with a dark green color.

Keywords: Biogas; anaerobic digestion; dairy wastewater; parameters; nutrients; fertilizer; flammability.

Numerical simulation of non-toxic aerospace propellant decomposition based on high-test peroxide (HTP) in a monopropellant system

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Abstract

High test peroxide (HTP) monopropellant is currently the most promising among all 'green propellants'. In this paper, the decomposition process of liquid HTP at a high concentration of 87.5% through the identical spherical silver particles as a porous medium in the catalyst bed for propulsion is numerically studied. This operation is performed in ANSYS Fluent computational fluid dynamics (CFD) software to solve the governing equation. A mathematical approach based on the Local Thermal Non-Equilibrium (LTNE) model was employed to describe the transfer of heat through the solid and fluid phases. The simulation results of the present study demonstrate the optimal decomposition of the HTP in the catalyst bed, which confirms that good operation is achieved in the monopropellant thruster performance as shown in the final distribution of temperature, mass fractions and absolute pressure are obtained.

Keywords: High test peroxide; Catalyst bed; Decomposition; Monopropellant thruster.

The influence of physical parameters on the evolution of the absorbed hydrogen mass in a metal hydride reactor

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Abstract

This In this paper, we present a numerical study of heat and mass transfer within a metal hydride reactor. The aim of this work is to investigate the management of heat transfer inside the reactor to improving the overall hydrogen absorption performance. Thus, a heat exchanger has been integrated into the reservoir design. This study focuses on the influence of key parameters on the heat propagation and the hydrogen absorption, namely : the volume of the reservoir, the heat transfer coefficient between the cooling fluid and the reservoir wall and the porosity of the metal hydride bed. The model adopted in this study is considered to be two-dimensional and transient. The system of governing equations for the transfer phenomena is based on the conservation principles of mass, momentum, and energy. The numerical resolution of the model is carried out using the finite volume method.

The obtained results show good agreement with those reported in the literature. The model solution successfully captured the behavior of the concerned parameters and their influence on the hydrogen absorption process.

Keywords: hydrogen storage; metal hydride; heat transfet; mass transfer.

Optimal Design of an IPM Motor for Electric Vehicles Using GPR Surrogates and NSGA-II: A Rotor Notch Geometry Sensitivity Approach

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Abstract

This paper presents a computationally efficient design and optimization framework for improving the electromagnetic and thermal performance of an Interior Permanent Magnet (IPM) motor through rotor notch geometry tuning. A sensitivity analysis of notch depth, inner arc, and outer arc is conducted using finite element analysis (FEA) to evaluate their effects on torque ripple, back-electromotive force (BEMF) harmonics, and winding hotspot temperature. To address the high computational cost of direct FEA-based optimization, Gaussian Process Regression (GPR) surrogate models are trained on the generated dataset of FEA simulations. These models are integrated with the Non-dominated Sorting Genetic Algorithm II (NSGA-II) to explore performance trade-offs and identify Pareto-optimal designs. Additional enhancements are achieved through rotor skewing, which reduces torque ripple and electromagnetic harmonics. The final design, validated via FEA, demonstrates significant improvements in torque smoothness, thermal stability, and BEMF quality. This methodology supports the robust and efficient development of high-performance IPM motors for electric vehicle (EV) applications.

Keywords: IPM motor, electric vehicle technology, Torque Ripple, Back-EMF Harmonics, NVH (Noise, Vibration, Harshness), Pareto-optimal, NSGA-II.

Study of Temperature Distribution and Current Density in an Inductively Coupled Plasma Torch at Atmospheric Pressure in Local Thermodynamic Equilibrium

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Abstract

This study focuses on the analysis of the electrical and thermal characteristics of an inductively coupled plasma torch operating at atmospheric pressure. The proposed model considers the discharge in local thermodynamic equilibrium, allowing to examine the temperature and current density distribution inside the plasma. The temperature distribution is influenced by the effects of ionization and joule dissipation, while the current density is related to the spatial variations of the plasma electrical properties, including conductivity. The impact of the magnetic field generated by the inductive coupling is also considered, as it plays a key role in plasma confinement and dynamics. The main objective is to provide a thorough understanding of the physical mechanisms governing the thermal and electrical behaviour of the plasma, which is essential to optimize the plasma torch performance in various industrial applications.

Keywords:

Study of Mechanic, Electronic and Optical characteristics for $AuBiF_3$ material

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Abstract

We present ab initio theoretical study of the mechanic, electronic and optical characteristics of the AuBiF3 material using ultrasoft pseudopotential as based on DFT implemented in Castep code. The investigated compounds verify the Born criteria which indicates its mechanical stability, and the pugh ratio B/G is greater than 1.75 which suggests that the studied mateil is ductile. The electronic properties show that this material is semiconductor with direct band gap (M-M) of 1.51 eV which is good for the use in the solar energy. The examination of the absorption coefficient indicate that this compounds present absorption in the visible and ultraviolet region.
Our findings suggested that the investigated materials have good absorption, and low reflectivity, which makes them promising for SC application.

Keywords: perovskite; absorption; ductile; solar cells, semiconductor

State of the art of Hydrogen Production by Photocatalysis

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Abstract

In general, the photo catalytic transformation of hydrogen involves three main processes : (i) light absorption by a particulate semiconductor photo catalyst to generate electron-hole pairs, (ii) charge separation and displacement of these photo-excited carriers, and (iii) surface chemical reactions for water separation. In detail, under light irradiation with a photon energy greater than or similar to the energy of the band gap of the semiconductor, under the impact of such a photon, an electron passes from the valence band to the conduction band, while the hole it leaves behind remains in the valence band. This electron-hole pair has powerful redox properties. H+ can accept electrons and undergo a reduction reaction to generate H2, while other sacrificial agents or water can combine with holes to obtain an oxidation reaction. When the conduction band potential is more negative than the reduction potential of H+/H2 and the valence band potential is more positive than the oxidation potential of O2/H2O (1.23 V), the photo catalytic hydrogen production reaction can proceed without difficulty. In other words, the conduction band rank of an ideal photo catalyst for the photo catalytic breakdown of water must be more negative than the H+/H2 potential, and the valence band must be more positive than 1.23 V.

Keywords: hydrogen production; photo catalysis; renewable energy.

Prediction of AC Flashover Voltage of Glass Insulators Under Environmental Pollution Using the Taguchi Method

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Abstract

The method's performance aimed to determine which factors can best predict flashover voltage under modeled experimental conditions. The factors affecting response are difficult to predict and can negatively affect transmission lines.

The Taguchi method has the ability to simultaneously optimize several variables by improving experimental design and by representing an economically feasible alternative to conventional experimental methods. The ANOVA and regression analyses of possible interactions between several response variables provided a comprehensive view of environmental effects on the performance of glass insulator.

The results revealed the relevant factors that affect flashover voltage, impacting the performance of insulators in extremely polluting environments. This study was therefore able to improve prediction of failures of HV insulators and enabled examination relevant factors for optimization based on the robust Taguchi system, potentially paving the way for industrial applications on distributed energy systems.

Keywords: Flashover, Taguchi Method, ANOVA, regression, SDD, NSDD, Wt, PU/PL.