3rd Energy, Efficiency and Environmental Sustainability Conference 2021

KEYNOTE SPEAKERS

Dr. Charles Meneveau. Johns Hopkins University, USA

-

Keynote: "Predicting Large Scale Wind Farm Generation: Current and Future Challenges".

Dr. Thomas Sterner. University of Gothenburg, Sweden

-

Keynote: "Pricing Carbon: Efficiency and fairness of policies to deal with emissions of carbon dioxide and other gases causing climate change"".

Dr. Rafael Ramírez. Center for Research and Advanced Studies of the National Polytechnic Institute CINVESTAV, Querétaro, México

-

Keynote: "Metal oxide nanofibers as multifunctional materials".

9 and **10**
december 2021

Completely **Online**
Via Videoconferencing

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cees2021@userena.cl

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UNIVERSIDAD DE LA SERENA CHILE

DOCTORADO EN Energía, Agua y Medio Ambiente

Comisión Nacional de Acreditación CNA-Chile

DOCTORADO ACREDITADO **2 AÑOS**
MAY. **2020** | MAY. **2022**

PROGRAM AND ABSTRACT BOOK

3rd ENERGY, EFFICIENCY

AND ENVIRONMENTAL SUSTAINABILITY CONFERENCE

9 and 10 December 2021

Universidad de La Serena, La Serena, Chile

Bienvenida del Vicerrector de Investigación y Postgrado de la Universidad de La Serena

La Universidad de La Serena (ULS), busca siempre cumplir con las exigencias de la sociedad y una de las demandas que más se han evidenciado en los últimos años son el problema energético y la escasez hídrica. En este contexto, las políticas institucionales en materia de investigación científica fundamental, investigación aplicada y formación de especialistas conducentes a la generación y desarrollo de energías limpias y tecnologías no contaminantes, son un eje de relevancia para la Universidad. Evidencia de aquello es la creciente productividad científica en el área y la creación de programas de Diplomados, Magister y Doctorado en temáticas de energías renovables y Sustentabilidad.

Desde un punto de vista global, el planeta está sufriendo un alza de temperatura con consecuencias graves para los sistemas biológicos y sus equilibrios naturales. Es así como uno de los objetivos principales de la Agencia Internacional de la Energía (AIE), compuesta por 30 países, es mantener el calentamiento global por debajo de los 2 grados centígrados, siendo para ello absolutamente necesario realizar una transición a energías limpias y reducir de forma sostenible la emisión de gases con efecto invernadero. Según la AIE, el escenario de desarrollo sostenible acordado por 193 países en el año 2015, para mantener los objetivos de París, considera la necesidad de producir al menos 300 GW de nuevas capacidades de energías renovables por año hasta el 2030. Por otro lado, muchos países comienzan a acordar reducir sus emisiones a tal punto de volverlas neutras. En el caso de Chile, se ha anunciado un ambicioso plan para convertir al país en carbono neutral al año 2050, proyectando para ello el cierre de todas las centrales energéticas basados a carbón y el potenciamiento de la generación de energías renovables. Ante este nuevo escenario, las nuevas tecnologías deben ser direccionadas a la consecución de los objetivos climáticos a largo plazo, siendo el desarrollo y acceso libre a la electromovilidad y la optimización de los sistemas de almacenamiento de energías obtenidas mediante fuentes renovables los desafíos que se avecinan para lograr un avance real en la transición energética y desarrollo sostenible de las naciones.

Para aportar al cambio en la matriz energética que requiere el país, es necesario enfrentar el problema que conlleva el cambio climático. En el año 2014 la ULS comenzó con un programa de investigación en la temática de energías renovables mediante un Proyecto de Mejoramiento Institucional financiado por el Ministerio de Educación, que luego dio origen a los programas de Diplomado en Eficiencia Energética y Energías Renovables No Convencionales, y Magíster en Energía y Medio Ambiente. En el año 2017, se creó el Programa de Doctorado en Energía, Agua y Medio Ambiente, y la Universidad organizó el primer congreso sobre energía, eficiencia y sustentabilidad ambiental (CEES-2017). Este tercer Congreso en Energía, Eficiencia y Sustentabilidad Ambiental 2019 es una muestra clara de la consolidación institucional que ha tenido la temática de Energía y Sustentabilidad. En ella, queda reflejado el esfuerzo de los investigadores de nuestra institución y su interés por promover la interacción con investigadores de otros centros para conversar, discutir y compartir experiencias e investigaciones que den respuestas a los desafíos que nos demanda la sociedad actual y del futuro. Este tercer congreso también favorece la formación de estudiantes nacionales e internacionales que actualmente cursan programas de Magister y Doctorado en áreas de Energía, Eficiencia y Sustentabilidad Ambiental.

Invito a los lectores a conocer las actas del congreso 2021, que sintetizan el esfuerzo de quienes realizaron tan valiosos aportes. Esperamos que el próximo año sigamos recibiendo más contribuciones y que esta iniciativa siga contribuyendo a un tema tan relevante como es la Energía, Eficiencia y Sustentabilidad Ambiental.

Cordialmente,

Eduardo Notte
Vicerrector de Investigación y Postgrado
Universidad de La Serena, Chile

Bienvenida del Presidente del Comité Organizador

Estimados asistentes al Tercer Congreso en Energía, Eficiencia y Sustentabilidad Ambiental (CEES 2021).

La Universidad de La Serena (ULS) se ha transformado en un referente no sólo regional, sino que también nacional en las temáticas de Eficiencia Energética, Energías Renovables y Sustentabilidad Ambiental. Prueba de ello, es la adjudicación del Plan de Mejoramiento Institucional PMI 1401, en Eficiencia Energética y Sustentabilidad Ambiental, cuyo periodo de ejecución estuvo comprendido entre los años 2015-2018. Adicionalmente, el año 2018 comienza el primer año del programa de Doctorado en Energía, Agua y Medio Ambiente, y el año 2019 se suma la primera versión del Magister en Energía y Sustentabilidad Ambiental. Lo anteriormente expuesto, demuestra el firme compromiso de la institución en dichas temáticas. En este sentido, la organización del II Congreso Internacional en Energía, Eficiencia y Sustentabilidad Ambiental (CEES), consolida a la Universidad de la Serena como referente en estas temáticas, e internacionaliza su alcance. Todo lo anterior, dentro de un contexto de preocupación mundial por el cambio climático, el uso eficiente de los recursos, tratamiento y reutilización de las aguas, y los diversos temas que permitan lograr un verdadero desarrollo sustentable.

El Congreso Internacional en Energía, Eficiencia y Sustentabilidad Ambiental, tiene como finalidad promover la generación y difusión del conocimiento científico con alcance internacional. El congreso estará bajo la organización de La Universidad de La Serena (ULS), con apoyo de la Universidad de Antofagasta, la Universidad Diego Portales, Universidad Católica del Norte, Universidad de Santiago de Chile, Universidad de Zaragoza y Universidad Tecnológica Metropolitana.

La última versión del Congreso realizada en 2019, permitió la participación de cerca de 120 asistentes, entre académicos e investigadores de diversas instituciones nacionales e internacionales. También se contó con la presencia de alumnos de pre y postgrado. Entre los países presentes, se destacan la participación de investigadores de Argentina, Colombia, Estados Unidos y Reino Unido. Se presentaron alrededor de 40 ponencias orales y 25 trabajos en modalidad póster.

Los programas de Doctorado en Energía, Agua y Medio Ambientes y el programa de Magister en Energía y Sustentabilidad Ambiental, han puesto a disposición del comité organizador, el recurso humano necesario para la correcta ejecución del congreso. Finalmente, es mi deseo manifestar mi más profundo reconocimiento y agradecimiento a todas las instituciones nacionales e internacionales, así como a los invitados, ponentes y asistentes cuya colaboración y apoyo fue vital para la organización de esta tercera versión del congreso CEES.

En nombre del comité científico y el comité organizador esperamos que disfruten de este Congreso, teniendo la certeza que su participación en el mismo, es de trascendencia para Chile y para el mundo.

Cordialmente,

Luis Silva Llanca, Ph.D.
Académico
Instituto de Investigación Multidisciplinario en Ciencia y Tecnología
Universidad de La Serena, Chile

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Scientific program

Thursday 09/12: Morning Sessions

9:00	Welcome	
10:00	Keynote: Thomas Sterner	
11:00	Break	
	Virtual Room A	Virtual Room B
11:15	ESS01	OM01
11:35	ESS02	OM02
11:55	ESS03	OM03
12:15	ESS04	OM04

Thursday 09/12: Afternoon Sessions

	Virtual Room A	Virtual Room B
14:30	ESS05	OM05
14:50	ESS06	OM06
15:10	ESS07	WMU01
15:30	ESS08	WMU02
15:50	Break	
16:05	Keynote: Charles Meneveau	
17:05	Break	
17:20	REC01	WMU03
17:40	REC02	WMU04
18:00	SED01	WMU05

Friday 10/12: Morning Sessions

	Virtual Room A	Virtual Room B
9:30	ESS09	SED02
9:50	ESS10	SED03
10:10	ESS11	SED04
10:30	Break	
10:45	ESS12	SED05
11:05	REC03	SEC01
11:25	REC04	SEC02
11:45	Break	
12:00	Keynote: Rafael Ramírez	
13:00	Conference end	

ESS: Energy Systems and Simulation

OM: Other Materials for Energy Conversion and Environmental Decontamination

REC: Renewable Energy Conversion

SEC: Semiconductor Materials for Energy Conversion

SED: Removal of Water and Air Pollution by Semiconductors

WMU: Water Management and Sustainable Water Usage

Contents

Keynote Presentations

KN1:
Pricing Carbon: Efficiency and fairness of policies to deal with emissions of carbon dioxide and other gases causing climate change.

