Solar Electric Powered Reverse Osmosis Water Desalination

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Technology, Operations, and Economics Routledge
Water stress is a worldwide reality. Planners and managers of water resources around the world are tasked with finding new, creative, and innovative solutions to challenges posed by growing populations and declining water supplies. Securing safe drinking water, however, has impacts beyond the water sector. In particular, the connection between energy and water must be carefully considered to avoid unwelcome increases in energy consumption as a result of new water management strategies. One strategy that is gaining increasing attention is desalination of brackish groundwater. However, desalination is an energy-intensive process and could have negative impacts in the energy sector if conventional approaches are used. Relying on fossil fuels for desalination could drive up carbon dioxide emissions associated with water treatment and increase the cost required to produce drinking water. Integrating desalination with renewable power sources such as wind and so- lar energy can mitigate concerns regarding the energy intensity of desalination. By coupling water treatment with non-carbon emitting sources of power, it is possible to meet growing water demands in a sustainable manner. At the same time, water pro- duction offers an opportunity to address problems associated with the intermittent nature of wind and solar power production. Desalination is a time-flexible process that pairs well with wind and solar power, two sources of energy that are limited in application by their daily and seasonal variability. Integrating desalination with wind and solar power offers a solution to energetic challenges of water production while using wind and solar power for desalination offers a solution to challenges associated with the intermittent nature of renewable power. Additionally, utilizing photovoltaic-thermal (PVT) solar modules in an inte- grated facility could be advantageous to both the water and solar power production processes. Brackish groundwater, which is at a relatively cool temperature, can be used to cool solar panels, which suffer from losses in efficiency associated with tem- perature increases. At the same time, solar panels can be used to preheat feed water, a process that reduces the energetic requirement for reverse osmosis desalination. Us- ing the temperature difference between brackish groundwater and solar panels to an engineering advantage can be beneficial for the production of both solar power and drinking water. This thesis offers an investigation of desalination powered by wind and solar energy, including a study of a configuration using PVT solar panels. First, a water treatment was developed to estimate the power requirement for brackish groundwa- ter reverse-osmosis (BWRO) desalination. Next, an energy model was designed to (1) size a wind farm based on this power requirement and (2) size a solar farm to preheat water before reverse osmosis treatment. Finally, an integrated model was developed that combines results from the water treatment and energy models. The integrated model uses optimization to simulate the performance of the proposed facil- ity by maximizing daily operational profits. Results indicate that integrated facility can reduce grid-purchased electricity costs by 88% during summer months and 89% during winter when compared to a stand-alone desalination plant. Additionally, the model suggests that the integrated configuration can generate $574 during summer and $252 from sales of wind- and solar-generated electricity to supplement revenue from water production. These results indicate that an integrated facility combin- ing desalination, wind power, and solar power can potentially reduce reliance on grid-purchased electricity and advance the use of renewable power. In addition, this analysis fills a knowledge gap in understanding the advantages and tradeoffs between using wind power, solar power, and a combination of wind and solar power for desali- nation. By providing insight into the potential operations of an integrated facility, the investigation discussed in this report aids to the understanding of the water-energy nexus associated with new sources of drinking water. Results from this thesis indicate that integrating desalination with renewable power provides an opportunity for collaboration that can be mutually beneficial to both the water and energy sectors. In particular combining desalination, wind power, and solar power can overcome challenges associated with each of these technologies and may be preferable to stand-alone water or power producing facilities.
Sun Power John Wiley & Sons
"This reference explores some of the most recent developments in sustainability, delving into topics beyond environmental science to cover issues of sustainable economic, political, and social development"--Provided by publisher.
Membranes for Clean and Renewable Power Applications Woodhead Publishing
The purpose of this thesis is to design and validate a controllable energy recovery device with application to photovoltaic powered reverse osmosis (PVRO). The energy consumption of a reverse osmosis plant depends significantly on the efficiency of its energy recovery process. This work presents a concept for a controllable energy recovery process, so that a system can operate optimally based on the incoming water and power characteristics. The design presented here uses a variable nozzle and a Pelton wheel to recover energy from the high pressure concentrated brine exiting the reverse osmosis membrane. The components are designed, analytically modeled using fundamental engineering principles, and experimentally tested. The experimental data is then used to check the validity of the formulated concept models. This research encompasses the modeling and testing of a variable nozzle using a needle valve to control the flow through the nozzle, and also of a Pelton bucket, to examine the effectiveness of the momentum transfer from a high velocity jet to the Pelton wheel. This research is done to examine the feasibility of this concept for potential implementation on a full scale PVRO system. The component validation is performed to prove that the concept is effective and competitive with other options.
Tenth E.C. Photovoltaic Solar Energy Conference Elsevier
Proceedings of the International Conference held at Seville, Spain, October 27-31, 1986.
SOLAR ENERGY CONVERSION AND PHOTOENERGY SYSTEMS: Thermal Systems and Desalination Plants-Volume V Routledge
Current Trends and Future Developments in (Bio-) Membranes: Renewable Energy Integrated with Membrane Operations offers an overview of advanced technologies in the field of water desalination, wastewater treatment and hydrogen production that is coupled with renewable energy sources. Membrane processes are well-recognized technologies in the field of water and wastewater treatment. This book reviews their potential and lists new technologies which allow for the use of solar, hydroelectric, wind, hydrothermal and other forms of renewable energy with the same effect. In addition, it highlights what has already been achieved in the integration of membrane reactors and energy produced by biomass. Provides an overview of the interconnections between membrane technology and renewable energy sources Provides a comprehensive review of advanced research on membrane processes for water desalination, wastewater treatment and hydrogen production Relates the various processes to energy sources, including solar, wind, biomass and geothermal energy Addresses key issues involved in the use of renewable energy in wastewater treatment
SOLAR ENERGY CONVERSION AND PHOTOENERGY SYSTEMS: Thermal Systems and Desalination Plants-Volume I Rand Corporation
Solar Energy Conversion and Photoenergy Systems: Thermal Systems and Desalination Plants theme in five volumes is a component of Encyclopedia of Energy Sciences, Engineering and Technology Resources in the global Encyclopedia of Life Support Systems (EOLSS), which is an integrated compendium of twenty one Encyclopedias. The Theme on Solar Energy Conversion and Photoenergy Systems: Thermal Systems and Desalination Plants with contributions from distinguished experts in the field, discusses solar energy, renewable energy, thermal systems, and desalination systems, some of which are already in commercial and practical applications and others are under research and testing level. The volumes provide an analysis and discussion about the reasons behind the current efforts of our society, considering both developed and developing countries, to accelerate the exploitation of the huge solar energy potential in our normal daily lives. The five volumes also provide some basic information about the solar energy potential, history and the amazing trip of a photon from its creation in the Sun until its arrival to the Earth. These five volumes are aimed at the following five major target audiences: University and College Students Educators, Professional