Thomas Sterner
Departament of Economics,
Uiversity of Gothengurg, Sweden.
Presenting author's email: thomas.sterner@economics.gu.se

The World is finally beginning to take the first small steps in the direction of climate regulation. Economists know that the most efficient and effective instrument would involve the setting of prices on emissions. However such policies are often fiercely resisted - not only by lobbyists from powerful vested interests but also from many other groups in society. In this talk I will start by discussing when emissions pricing is really most useful. I will then continue by discussing the distributional consequences of such pricing and finally the political resistance which is often founded on perceived fairness which, in turn, may or may not be related to measurable fairness.

Biography

Thomas Sterner is a professor of environmental economics in Gothenburg. During the last three decades he built up the Unit for Environmental Economics with a staff of about a dozen PhDs and a number of graduate students. They give a unique PhD program in environmental economics and have had more than 50 graduate students from developing countries (financed by the Swedish International Development Cooperation Agency, Sida), as well as masters and undergraduate programs and a large number of other research and teaching activities. In 2018 he presided over the World Conference of Environmental and Resource Economics in Gothenburg. With 1500 participants it was the biggest ever! For the academic year 2015-2016 he was elected to a guest professorship at the Collège de France. From 2011 to 2014 he spent in part on the AR5 of the IPCC where he was CLA of chapter 15 on policy instruments. Dr. Sterner has published over 110 articles in refereed journals, authored or edited more than a dozen books and a large number of book chapters and official reports. He has also been quite prolific in the diffusion into journalistic articles ranging from having his own opinion piece in local media to writing for New York Times, Le Monde or The Times. Dr. Sterner's main focus has been on environmental policy instruments with applications to energy and climate, industry, transport economics and finally resource management in developing countries. He teaches courses in natural resource economics and environmental policy at the graduate and undergraduate levels. He has been the advisor for approximately two dozen PhD theses and he does substantial external lecturing and consulting.

KN2:
Predicting Large Scale Wind Farm Generation: Current and Future Challenges

Charles Menevau
Department of Mechanical Engineering
Johns Hopkins University, United States
Tel +1 (410) 516-7802
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Wind power has experienced remarkable growth, currently encompassing 6% of the global energy demand. In the United States, renewable power generation has already surpassed traditional coal generation. A Wind Farm is a complex system, which combines engineering and atmospheric sciences. They can extend to impressive sizes and interact with natural phenomena that render them hard to predict. Modeling a Wind Farm depends mostly on Fluid Dynamics, Turbulence, and Aerodynamics, which have seen significant progress in recent years, promoting the development of Wind Farm technology breakthroughs. In this talk, we provide research examples focused on the modeling of the mean velocity distribution across wind farms, the implications for power density, and the possibility of using yaw to control wake development. We also present future perspectives, describing the challenges that remain to bring this technology into its maturity in time as the world transitions to predominant renewable-powered grids.

Biography

Charles Meneveau is the Louis M. Sardella Professor in the Department of Mechanical Engineering, is Associate Director of the Institute for Data Intensive Engineering and Science (IDIES) and is jointly appointed as Professor in the Departments of Physics and Astronomy and Environmental Health Engineering at Johns Hopkins.
He received his B.S. degree in Mechanical Engineering from the Universidad Técnica Federico Santa María in Valparaíso, Chile, in 1985 and M.S, M.Phil. and Ph.D. degrees from Yale University in 1987, 1988 and 1989, respectively. During 1989/90 he was a postdoctoral fellow at the Center for Turbulence Research at Stanford. He has been on the Johns Hopkins faculty since 1990. His area of research is focused on understanding and modeling hydrodynamic turbulence, and complexity in fluid mechanics in general. The insights that have emerged from Professor Meneveau's work have led to new numerical models for Large Eddy Simulations (LES) and applications in engineering and environmental flows, including wind farms. He also focuses on developing methods to share the very large data sets that arise in computational fluid dynamics.
He is Deputy Editor of the Journal of Fluid Mechanics and has served as the Editor-in-Chief of the Journal of Turbulence.
Professor Meneveau is a member of the US National Academy of Engineering, a foreign corresponding member of the Chilean Academy of Sciences, a Fellow of APS, ASME, AMS and recipient of the Stanley Corrsin Award from the APS, the JHU Alumni Association's Excellence in Teaching Award, and the APS' François N. Frenkiel Award for Fluid Mechanics.

KN3:
Metal oxide nanofibers as multifunctional materials

Rafael Ramírez Bon
Center for Research and Advance Studies National Polytechnique Institute, CINVESTAV, Querétaro, Mexico.
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Electrospinning is a simple and versatile method for fabricating continuous fibers with diameters ranging from several nanometers to micrometers. This technique is typically applied to obtain polymer nanofibers. The combination of appropriate polymers with metal oxide precursors enables the formation of composite fibers, which after calcination results in crystalline metal oxide nanofibers. Herein, we describe the electrospinning processes to obtain thin films of metal oxide semiconductor nanofibers (NFs) and analyze their structural and morphological properties. Then, their multifunctional character is demonstrated in several applications. By direct single step deposition of p-type NiO nanofibers on n–type Si, after analysis of the electrical response in dark and under UV illumination, we show that the NiO-p NFs/Si-n heterostructure works as a self-powered photodetector of UV radiation. The same NiO-p nanofibers deposited on a Ni electrode can work as an electrochemical glucose sensor, as shown by the cyclic voltammetry curves measured at different glucose concentrations. Finally, NiO-p and ZnO-n NFs thin films immobilized on glass substrates were applied to the photodegradation of methylene blue in aqueous solutions activated by sunlight. After the photodegradation experiments, the metal oxide NFs remain integral and well adhered to the substrate, then they were reutilized in subsequent experiments.

Biography

Rafael Ramírez is a professor at The Center for Research and Advanced Studies of the National Polytechnic Institute, CINVESTAV-IPN, in Querétaro. He received his Bachelor's Degree in Physics from the University of Sonora in 1986, his Master's Degree in Physics from the University of Sonora in 1988, and his Ph.D. in Physics from the CINVESTAV-IPN in 1992. His interests range between Synthesis and study of optical, electrical, and structural properties of semiconductor, metallic and ceramic coatings prepared by different deposition techniques. Fabrication and characterization of semiconductor electronic devices, including solar cells, photodetectors, and thin-film transistors. Ha has been the Principal Investigator of 15 projects financed by the government and the private sector. He has published 215 papers in peer-reviewed journals with over 2,400 citations. Dr. Ramirez has also directed more than 120 theses at the undergraduate and graduate levels. Dr. Ramírez has been the President of the Mexican Vacuum Society from 1997 to 1998, a Member of the Mexican Academy of Science since 1996, and an Investigator Level 3 of the Mexican System of National Investigators since 2002. In addition, he is one of the Mexican top five authors in Materials Sience (2002), a Member of the Junta Universitaria of the University of Sonora since 2018, and a Fullbright Scholar at the University of Texas at Dallas between 2017 and 2018.

ESS: Energy Systems and Simulation

ESS01:
Energy and exergy analyses of mixed heat convection in cavities with an inner-solid: Application to the food freezing process

Diego Rivera, Nelson Moraga*
Departamento de Ingeniería Mecánica, Universidad de La Serena, Chile
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The description of natural and forced (mixed) heat convection in cavities has been fundamental to improve the energy efficiency of several thermal applications. Lately, the exergy analyses have gained relevance as powerful tools to quantify the available energy lost by internal irreversibilities. However, few works have studied the effect of turbulence and thermal radiation on the exergy of conjugated solid-fluid heat transfer problems. This work investigates the effect of turbulence and thermal radiation on the heat transfer and exergy destruction of mixed air convection in a cavity with a heat-conducting inner-solid through the variation of dimensionless parameters. Furthermore, the application of food freezing is studied by describing the local exergy destruction in the freezing process of meat by natural air convection inside a domestic freezer. The accuracy of laminar/turbulent and two/three-dimensional models is compared with experimental results. The simulations were performed using an in-house code solved with the finite volume method. The methodology includes a turbulent k-ϵ model with damping functions, the apparent enthalpy method for the phase-changing food and a direct method to compute the exergy destruction. The main results indicate that the increment of Grashof number and surface emissivity increases the heat transfer of the inner-solid, while drastically reduces the total exergy destroyed in the mixed convection problem. Regarding the freezing process, 187 W of exergy was destroyed during the process, with a 53% lost in the food and the rest, 47%, in the air. Finally, the turbulent and three-dimensional models predict more accurately the freezing time.

Acknowledgments

The authors acknowledge ANID for the financial support in the project FONDECYT 1200572, and for the doctoral scholarship fund to Diego R. Rivera (2021).

ESS02:
Mathematical conjugated model of fluid mechanics and heat transfer for food freezing in an air tunnel modified with baffles to reduce the energy consumption

Edgardo J. Tabilo[1], Nelson O. Moraga[2,*]

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[2] *Departamento de Ingeniería Mecánica, Universidad de La Serena, Chile.*

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This work describes the energy efficiency for the unsteady natural heat convection with change phase of water contained in a square container of conductive material, caused by the mixed heat convection of air, and the effect of two parallel baffles of high thermal conductive material attached to the freezing tunnel walls. The partial differential equations of the conjugated mathematical model were solved by the Finite Volume method with the SIMPLE algorithm. The effect of baffles on the freezing time, the evolution of local dimensionless heat flux, and the energy consumption were studied. The numerical results describes that a reduction of the fluid dynamics and thermal boundary layers have been achieved by the two baffles attached to the upper and lower walls, decreasing the freezing time and the energy consumption. Additionally, the effect of the length of baffles and their position on the heat flux removed from the water in the freezing process were evaluated. An estimate for the thermal loads was calculated for the freezing tunnel with baffles and without baffles, based on the time that each configuration required to reach -20 $^{\circ}C$, at the thermal center of the container with water. The results indicate that the thermal load of the system without baffles was 47.5 W, while the use of baffles increased this value up to 108.9 W, indicating that the effect of the deflectors was to achieve an increment in the energy removed from the water that amounted to 44%, per unit of time.

Acknowledgments

Thanks to the Research and Development Department of the University of La Serena and ANID for supporting the Fondecyt Project 1200572.

ESS03:
Computational modeling of a PV-PCM passive cooling system during a day-night cycle at arid and semi-arid climate zones

Felipe A. Díaz[1,*], Nelson O. Moraga[1], Roberto C. Cabrales[2]

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This work investigates the use of phase change materials (PCM) as a passive cooling system to increase the electric power generation of photovoltaic panels (PV) by a reduction of the temperature of the panels. This study aims to evaluate different configurations of PV-PCM cooling systems, by changing the phase change material, to achieve a high efficiency in silicon PV. Each configuration is studied for three day-night cycles under seasonal variable atmospheric conditions. Two Chilean cities with a semi-arid climate and arid climate - Vicuña and Calama, respectively - were selected as the study locations. The development of the PV-PCM improved system is carried out by solving the one-dimensional unsteady thermal energy equation with computational simulations by the finite volume method (MVF). An Enchanted Conduction Model (ECM) was used to include the convective heat transfer in the melted PCM. The ECM was validated with experimental measurements of a PV-PCM system, finding a maximum deviation for the PV frontal temperature of 2 °C. The numerical model was validated with experimental and numerical results of a PV-PCM system under a 24-hour cycle with variable atmospheric conditions. The results obtained indicate that the use of phase change materials as a cooling system decreases the temperature in PV, diminishing the losses of efficiency and increasing the generation of electricity. The electrical production in one year can increase by 5.92% for Vicuña and 5.86% for Calama when a layer of $CaCl_2 - 6H_2O$ with a thickness of 50 mm is used.

Acknowledgments

This work was supported by the National Agency of Research and Development - Chile (ANID) under grant to FONDECYT 1200572 project, and by the Doctoral Scholarship Program, grant 21211434.

ESS04:
Active flow control and aerodynamic improvement using adjacent synthetic jets on a NACA0012 airfoil

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Synthetic jets are a type of jet that produce a train of counter-rotating vortex pairs and–in time- averaged terms–resemble a turbulent jet. They primarily have been used in electronic cooling and active flow control. When two synthetic jets advect adjacently, the resulting flow can tilt in a process known as "vectoring". This work examines the aerodynamics generated by a NACA0012 airfoil and two adjacent synthetic jets located in its trailing edge. Our primary purpose is to elucidate the vortex dynamics near the airfoil surface and apply the vectoring phenomenon to improve the airfoil's aerodynamics. We performed numerical simulations in turbulent regime using the $k-\omega$ SST model with the software ANSYS Fluent. We varied the governing parameters such as the Reynolds number ratio (R), the dimensionless frequency (Ω), and the phase difference between the synthetic jets ($\Delta\Phi$), keeping a constant distance between synthetic jets of $2w$, where w=4 mm. We identified an inclination of the fluid past the airfoil when we used a high value of $\Delta\Phi$, reaching a vectoring angle of up to 22°. Furthermore, we observed an increase in the lift to drag ratio (C_l/C_d) compared to a base case without the jets. Active flow control can improve airfoil aerodynamics, which could positively impact turbomachinery performance such as turbines and propellers.

Acknowledgments

Authors gratefully acknowledge the support by Agencia Nacional de Investigación y Desarrollo (ANID), scholarship program Doctorado Nacional 21210335.

ESS05:
Techno-economic assessment of grid-connected hydrogen plants considering locational electricity pricing

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Green hydrogen has gained extraordinary importance in recent years as a promising clean fuel. It can be produced with on-site renewable electricity and/or electricity from the power grid. For the last case, there is a wide range of electricity prices available in the market, that vary for different locations, and whose magnitude and structure could have a significant impact on the levelized cost of hydrogen (LCOH). The local renewable resource for producing hydrogen can also largely vary for different locations. There are no studies on the impact of local electricity prices and local renewable potential on the LCOH. In this research, we develop a model to find the key locational aspects that drives LCOHs, considering local electricity prices and the local solar and wind resources. The model finds the optimal capacity of the onsite solar and wind generators and the electrolyzer, together with the required grid electricity. We use real hourly data of local electricity prices and the renewable generation in the Chilean electricity system. We found very low electrolyzer capacity factors ($< 40\%$) in locations with very high renewable resources. Moreover, the lowest LCOHs were found for the case of hydrogen produced by a combination of both electricity from the grid (with variable pricing) and onsite renewable generation. Finally, considering a fixed grid electricity price in our simulations favors the use of renewable generation in the production of hydrogen.

Acknowledgments

This work was partially supported by ANID/FONDECYT-Iniciacion/11201052 grant and by ANID/FONDAP-SERC-Chile/15110019 grant.

ESS06:
Evaluation of two energy storage technologies to mitigate renewable energy curtailments in northern Chile

Mauro Henriquez[1], Luis Silva-Llanca[2,*], Danilo Carvajal[2], Camila Núñez[2], Sonia Montecinos[3], Yarela Flores[2], Jorge Vega[4], Abel Taquirichi[4], Abdiel Mallco[4]

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Power plants based on variable renewable energies (solar, wind) waste a significant amount of energy due to technical issues that prevent reinjecting it into the electric grid [1]. The latter is technically known as energy curtailment. In Chile, this energy is defined as the difference between the renewal power generation potential and the energy injected into the grid. The energy curtailments may occur for various reasons, for instance, congestion in the transmission system or decoupling between demand and renewable generation. In this work, we study two large-scale energy storage technologies: Molten Salt Energy Storage (MSES) and Liquid Air Energy Storage (LAES) [2] [3]. The MSES system stores energy as heat that increases the temperature of solar salts; during the discharge stage, the high-temperature solar salts superheat steam to run a Rankine cycle to return the power to the grid. During its charging, the LAES system liquifies air and stores it in cryogenic tanks; during discharge, the liquid air is gasified and ran through turbines that generate power. We collected the curtailment data from the National Electrical Coordinator (Fig.1). We evaluated the storage systems and compared them using cycle efficiency, energy density, power density, capital cost, operation cost, and cost per energy storage. Based on their Levelized Cost of Storage (LCOS), we found that both systems can compete under a predominantly renewable electric grid. We recommend extending the study to include more energy storage technologies and different environmental conditions–as found in the Chilean territory.

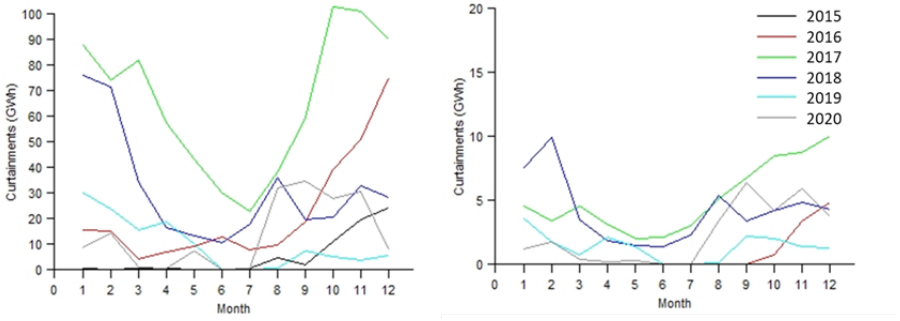

Figure 1: Left: scheme of an operando FTIR reactor developed for photocatalytic study in surface/gas phase. Right: illustration of the information collected from the different reaction steps (conversion, selectivity and involved intermediates)

Acknowledgments

The authors would like to acknowledge the financial support provided by CONICYT / FONDAP 15110019 "Solar Energy Research Center" SERC-Chile. FIC-R 30413089 – 30488809 funded by Antofagasta Government.