Practitioners, Research Personnel and Policy Analysts, Managers, and Decision Makers, NGOs and GOs.

Engineering and Economics of Coupling Multi-Effect Distillation and Solar Plants EOLSS Publications

Renewable Energy Systems and Desalination is a component of Encyclopedia of Water Sciences, Engineering and Technology Resources in the global Encyclopedia of Life Support Systems (EOLSS), which is an integrated compendium of twenty one Encyclopedias. The two volumes present state-of-the art subject matter of various aspects of Renewable Energy Systems and Desalination such as: A Short Historical Review Of Renewable Energy; Renewable Energy Resources; Desalination With Renewable Energy - A Review; Renewable Energy And Desalination Systems; Why Use Renewable Energy For Desalination; Thermal Energy Storage; Electrical Energy Storage; Tidal Energy; Desalination Using Tidal Energy; Wave Energy; Availability Of Wind Energy And Its Estimation; The Use Of Geothermal Energy In Desalination; Solar Radiation Energy (Fundamentals); High Temperature Solar Concentrators; Medium Temperature Solar Concentrators (Parabolic-Troughs Collectors); Low Temperature Solar Collectors; Solar Photovoltaic Energy Conversion; Photovoltaics; Flat-Plate Collectors; Large Active Solar Systems: Load; Integration Of Solar Pond With Water Desalination; Large Active Solar Systems: Typical Economic Analysis; Evacuated Tube Collectors; Parabolic Trough Collectors; Central Receivers; Configuration, Theoretical Analysis And Performance Of Simple Solar Stills; Development In Simple Solar Stills; Multi-Effect Solar Stills; Materials For Construction Of Solar Stills; Reverse Osmosis By Solar Energy; Solar Distillation; Solar Photochemistry; Photochemical Conversion Of Solar Energy; Availability Of Solar Radiation And Its Estimation; Economics Of Small Solar-Assisted Multipleeffect Seawater Distillation Plants; A Solar-Assisted Sea Water Multiple Effect Distillation Plant 15 Years Of Operating Performance (1985-1999);Mathematical Simulation Of A Solar Desalination Plant; Mathematical Models Of Solar Energy Conversion Systems; Multiple Effect Distillation Of Seawater Using Solar Energy – The Case Of Abu Dhabi Solar Desalination Plant; Solar Irradiation Fundamentals; Water Desalination By Humidification And Dehumidification Of Air, Seawater Greenhouse Process. These volumes are aimed at the following five major target audiences: University and College Students Educators, Professional Practitioners, Research Personnel and Policy and Decision Makers