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ESS07:
The effect of topography on wake development and power generation in a wind farm

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Wind energy has reached a state of maturity that has allowed its implementation on a large scale, with significant participation in the Chilean electric market. Turbulence and wake evolution dictate how wind farms generate power. Computational Fluid Dynamics (CFD) is the preferred tool for studying the fluid flow in wind farms thanks to its acceptable accuracy and reasonable computational cost. Several authors focus their modeling on turbines and wind farms in flat topography. However, topography can affect how the wind develops and consequently how a wind farm generates power. In this work, we used the commercial software ANSYS Fluent™ to model the fluid mechanics of the Totoral Wind Farm through the k-ω SST turbulence model. We modeled the wind farm inside a virtual wind tunnel with steady-state boundary conditions, and we used the Actuator Disk model to represent the turbines. We validated the numerical model using field measurements at the site. We found that the complex terrain at the Totoral area affects the wakes, whose length depends on topographic conditions: regions with more topographic features favor wake recovery. The wakes lengthen downwind, which decreases the performance of the turbines located downwind. We suggest that future works include boundary conditions that better represent the unsteadiness of a typical day and the effect of thermal winds.

Acknowledgments

This work was supported by the Universidad de La Serena through DIDULS projects PR192138 and PTE192139. The authors thank Latin American Power (LAP) for the data provided.

ESS08:
Thermoeconomic analysis of a central tower concentrating solar power plant

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This work evaluates a central tower concentrating plant under different solar irradiation levels and climate conditions. The goal is to investigate the effect of geographical location on both the Levelized Cost of Energy (LCOE) and water consumption. The selected plant has a capacity of 150 MW, which is evaluated considering four subsystems: solar field, central tower receiver, thermal storage (based on molten salts as heat transfer fluid), and power block. Thermodynamic equations are solved using the Engineering Equation Solver (EES) software. Preliminary results show a decrease in the energy generation costs in areas with higher irradiation levels, although there is a trade-off given the difficult access in these locations, mainly due to geographical conditions. Finally, this analysis is expected to determine whether the costs associated with the chosen technology are competitive in comparison with other technologies and, on the other hand, how water consumption varies with different types of climates, allowing the correct choice of the cooling system in the plant.

Acknowledgments

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ESS09:
High-performance Lithium-ion battery combining a biomass derived Carbon-Sulfur cathode and a Silicon oxide-based anode

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Lithium-sulfur batteries have attracted much attention in the area of electrochemical energy storage systems, due to the very high theoretical energy density (2600 $Wh \cdot kg^{-1}$) and specific capacity (1675 $mAh \cdot g^{-1}$) of sulfur. However, several obstacles, such as "Shuttle" effect, frustrate these promising prospects. Carbon is the paradigmatic material for enhancing the electron migration of the sulfur electrode because of its high conductivity. The pore system can trap the polysulfides mitigating their dissolution in the electrolyte and at the same time can buffer the volume changes during the reaction processes. To meet the objective of sustainable development it is proposed the use of a lignocellulosic waste, cherry pits, as a starting material to synthesize a carbon activated with phosphoric acid [1], and use it as a matrix to hold sulfur. The physical-chemical characterization of sulfur-carbon composite (AC-H@S), with a 75% of sulfur, has been carried out using several techniques such as X-ray diffraction, Raman spectroscopy, energy dispersive spectroscopy, thermogravimetry, scanning and transmission electron microscopy. The sulfur-carbon electrode exhibits in lithium half-cell a maximum capacity higher than 1200 $mAh \cdot g_s^{-1}$, reversible electrochemical process, limited electrode/electrolyte interphase resistance, and a rate capability up to C/2. A full lithium-ion sulfur cell has been prepared by combining the biomass-derived sulfur-carbon cathode and a pre-lithiated silicon oxide anode [2], showing a remarkable cycle life, an initial capacity as high as 1200 $mAh \cdot g_s^{-1}$, a retention increased to more than 79% for 100 galvanostatic cycles, and of 56% over 500 cycles.

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Acknowledgments

This work was performed with the financial support of the MINECO (MAT2017-87541-R & PID2020-113931RB-I00), MICIU (FPU 16/03718) and Junta de Andalucía (Group FQM-175).

ESS10:
A heat diffusion model of liquid solid phase-change to estimate extended transient energy and mass balances in snow-firn-ice structures

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Parameterized energy and mass balance models are often applied to estimate energy fluxes at the surface that are available for melting and sublimation of snow and ice surfaces. In this study we evaluate the suitability of quantifying transient energy and mass fluxes on frozen surface using the finite volume method [1] in comparison with the traditional glaciological energy balance approach [2]. To assess the model application, we apply the methods to two datasets: a glacier in the semiarid Andes, and an Antarctic ice shelf, estimating the effect of time varying surface irradiation, wind velocity, air temperature and humidity on the history of temperature, liquid water and heat fluxes during 30 months. Results of energy and mass balances are validated with previously published results of global balances and meteorological datasets [3].

Acknowledgments

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ESS11:
Predicting conjugate freezing of salmon to assess the relation cooling rate-quality and the exergy destruction

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Accurate predictions of freezing processes are necessary to reduce the residence time of the product in a freezer, decrease the energy consumption and increase the sustainability of food processing. Because most of the salmon is exported, extending the shelf life of food, increasing the quality of the final product, and decreasing the energy consumption are the key issues. In this work, the influence of the position and number of blocks of salmon in a freezer on its cooling rate and local exergy destruction was investigated using computational modelling. The mathematical model included the turbulent heat natural convection in air inside the freezer and the unsteady heat diffusion with the phase change of water in the salmon meat, located at the bottom, center and at the lower corner of the freezer. A local exergy destruction analysis was performed to quantify the irreversibility produced by viscous dissipation and heat transfer during the freezing process. The results obtained include the unsteady description of streamlines, temperature, cooling-rate and dimensionless heat flux, calculated in terms of the Nusselt number in the meat surface. The highest cooling rate calculated was for the food at the lower corner, and the lowest when was located at the center of the freezer. The conjugate model allowed to relate the freezing rate with the luminosity of the food to predict the changes in the color of the pieces of salmon-a key quality parameter in salmon price. The exergy destruction determined the useful energy lost during the freezing process.

Acknowledgments

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ESS12:
Study of bromine complexing agents in a Zinc-Bromine flow battery

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Flow batteries are known as rechargeable devices, where the electrolyte (which has one or more active species) is flowing through the electrochemical cell and transforms chemical energy into electrical energy. A characteristic of this type of batteries is the decoupling of power and energy capacity, because the storage of the electrolyte is outside the electrochemical cell [1,2]. Bromine complexing agents (BCA) are essential for the proper performance of Zinc-Bromine flow batteries (ZBFB), as bromine catchers. These BCAs are quaternary amines synthesized using a special bimolecular substitution reaction (SN2), known as the Menshutkin reaction [3]. The most commonly used BCAs in ZBFB due to good results are 1-ethylmethylmorpholinium bromide (MEM-Br) and N-ethylmethylpyrrolidinium bromide (MEP-Br). In this work, the synthesis of different BCAs and their comparison with MEM-Br and MEP-Br have been studied. The synthesized BCAs have been characterized with electrochemical techniques, using them in batteries as complexing agents. Due to this, a ZBFB has been assembled with all its own design components, such as the electrochemical cell, tanks, pumps and hydraulic circuit. Different electrolytes have been prepared using the synthesized BCAs and they have been introduced into the ZBFB, carrying out charge and discharge cycles. After the comparison of the energetic efficiency, it can be suggested that the synthesized BCAs are really promising for the future of the ZBFB.

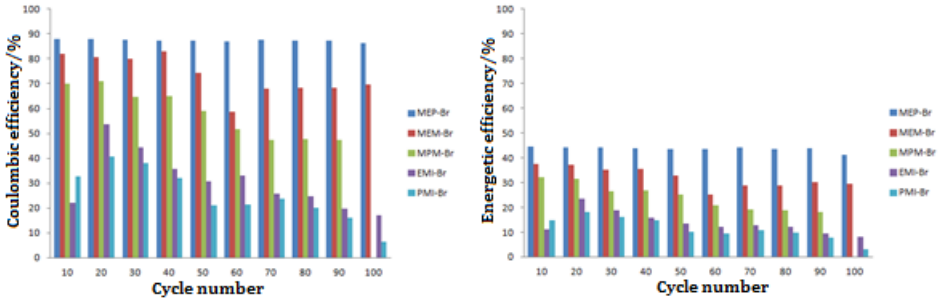

Figure 1: Efficiency comparison between different BCAs tested in a ZBFB.

Acknowledgments

This article is partially funded by the Dirección de Investigación, Universidad de La Serena, Projects PR192138 and PT192139.