The Global Technology Revolution, China, In-depth Analyses Academic Press

The book explores basic concepts and advanced topics in the field of water technologies. It deals extensively with advances in materials, material selection, preparation, characterization and application. The relevance of water technologies in industries is considered, and a section is dedicated to describing and analyzing the technologies required for water reuse and advanced purification, including desalination. Nuclear desalination, low-carbon desalination and water purification technologies to address the adverse impacts of climate change are examined from both the adaptation and mitigation points of view. Aimed at senior undergraduate/graduate students in chemical, civil and environmental engineering, along with wastewater and desalination researchers, this book: Details advanced water treatments for varied processes. Describes membrane and desalination techniques for water reuse and advanced purification. Elaborates water technologies at both the front and back ends of the process. Discusses modern technologies for effluent treatment and water recycling. Explores the role of information technology in the water sector.

Microgrids Cavendish Square Publishing, LLC

The development and deployment of membrane technologies continues to advance thanks to innovative materials and novel engineering approaches. Membranes for clean and renewable power applications introduces the principles and concepts of membrane technology and explores the use of this technology in clean energy applications. Chapters in part one introduce the utilization of membrane technology in the production of clean and renewable power and the combining of membrane processes with renewable energy technologies. Part two focusses on membranes for biofuel production and processing including membranes and membrane reactors for the production of biodiesel and second generation biofuels. Part three discusses membranes for syngas, hydrogen and oxygen production and processing. Chapters highlight steam reforming of biofuels for the production of hydrogen-rich gas A., perovskite membrane reactors, and environmental analysis of hydrogen-methane blends for transportation. Chapters in part four explore membranes for fuel cells including ceramic membranes for intermediate temperature solid oxide fuel cells (SOFC), microbial fuel cells, and direct bioethanol fuel cells. Finally, part five discusses membranes integrated with solar, wind energy and water-related applications including membrane technologies for solar-hydrogen production, solar-desalination plants, and the storage as methane of energy generated by wind power and other renewable sources. A final chapter introduces wastewater processing, energy conservation and energy generation. Membranes for clean and renewable power applications is a comprehensive resource for professionals and consultants in the clean and renewable energy industry, membrane and materials scientists and professionals, and academics and researchers in the field. Introduces the principles and concepts of membrane technology and explores the use of this technology in clean energy applications

SOLAR ENERGY CONVERSION AND PHOTOENERGY SYSTEMS: Thermal Systems and Desalination Plants-Volume IV Springer Nature

This edited book explores the most promising and reliable technological developments expected to impact on the next generation of desalination systems. The book includes research studies which takes the reader on a fascinating walk through the multidisciplinary world of membrane science applied to water treatment. Concerning the ultimate technological advancement, the book seeks to investigate how to bridge the gap between the laboratory scale and the applicability to industry.

Concentrating Solar Power and Desalination Plants Development of a Photovoltaic Powered Reverse Osmosis Water Desalination SystemFinal ReportDescription of the engineering development and testing of a desalination system for brackish water, powered by solar electric (photovoltaic) modules, intended for use in remote areas where potable water and electric power are not now available. The system consists of a 24 V battery, DC motor, high pressure pump, reverse osmosis membranes, a filter and an electronic controller, and is powered by an array of 24 standard PV modules.Concentrating Solar Power and Desalination PlantsEngineering and Economics of Coupling Multi-Effect Distillation and Solar Plants

Solar Energy Conversion and Photoenergy Systems: Thermal Systems and Desalination Plants theme in five volumes is a component of Encyclopedia of Energy Sciences, Engineering and Technology Resources in the global Encyclopedia of Life Support Systems (EOLSS), which is an integrated compendium of twenty one Encyclopedias. The Theme on Solar Energy Conversion and Photoenergy Systems: Thermal Systems and Desalination Plants with contributions from distinguished experts in the field, discusses solar energy, renewable energy, thermal systems, and desalination systems, some of which are already in commercial and practical applications and others are under research and testing level. The volumes provide an analysis and discussion about the reasons behind the current efforts of our society, considering both developed and developing countries, to accelerate the exploitation of the huge solar energy potential in our normal daily lives. The five volumes also provide some basic information about the solar energy potential, history and the amazing trip of a photon from its creation in the Sun until its arrival to the Earth. These five volumes are aimed at the following five major target audiences: University and College Students Educators, Professional Practitioners, Research Personnel and Policy Analysts, Managers, and Decision Makers, NGOs and GOs.

Development of a Photovoltaic Powered Reverse Osmosis Water Desalination System EOLSS Publications

This book provides a detailed examination of how two key concerns in many communities across the globe- power and water- can be simultaneously addressed through the coupling of Concentrating Solar Power and Desalination (CSP+D) plants. It undertakes a technological and economic evaluation of the integration of Multi-effect Distillation Plants into CSP plants based on Parabolic Trough solar collectors (PT-CSP+MED), as compared to independent water and power production through Reverse Osmosis unit connection to a CSP plant (CSP+RO). Through this compare and contrast method of analysis, the author establishes guidelines to assist readers in identifying cases wherein PT-CSP+MED systems provide greater benefits from a thermodynamic and economic point of view. The text outlines efficiencies and challenges derived from the combination of PT-CSP power generation with four different desalination plant scenarios, beginning with a description of the equations used in the modeling and validation of a pilot MED plant and followed by detailed thermodynamic analysis of several currently operating CSP+D systems. Comparative thermodynamic assessments are based on a sensitivity analysis from which the overall efficiency of the cogeneration system is determined. The author outlines all the equations used for the modeling of each component and includes 97 comparative tables obtained from the sensitivity analysis, showing the variation of the overall thermal efficiency of the CSP+D as a function of fundamental parameters of the cogeneration cycle, such as the specific electric consumption of the desalination plants, and the turbine outlet temperature of the power cycle. These findings are then placed in practical context through a complete thermo-economic analysis, which is carried out for two specific locations in the Middle East and Europe in order to identify the most practically and economically viable CSP+D system in each region as informed by actual operating conditions, meteorological data and real cost figures for each location.

Solar Power Earthscan

Solar Energy Conversion and Photoenergy Systems: Thermal Systems and Desalination Plants theme in five volumes is a component of Encyclopedia of Energy Sciences, Engineering and Technology Resources in the global Encyclopedia of Life Support Systems (EOLSS), which is an integrated compendium of twenty one Encyclopedias. The Theme on Solar Energy Conversion and Photoenergy Systems: Thermal Systems and Desalination Plants with contributions from distinguished experts in the field, discusses solar energy, renewable energy, thermal systems, and desalination systems, some of which are already in commercial and practical applications and others are under research and testing level. The volumes provide an analysis and discussion about the reasons behind the current efforts of our society, considering both developed and developing countries, to accelerate the exploitation of the huge solar energy potential in our normal daily lives. The five volumes also provide some basic information about the solar energy potential, history and the amazing trip of a photon from its creation in the Sun until its arrival to the Earth. These five volumes are aimed at the following five major target audiences: University and College Students Educators, Professional Practitioners, Research Personnel and Policy Analysts, Managers, and Decision Makers, NGOs and GOs.

Renewable Energy Technologies for Water Desalination World Scientific

The continued lack of access to adequate amounts of safe drinking water is one of the primary causes of infant morbidity and mortality worldwide and a serious situation which governments, international agencies and private organizations are striving to alleviate. Barriers to providing safe drinking water for rural areas and small communities that must be overcome include the financing and stability of small systems, their operation, and appropriate, cost-effective technologies to treat and deliver water to consumers. While we know how to technically produce safe drinking water, we are not always able to achieve sustainable safe water supplies for small systems in developed and developing countries. Everyone wants to move rapidly to reach the goal of universal safe drinking water, because safe water is the most fundamental essential element for personal and social health and welfare. Without safe water and a safe environment, sustained personal economic and cultural development is impossible. Often small rural systems are the last in the opportunity line. Safe Drinking Water in Small Systems describes feasible technologies, operating procedures, management, and financing opportunities to alleviate problems faced by small water systems in both developed and developing countries. In addition to widely used traditional technologies this reference presents emerging technologies and non-traditional approaches to water treatment, management, sources of energy, and the delivery of safe water.