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OM: Other Materials for Energy Conversion and Environmental Decontamination

OM01:
Effect of applied voltage on co-digestion of cattle manure and wastewater biosolids in Anaerobic Digestion-Microbial Electrolysis Cell (AD-MEC) systems

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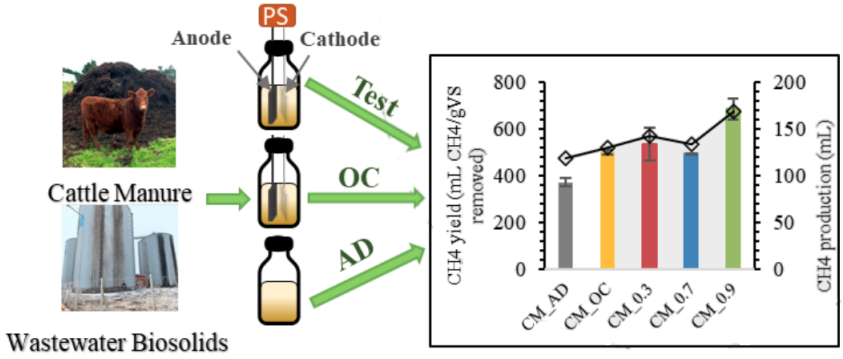
A novel bioelectrochemical technology, known as microbial electrolysis cell (MEC) has been integrated to conventional anaerobic digestion (AD) systems to boost methane production and speed up the process. The integrated AD-MEC system was applied for co-digestion of cattle manure (CM) and wastewater biosolids (WBS) composed of primary sludge and waste activated sludge. In the experimental design, three different voltages (0.3, 0.7 and 0.9 V) and different substrate mixing ratios were used in single chamber AD-MEC systems to investigate the effects of different applied voltages and substrate mixing ratio on methane production. The reactors consisted of conventional AD, open circuit (OC), and applied potential (test) reactors with different CM to WBS mixing ratios of 100:0, 30:70, 70:30 and 0:100. Reactors were operated with graphite anode and stainless-steel mesh cathode under mesophilic conditions (35oC) with no mixing, and current production was monitored continuously during incubation. There was no significant impact of applied voltage on methane production in the WBS reactors, however, AD- MEC integration significantly enhanced methane production from CM. Methane yield of CM reactors at an applied voltage of 0.9V was 685 mL CH_4/g $VS_{removed}$ which is about 1.85 times higher than conventional AD reactors (370mL CH_4/g $VS_{removed}$) and 1.37 times higher than OC reactors (500mL CH_4/g $VS_{removed}$). Integrated AD-MEC system fed with CM presents a significant opportunity to enhance the effectiveness of conventional AD systems with a relatively simple modification.



Acknowledgments

This study was funded by The Scientific and Technological Research Council of Turkey (TUBITAK), Grant No: 218M854.

OM02:
Cobaloxime-based periodic mesoporous organosilicas for photocatalytic hydrogen production

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Our society is dealing with a big energy challenge in order to produce enough energy for the future generations always respecting the environment. At present, non-renewable energy, resources such as carbon, petroleum or natural gas provide 80% of the energy consumed. The continuous use of these types of resources produce huge amounts of dangerous gases, such
as NO_2 or CO_2, which cause health problems and greenhouse effect. In addition, non- renewable energy resources are starting to run out, hence the urgency to investigate eco- friendly and renewable resources.
Hydrogen is considered one of the best energetic vectors for the future since it has a high energy density for mass unit and it is respectful with the environment because its combustion with oxygen only produces water. Many researchers, inspired by the photosynthesis process in plants, have created artificial photocatalytic systems in order to produce hydrogen. In this context, cobaloxime complexes (based on a dimethylglyoxime unit with a cobalt centre) are promising catalysts. They are gaining importance in photocatalytic hydrogen production due to its low cost and high activity. The main purpose of this research is to synthetize different periodic mesoporous organosilicas (PMOs) to be used as support for cobaloxime complexes. PMOs are synthetized by a co-condensation method involving 1,2-bis(ethoxysilyl)ethane (BTEE) and 2-(4-pyridylethyl)triethoxysilane as silane precursors. Catalysts were obtained by functionalization of those PMOs with cobaloxime complex. All synthetized catalysts have been tested in the hydrogen production reaction under visible irradiation with promising results.

Results

Supported materials (PMOs) and catalysts were full characterized by X-ray diffraction, N2 adsorption-desorption isotherms, FT-IR spectroscopy, and ^{13}C CP/MAS NMR.
The powder X-Ray diffraction (PXRD) patters of different PMO shown that both supported materials (80-20NaOH-PMO and 90-10NaOH-PMO) displayed three peaks characteristic of 2D-hexagonal (p6mm) structure. After grafting process with cobaloxime complex the 80- 20NaOH-PMO@Co and 90-10NaOH-PMO@Co catalysts kept the same hexagonal ordered structure.

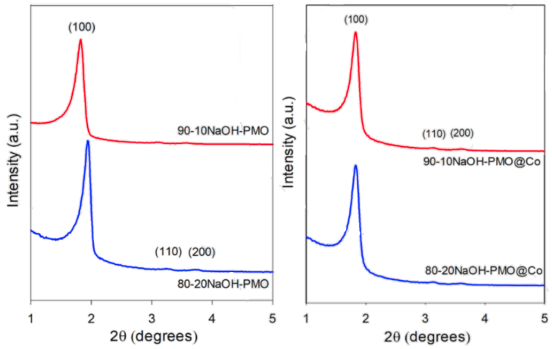

Figure 1: PXRD of supported materials (left) and catalysts (right).

Nitrogen adsorption-desorption isotherms (Fig 2) of supported materials and catalyst displayed type-IV isotherm characteristic of mesoporous materials. The BET surface, pore volume and pore diameter are summarized in Table 1. In both cases after de grafting process the BET surface area and pore diameter decrease due to decoration of pores in the pore surface of the PMOs with moieties of cobaloxime complex.

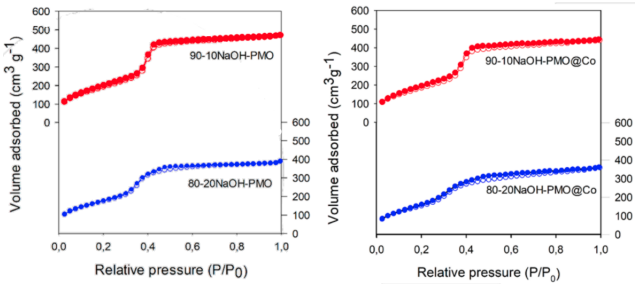

Figure 2: Nitrogen adsorption-desorption isotherms of supported materials (left) and catalysts (right)

Table 1: Textural properties of supported materials and catalysts synthetized.

MATERIAL	Área superficial (SBET) (m^2 g^{-1})	Volúmen de poro (cm^3 g^{-1})	Diámetro de poro (nm)
90-10NaOH-PMO	750	0.7	4.4
90-10NaOH-PMO@Co	715	0.7	4.3
80-20NaOH-PMO	683	0.57	4.1
80-20NaOH-PMO@Co	651	0.53	3.7

FT–IR spectra and $^{1}3C$ NMR (Fig 3) corroborate the success in the grafting process, so in both techniques are present the groups belong to cobaloxime complex. In IR-spectra small vibrations are present characteristic of the cobaloxime complex with axial pyridine ligands were observed at 1250 (νN-O) and 515 (νCo-N) cm^{-1}. In 13C NMR of 80-20NaOH-PMO appeared an intense peak at5ppm corresponded to sp3 carbons on ethylene groups. Also signal at 20, 30 and 148 ppm are associated to pyridylethyl groups in the pores. After grafting process (80-20NaOH-PMO@Co) new signals appeared at 13 and 158 ppm belonging to CH3 and C=N from glyoximate ligand.

Catalytic activity

The potential of 80-20NaOH-PMO@Co and 90-10NaOH-PMO@Co as catalyst for the hydrogen production were investigated in a visible light-activated system in the presence of eosin Y (EY) as photosentizer and triethanolamine (TEOA) as electron donnor. In a typical experiment, 1 mg of 80-20NaOH-PMO@Co or 90-10NaOH-PMO@Co was suspended into the nitrogen purged CH3CN:H2O (1:1) solution containing certain quantity of EY and TEOA. After irradiation with visible light (>400 nm), the hydrogen evolving activity of the catalyst was examined by monitoring the headspace gas by GC at different time intervals.

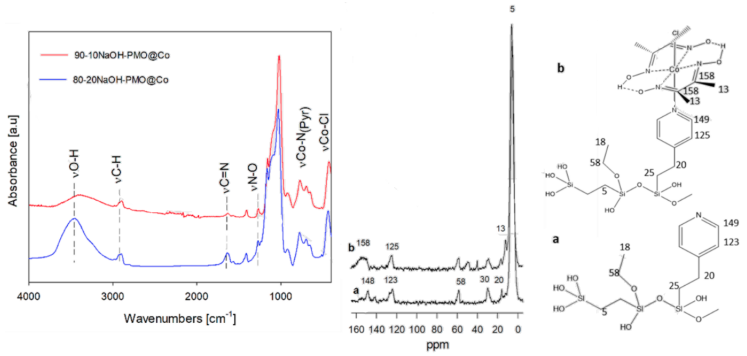

Figure 3: FT-IR spectra of catalyst (left) and 13C NMR of 80-20NaOH-PMO (a) and 80- 20NaOH-PMO@Co (b) (right)

As can be observed the hydrogen evolution reaction (HER) (Fig 4) was carried out during 4h. The maximum amount of hydrogen was produce after 4 hours of irradiation. The 90- 10NaOH-PMO@Co catalyst produced 8 mmol H2/gr catalyst with a TON of 150, however the 80-20 NaOH-PMO@Co catalyst produce 18 mmol H2/gr catalyst with TON of 112.