Power for the World MDPI

Solar-Driven Water Treatment: Re-engineering and Accelerating Nature’s Water Cycle looks at the use of solar energy and in particular photovoltaic technologies, as a viable, accessible and sustainable option in the treatment of water. Solar-Driven Water Treatment: Re-engineering and Accelerating Nature’s Water Cycle provides insight into the different solar powered technologies, in-depth information about the viability of sunlight in the water treatment process, the potential environmental implications as well as the performance, economics, operation and maintenance of the discussed technologies. Elaborating on the potential issues and health risks associated with the water purification systems this reference also covers the need for appropriate technologies in the present scenario to improve worldwide access to clean drinking water. Readers will learn the most appropriate technology for their specific need making this book useful for renewable energy and environmental engineers in investigating energy efficiency, water treatment technologies, and the economics of technological change in the treatment of water by solar technologies. Provides a valuable resource on how to solve the issue of drinking water scarcity by solar energy Describes various solar water treatment techniques with their environmental impacts Cover issues associated with solar water purification and the need for technology assessment

The Pros and Cons of Solar Power EOLSS Publications

The world's deserts are sufficiently large that, in theory, covering a fraction of their landmass with PV systems could generate many times the current primary global energy supply.The Energy from the Desert two-volume set details the background and concept of Very Large Scale Photovoltaics (VLS-PC) and examines and evaluates their potential as viable power generation systems. The authors present case studies of both virtual and real projects based on selected regions (including the Mediterranean, Sahara, Chinese Gobi, Mongolian Gobi, Indian Thar, Australian Desert and the US) and their specific socio-economic dynamics, and argue that VLS-PV systems in desert areas will be readily achievable in the near future.

The Design of a Controllable Energy Recovery Device for Solar Powered Reverse Osmosis Desalination with Experimental Validation Springer

Desalination Sustainability: A Technical, Socioeconomic, and Environmental Approach presents a technical, socioeconomical, and environmental approach that guides researchers and technology developers on how to quantify the energy efficiency of a proposed desalination process using thermodynamics-based tools. The book offers the technical reader an understanding of the issues related to desalination sustainability. For example, technology users, such as public utility managers will gain the ability and tools to assess whether or not desalination is a good choice for a city or

country. Readers will learn new insights on a clear and practical methodology on how to probe the economic feasibility of desalination using simple and effective tools, such as levelized cost of water (LCOW) calculation. Decision-makers will find this book to be a valuable resource for the preliminary assessment of whether renewable-powered desalination is a good choice for their particular setting. Presents the issues related to desalination sustainability Guides researchers and technology developers on how to quantify the energy efficiency of a proposed desalination process using thermodynamics-based tools Outlines a clear and practical methodology on how to probe the economic feasibility of desalination using simple and effective tools Provides a roadmap for decision-makers on the applicability of a desalination process at a particular setting

Sustainable Practices: Concepts, Methodologies, Tools, and Applications Elsevier

Sun Power: An Introduction to the Applications of Solar Energy, Second Edition is a non-technical introduction to the wide range of solar energy applications. It has been extensively updated and enlarged to include new sections on passive solar heating and cooling and an examination of the social, legal and environmental issues concerning solar technology and utilization. Practical construction details of several modern solar systems are included together with methods of assessing their economic viability. Contains an extensive bibliography of over 600 references.

The Energy-water Nexus EOLSS Publications

Microgrids are a growing segment of the energy industry, representing a paradigm shift from centralized structures toward more localized, autonomous, dynamic, and bi-directional energy networks, especially in cities and communities. The ability to isolate from the larger grid makes microgrids resilient, while their capability of forming scalable energy clusters permits the delivery of services that make the grid more sustainable and competitive. Through an optimal design and management process, microgrids could also provide efficient, low-cost, clean energy and help to improve the operation and stability of regional energy systems. This book covers these promising and dynamic areas of research and development and gathers contributions on different aspects of microgrids in an aim to impart higher degrees of sustainability and resilience to energy systems.

Renewable Energy Integrated with Membrane Operations Elsevier

A wide variety of detail regarding genuine and proprietary research from distinguished authors is presented, ranging from new means of evaluation of the local solar irradiance to the manufacturing technology of photovoltaic cells. Also included is the topic of biotechnology based on solar energy and electricity generation onboard space vehicles in an optimised manner with possible transfer to the Earth. The graphical material supports the presentation, transforming the reading into a pleasant and instructive labor for any interested specialist or student.