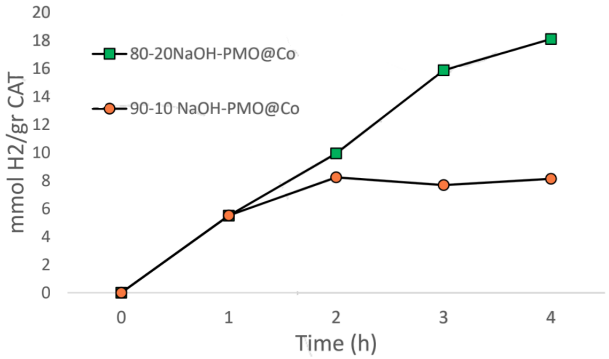

Figure 4: Photocatalytic hydrogen reaction of 80-20NaOH-PMO@Co and 90-10NaOH- PMO@Co

Acknowledgments

The authors are grateful to Ramon Areces Foundation, Spanish Ministry of Science, Innovation and Universities (Project RTI2018-101611-B-I00) and Feder Funds for financial support. The technical support from IUIQFN and SCAI are greatly appreciated.

OM03:
Multi-objective optimization of the construction variables of a housing typology in the Metropolitan Region of Chile incorporating Pinus radiata wood impregnated with a phase change material

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The demand for air conditioning and heating in the residential sector has increased in the last few years because of climate change and demographic and economic growth. However, this increase in energy consumption generates more greenhouse gas emissions. For this reason, this work proposes a methodology that allows reducing the HVAC energy consumption and increases the thermal comfort levels of the occupants of a representative dwelling of the Metropolitan region in Chile. This goal requires choosing a representative dwelling of the housing stock of the climatic zone from the National Housing Monitoring Network. Furthermore, a typology that fits the selected house was validated. The selected design parameters correspond to the type of windows, type and thickness of ceiling insulation, and type of PCM-impregnated Pinus radiata wood panel, with melting temperatures between 8 and 27 °C. Subsequently, the hours of thermal discomfort and the electrical consumption of heating and cooling of the dwelling typology were minimized with the multi-objective optimization NSGA-II. Therefore, the discussion focuses on the set of optimal solutions. Finally, an economic feasibility analysis was carried out using the net present value, internal rate of return, and the discounted payback period. The main results were a reduction of up to 17.3% in the thermal discomfort hours and a decrease of 45.6% in electricity consumption associated with heating and cooling of the optimal housing typology compared to the base case. In addition, according to the economic analysis carried out, the payback period is 12 years.

Agradecimientos

This work was developed in the context of the Fondecyt 1201520 Project "Preparation and characterization of a shape-stabilized phase change material based on Pinus radiata wood for housing applications in Chile".

OM04:
Photodegradation of methylene blue using amorphous films of ZnO and ZnO/CuO photochemically obtained

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ZnO amorphous films doped with 0.7-5.0 mol % of CuO has been synthetized by a photochemical deposition method followed by an annealed at 600 °C. The films photo-deposited on silicon substrates were characterized by X-ray diffraction (XRD) and by scanning electron microscopy (SEM), with the purpose of studying its structure and morphology, respectively. The results of both characterization techniques demonstrate the amorphous character of the samples. The evaluation of its photocatalytic properties was carried out using methylene blue as a contaminant and using a lamp with sun light source. The results of the photocatalytic properties showed that the ZnO films have a degradation percentage of 70.2% compared to the ZnO/CuO films whose degradation results reach 92.9% in samples doped with 0.7 and 1.0 mol % of CuO. These preliminary results allow us to apply this photochemical methodology in the deposition of other semiconductor oxides as photocatalysts in the degradation of other organic pollutants..

Acknowledgments

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OM05:
How using recycled PET agggregates reduce the ecological footprinting concrete: willingness to pay (WTP) for their potential applications in the construction industry

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Economic growth has accelerated the industrial extraction of coarse and fine aggregates from quarries and riverbeds for the construction industry. Concrete mixtures contribute to global warming in approximately 200 to 300 kg CO2eq by cubic meter. Concurrently, environmental regulations have been tightened by national governments. Furthermore, polyethylene terephthalate (PET) is a widely used compound in the plastic bottle industry that can be used as recycled aggregates in concrete mixtures, by replacing certain proportions of natural aggregates. According to 2020 data, 101,801 tones of PET are consumed in Chile per annum, of which no more than 10% is recycled. This study on the demand for alternative raw materials draws on 112 surveys, 13 semi-structured interviews with relevant actors in the construction and recycling industry as primary data. This study also draws on secondary data to evaluate the potential applications of PET aggregates in concrete mixtures and their ecological footprint - but maintaining their original technical properties. Results showed that most of the potential clients expressed their willingness to pay (WTP) for PET-concrete mixtures - particularly high-income customers – provided that they meet certain construction technical standards. In terms of the ecological footprint of these PET-concrete mixtures, when the replacement of coarse aggregate by 10 mm PET aggregates amounts up to 15-20%, it still shows acceptable technical properties, including compression strength. This entails two positive effects: while the construction industry can partially reduce its needs of stony aggregates, PET waste could be significantly reduced from the environment.

Agradecimientos

The authors acknowledge the valuable funding support of the O'Higgins Regional Government (GORE) to fund this study (FIC project code: IDI 40027684-0). The funding source had no involvement in this research

OM06:
The effect of mesoporous structure of different mesoporous silica prepared from rice husk with potential application in contaminants removals.

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During recent years, a persistent interest of researchers has been in the possibility of developing new, safe, non-toxic, and environmentally sustainable materials using waste and more environmentally friendly processes. Recently, a large part of the research has been focused on the efficient use of biomass to produce engineering materials and value-added products. The crop residues represent one of the largest biomass resources globally. Among them, rice husk (RH) is an abundant and sustainable waste biomass available in the world. These wastes often are discarded or burn for energy recovery, producing rice husk ash, causing great environmental problems for disposal. Thus, rice husk ash (RHA) presents over 80 wt.% of silica. This makes possible to use RH as an alternative cheap source of amorphous silica for the production of silicon-based materials. The most common types of silica materials in the mesoporous pore size range are MCM-41 and SBA-15, with hexagonal pore structure, which have been applied as supports for various catalytic active species due to their high specific areas and pore volumes. The main objective of the present work was synthesizing siliceous mesoporous materials (MCM-41 and SBA-15) using a commercial organic silica and a natural, non-toxic, and cheap source of silica. This last synthesis methodology is effective, simple, and more environmentally friendly. The pure silica supports were modified with different loadings of Fe and a multi-technique characterization was employed. The chemical and physic properties of mesoporous solids synthesized from rice husk were similar to those of supports synthesized from commercial silica by conventional method.

Acknowledgments

The authors are grateful to Universidad Tecnológica Nacional (UTN-FRC) and Consejo Nacional de Investigaciones Científicas (CONICET) for the financial support

REC: Renewable Energy Conversion

REC01:
Valorization of a regional waste employing a modified natural zeolite

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The goal of this study was the valorization and recycling of residual biomass from the agro-alimentary industry with the aim of promoting the circular economy. Peanut shells (PS) were selected as feedstock since they lack value added applications and their abundance and local concentration make them of easy availability. Considering that clinoptilolite is the most abundant natural zeolite on Earth, it can be used for the development of low-cost catalysts. In this sense, clinoptilolites were modified by iron (Fe) incorporation and employed as heterogeneous catalysts for in-situ PS catalytic pyrolysis. The metal was incorporated to the zeolites by ion exchange. The material obtained was extensively characterized by means of X-Ray Diffraction, Infrared Fourier Transform Spectroscopy, BET surface area, UV–vis Diffuse Reflectance Spectra and Temperature Programmed Reduction. PS pyrolysis and bio-oil upgrade were simultaneously carried out in a fixed bed glass reactor at 500 °C, for 10 min. Chemical composition of the bio-oil was assessed by the GC-MS technique. Results showed an important reduction in organic acids' yield, from 43 wt% in thermal runs, to 8 wt% in catalytic runs and a significant increase in selectivity towards phenols and alcohols; from 14 wt% to 24 wt% and 20 wt% to 27 wt%, respectively.

Acknowledgments

The authors of this work would like to thank Universidad Tecnológica Nacional (PID UTN 6562), Ministerio de Ciencia y Tecnología de Córdoba (PIOdo18) and Consejo Nacional de Investigaciones Científicas y Técnicas (CONICET).

REC02:
The challenge of constructing a pilot-scale solar absorption refrigeration system

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About a third of vegetable food production is lost because of the lack of refrigeration equipment. One of the most common methods for food conservation is conventional compression refrigeration, which require high electrical power. An alternative to compression systems is absorption refrigeration which requires a minimum electrical energy power, while it mainly uses thermal energy that can be obtained from solar thermal collectors or waste heat energy. This work presents the challenges and lessons learned during the construction of a prototype of a solar absorption refrigerator under the project FIC BIP 30485945, "Solar Refrigeration for Agriculture and Aquaculture", funded by the Regional Government of Coquimbo, Chile. The design, construction, and the first tests of the system, emphasizing technological challenges and innovative solutions are presented and discussed. It is expected that the results obtained will be beneficial for the application of this technology to small-scale agriculture and aquaculture in Chile and abroad.

Acknowledgments

This project was funded by the Regional Government of Coquimbo (Chile) through grant FIC BIP 30485945 "Solar Refrigeration for Agriculture and Aquaculture"

REC03:
Study of the energy efficiency of Lithium-Sulfur batteries using different current collectors

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Despite lithium–sulfur batteries researching have attracted great interest in the last years for its high specific capacity, energy density and low cost, the main problems derived from sulfur such as insulating nature, volumetric expansion, and the shuttle effect of the polysulfides, still stop its final commercialization. Recently, numerous progresses have been made in the design of advanced materials for carbon/sulfur composite cathodes, protective coatings in Li anodes, novel additives in the electrolytes, and modified separators or interlayers. [1] Nevertheless, to date only three commercial current collectors are used in Li–S batteries: Al foil (Al), carbon-coated Al foil (Al- C), and carbon paper (gas diffusion layer, GDL). In this work, an exhaustive study of electrochemical response and post-cycled characterization of these collectors has been carried out in two different carbon/sulfur composites. In both systems, the cathode electrodes supported on GDL showed higher specific capacities and greater capacity retentions than those supported on Al and Al-C. The explanation for these differences lies mainly in the SEM images, which revealed a rough and cracked surface on GDL formed by the agglomerated carbon particles that provide a hierarchical system of mesopores and macropores. Thus, these textural properties achieve a strong fixation of the active material on the collector surface, in addition to enhancing the impregnation of the electrolyte and favoring redox reaction kinetics, as opposed to Al-based collectors with smooth and non-porous surfaces, which do not guarantee an optimal impregnation of active material by the electrolyte, causing poor charge-transfers and great cell polarization. [2]

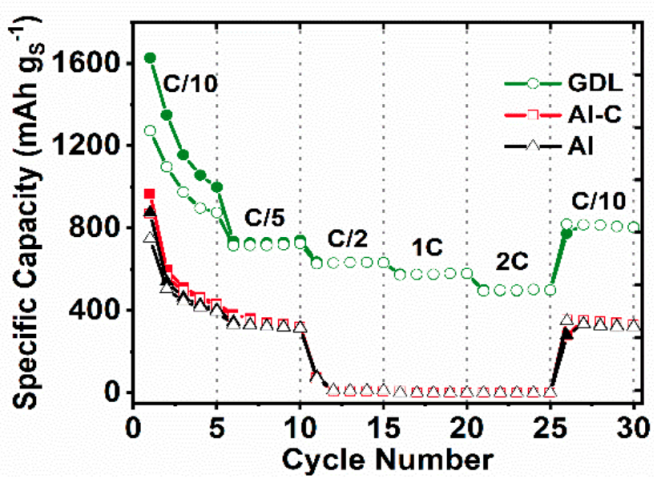

Figure 1: Rate Capability test of carbon black/sulfur composite supported on different collectors

Acknowledgments

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REC04:
On and off grid study of levelized cost of green hydrogen in different locations of Chile considering logistic and geographic conditions

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Chile has been recognized for its high potential for green hydrogen production due to its high availability of renewable energies. However, most of the studies carried out to calculate the Levelized Cost of Hydrogen (LCOH) do not consider the effect of the storage and delivery scheme. These simplifications tend to underestimate the LCOH. This work studies the effect of variable renewable energies (solar, wind) and logistic conditions in the LCOH based on a PEM electrolyzer in two locations in Chile. Scales of production, storage, on/off grid scenarios, and daily to quarter delivery schemes are analyzed. Compressed hydrogen using a multistage compressor is considered as storage system.

The LCOH is calculated and minimized using FICO Xpress Workbench, which is a software that allows the optimization of linear models selecting automatically the most suitable solver. The model developed uses hourly data of Solar and Wind energy and optimizes the nominal size of equipment, including the electrolyzer, compressors, storage capacity, and solar/wind farm capacities.

The results indicate that with the inclusion of delivery schemes restrictions, OFF grid scenarios have a more significant increase in the LCOH than ON grid scenarios due to the variability of renewable resources leading to less flexibility in the hydrogen production and oversizing of equipment. Also, it is obtained that a lower frequency of delivery increases the LCOH in each scenario due to the increase in storage costs. Curtailment of renewable energies showed to be necessary for OFF grid scenarios, decreasing storage costs in the LCOH.

Acknowledgments

This work was supported by the Fondecyt project N° 11201052 from ANID (Chile), entitled "Designing new microgrid business models to maximize energy and environmental value in highly uncertain electricity system", from the Principal Investigator Dr. Sebastián Oliva Henríquez.

SEC: Semiconductor Materials for Energy Conversion

SEC01:
Development of optimized photovoltaic devices: dye-sensitized solar cells with gold nanoparticles

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Dye-sensitized solar cells (DSSCs) were first described by Graetzel and O'Regan in the early 1990s, standing out for a simpler manufacturing process and relatively low-cost materials as compared with other photovoltaic devices. One of the strategies to increase cell efficiency is based on the incorporation of metal nanoparticles (NPs) into the photoanode. This approach aims to improve the absorption of photons, and thus photon to electron conversion, through Localized Surface Plasmon Resonance (LRPS) effects. LRPS occurs when the frequency of the light coincides with that of free electron oscillation in a metal, causing the increase of the local field around the NP and subsequently of the absorption of light in the surrounding area. This work includes the synthesis, functionalization and coating with SiO_2 of gold nanoparticles, as well as the incorporation of core-shell Au@SiO_2 structures into TiO_2 photoanodes used in DSSCs. We have analyzed the effect of NPs content on the adsorption process of dye molecules by using UV-Vis absorption and reflectance measurements. These optical studies helped us to optimize dye immersion conditions for preparing the solar cells. We have compared the overall efficiency of conventional DSSCs (with organic dyes synthesized in our research group and commercial ones) and those prepared with photoanodes incorporating gold NPs, paying attention to the effect of NPs content on each photovoltaic parameter (i.e. JSC, VOC).

Acknowledgments

Project: "Design and evaluation of π-conjugated systems for optical and photovoltaic applications". (-SOPHIA) State Investigation Agency. DB thanks the Aid Program for Doctoral Studies Santander-UZ 2018. ID thanks DGA PhD fellowship. Authors would like to acknowledge the use of Servicio General de Apoyo a la Investigación-SAI, Universidad de Zaragoza.

SECo2:
Light as a construction tool of CeO_2 thin films co-doped with Er/Pr and their evaluation on NIR emissions

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The development of methods for the synthesis of metallic or metal oxide nanostructures (e.g. nanoparticles, nanowires, nanotubes and thin films) has been a subject of interest in diverse fields. One of these concerns is the search for environmentally friendly methodologies, avoiding the generation of toxic waste and that do not involve large energy costs in the process. In this context, photochemical deposition methods respond to these requirements.
In recent decades, there have been proposed methods of photochemical deposition based on the use of UV light for preparation of thin films of ceramic materials or metal nano-particles deposited on substrates diverse. In a general way, the photo-deposition process takes place when the chromophore of a complex absorbs a photon resulting in a photoexcited state, then, the complex may decompose by a photo-redox reaction to produce a solid metallic phase able to deposit over the substrate surface. Some of these deposition methods, are: Photochemical deposition technique (PCD), Photochemical synthesis or Photochemical process, Photo-deposition from colloid solutions (PDCS), Photocatalytic deposition, Liquid phase photo- deposition (LPPD) and Photochemical metal organic deposition (PMOD).
CeO_2 has gained much attention as a host matrix as well as an activator of phosphor materials because it has a strong absorption of UV light through the charge-transfer (CT) transition from O^{2-} to Ce^{4+} and easily takes part in the energy transfer to other activators. Additionally, CeO_2 has low phonon cutoff energy (465 cm^{-1}) and high solubility with rare earth ions. Investigations on rare earth elements, like Er^{III}, Eu^{III}, Sm^{III} and Tb^{III}, incorporated into CeO_2 nanoparticles have been given much attention in a view of their applications in the fields of bioimaging, optical amplifiers, display devices and UV-LEDs.
In this work we propose the preparation of thin films of CeO2 doped with Er and co-doped with Er/Pr by means of PMOD and their evaluation of the optical properties as NIR luminescent materials and as amplifiers devices as prototypes in the development of telecommunications technology.

Acknowledgments

The authors are grateful to the FONDECYT- Chile, Grant No 1190357, for financial support.

SED: Removal of Water and Air Pollution by Semiconductors

SED01:
Chitosan films containing visible light absorbing TiO_2 nanoparticles and their photoinduced self-cleaning and antimicrobial properties under visible and actinic light irradiation

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Sol-gel synthesized TiO_2 nanoparticles modified with urea exhibited visible light absorption between 400 and 500 nm due to the presence of graphitic carbon nitride (g-C_3N_4), demonstrating that urea modification of TiO_2 does not lead to nitrogen doping as it is often reported in the literature. Urea undergoes thermal condensation reactions catalyzed by the presence of Ti-OH species producing melamine as one of the main byproducts, which at temperatures beyond 300 °C, generates g-C_3N_4 structures instead interstitial nitrogen doping. This latter was confirmed by DRIFT and XPS measurements. These nanoparticles were successfully immobilized onto chitosan films through casting method. SEM-EDS micrographs, AFM images, and XPS spectra revealed that modified TiO_2 was mainly incorporated on the film's surface. These films exhibited interesting properties to degrade malachite green dye stains under visible light irradiation ($\lambda > 455$ nm). It was suggested the participation of visible-light photoinduced hydroxyl radicals ($^{\bullet}OH$) and singlet oxygen ($^1O_2$) as reactive oxygen species (ROS) responsible of dye abatement.
On the other hand, under actinic light irradiation (indoor lighting), these photocatalytic films showed a high self-cleaning activity degrading malachite green dye stains after 72 h of continuous irradiation. Furthermore, under the same irradiation conditions, these materials were able to decrease (3 logs) the Staphylococcus aureus cultivability after 3 h of actinic irradiation. Regarding their reusing, films exhibited the ability of photo fade malachite green stains after 5 reusing cycles (15 days) of continuous actinic light exposure.

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SED02:
Synthesis of BiOI/magnetite heterostructures for photocatalytic degradation of phenolic compounds in water

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Currently, conventional wastewater treatments are not efficiently to remove organic compounds difficult to degrade. In this contex, advanced oxidation processes (AOP) are a good alternative to remove persistent organic compounds, due to their high oxidizing capacity. Heterogeneous photocatalysis is a fast, low-cost advanced oxidation process using solar radiation. In addition, this process have demonstrated a high efficiency in the degradation and mineralization of different pollutants.

Bismuth oxyiodide (BiOI) has been studied as a potential semiconductor for the removal of organic pollutants with low biodegradability, due to its high photocatalytic activity at a laboratory scale under simulated solar radiation. However, pure BiOI shows problems in the separation, recovery and reuse processes for its possible application at industrial scale. Therefore, it is necessary to immobilize BiOI for application a larger scale. A good alternative is use of a magnetic material, due requires an external magnetic force with minimal energy expenditure is necessary to separate photocatalyst from treated water.

This study synthesized using solvothermal method BiOI / magnetite heterostructures by varying stoichiometric ratios between Bi and Fe (x / y) to determine the best photocatalytic performance on model compound (caffeic acid). Preliminary results show a 40% degradation of caffeic acid in water using BiOI / magnetite with a molar ratio of 3:1.

Keywords: *Bismuth oxyiodide (BiOI), magnetic material, heterogeneous photocatalysis.*

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SED03:
Photocatalytic system to reduce fecal coliform in water used for irrigation of vegetables in the region of Coquimbo, Chile.

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The global importance that the implementation of the 2030 Agenda for Sustainable Development has acquired, urges us to seek agricultural practices that improve the yield and safety of crops, increase productivity and are sustainable over time. The objective of the research was to evaluate the efficiency of a photocatalytic process, in the reduction of fecal coliforms in the water used for the irrigation of vegetables. For this, four water samples were analyzed, one from an irrigation canal without treatment and another three treated with a commercial photolysis system in the field, photolysis in the laboratory and a prototype based on heterogeneous photocatalysis, using UVC + TiO2 light. The results obtained from all the samples analyzed without treatment exceed more than 10 times the NCh 1333. When analyzing the results of the treatments in which photolysis was applied, in the first contact with light there is an approximate reduction of 45%, at 5 minutes are still out of the norm and the 15 minutes resulted in a 100% elimination of pathogens. On the other hand, in heterogeneous photocatalysis treatments it is much more efficient, since, from the moment the water is exposed to light until 5 minutes, there is an evident decrease in the presence of fecal coliforms, reaching 0 CFU / 100ml. Consequently, this research shows great potential in relation to the improvement of water and the efficient use of this resource.

Keywords: *photocatalytic, irrigation, fecal coliforms, efficiency, safety, 2030 agenda*

Acknowledgments

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SED04:
Reduced graphene oxide modified anatase “black TiO_2” nanosheets with exposed {001} facets towards photocatalytic oxidation of Endocrine Disrupting Chemicals (EDCs) under natural Solar light irradiation.

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Endocrine disrupting chemicals (EDCs) in particular medicines, pesticides, detergents and industrial chemicals at very small (ng/L) concentration cause serious health and environmental effects. Unfortunately, conventional wastewater treatment systems are limited to complete removal of EDCs. Heterogeneous photocatalysis has emerged as one of the best technologies for complete removal of toxic contaminants from water. Titanium dioxide (TiO_2) has been by far the most used photocatalyst for environmental remediation. However, its implementation at industrial scale is restricted by TiO_2 deactivation, competing reactions and low adsorption capacity towards EDCs. Considering the above facts, the present work aimed to overcome the limitations of TiO_2 photocatalysts through modification of it’s bandgap, crystal facet, size and shape by simple solvothermal and solid face reaction. More specifically, anatase {001} black TiO_2 nanosheets (NShTs) was synthesized and it’s surface was modified with reduced graphene oxide (rGO). Synthesized photocatalysts were characterized in detailed using different characterization techniques (HRTEM, SEM, XRD, Raman spectroscopy, DRS, FT-IR, and BET). Photocatalytic efficiency of synthesized photocatalysts were assessed using Bisphenol-A as a target pollutant under natural solar light irradiation. In addition, photocatalytic activity was compared to benchmark TiO_2 (Degussa P25). The rGO modified {001} black TiO_2 NShTs boosts the photocatalytic activity through their virtue of visible-light absorption properties and the rapid electron-hole separation at the rGO {001} black TiO_2 NShTs interfaces. The above results suggest that rGO modified {001} black TiO_2 NShTs could be used for the effective removal of various EDCs in large wastewater treatment plants by exploiting natural solar light source.

Acknowledgments

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SED05:
TiO_2 nanowires doped with hæmatite nanoparticles for enhanced photocatalytic degradation of methyl orange

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Haematite nanoparticles with a truncated dodecahedron crystal shape were synthesized by hydrothermal method at 180 °C and self-generated pressure. $FeCl_3.7H_2O$, acetic acid and NaOH were employed as precursors. This crystal shape has an improved performance in the photo-Fenton reaction due to terminal Fe exposure. The nanoparticles were previously characterized and further added to a sol-gel mixture to prepare the TiO2 nanowires with a coaxial setup for the electrospinning. The composite nanowires were characterized through HR-TEM, UV-Vis DRS, TGA and XRD and tested in the photodegradation of methyl orange with the addition of H_2O_2. Rutile and anatase and hematite were identified in the diffraction patterns. By TEM it was possible to confirm a good nanoparticle dispersion along the nanowires. The nanowires showed an improved absorption in the visible spectrum compared to that of pure TiO_2. The discoloration yield was 85% after 2 h of reaction. This result is comparable to the one obtained with a suspension of hæmatite nanoparticles alone. It should be noted that the colourant discoloration under UV activated H_2O_2 reached only 40%. In conclusion, these composite nanowires have two attractive features with regard to water treatment technologies, namely the advantage of easy recovery and the possibility to carry out the reaction without H_2O_2, due to the enhanced semiconductor capacity of TiO_2.

Acknowledgments

Authors wish to thank CONICET and Universidad Tecnológica Nacional (PID 6562).

WMU: Water Management and Sustainable Water Usage

WMU01:
Efficient treatment of landfill leachates using sequential processes: coagulation followed by persulfate/H_2O_2/US/UV oxidation

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Conventional physical-chemical processes have been normally used in the treatment of stabilized leachate. In this work, a series of sequential processes are applied including coagulation-flocculation (C-F) pretreatment followed by a post-treatment step based on a sulfate/hydroxyl radicals-advanced oxidation process using persulfate (1500 mg/L), H2O2 (1327 mg/L) activated by ultrasonic (US) waves and ultraviolet (UV-A) light for the treatment of leachate from the landfill of Fez city (Morocco). Results showed a reduction of 71% of chemical oxygen demand (COD) and 95% of turbidity of the raw stabilized leachate after the C-F pretreatment step. Additionally, 89% of COD removal was achieved after the application of H_2O_2-$S_2O_8^{2-}$–US-UV. However, a lower COD removal efficiency (19%) was obtained when $S_2O_2^8$- was applied alone. Therefore, the application of sequential processes allowed to obtain a total removal of COD, absorbance at 254 nm, and color number of 97%, 97%, and of 99%, respectively. The sequential application of AOPs after preliminary treatment using coagulation-flocculation is a promising alternative to reducing the high organic load of stabilized leachate.

WMU02:
Advanced oxidation processes for treatment of stabilized leachate from the controlled landfill of Fez city (Morocco): comparison study

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Nowadays, Morocco is making considerable efforts to reduce the harmful effects of leachate from landfills. In order to achieve national liquid discharge standards and international agreements, new treatment processes are under development and implementation. This work aimed to assess different advanced oxidation processes (AOPs) based on hydroxyl and sulfate radical generation for the treatment of stabilized leachate from the controlled landfill of Fez city. The efficiency of Fenton, photo-Fenton, Fenton-like, photo-Fenton-like, and sulfate radicals-based oxidation was compared based on chemical oxygen demand (COD) and color removal. Different oxidation agents (H_2O_2, UV-A, Fe^{2+}, Fe^{3+}, $S_2O_8^{2-}$) and combined systems were applied in each treatment process (Fe^{2+}/H_2O_2/UV-A, Fe^{2+}/H_2O_2, Fe^{2+}/UV-A, H_2O_2/UV-A, Fe^{3+}/H_2O_2/UV-A, Fe^{3+}/H_2O_2, Fe^{3+}/UV-A, PS/Fe^{2+}/UV-A, PS/Fe^{2+}, PS/UV-A). Results showed a variety of efficiencies for the different applied AOPs. Maximum removal values of 85%, 96%, and 98% for COD, color, and BOD5 were obtained, respectively. These findings may open up new perspectives to use AOPs as efficient treatments for the removal of the organic load of highly hazardous leachates.

WMU03:
Evaluation of water consumption in hybrid cooling system under several climatic conditions

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This study analyzes and compares hybrid cooling systems versus a conventional wet cooling system, implemented in a Data Center, under different climatic conditions. The objective of this research is to quantify the impact of climatic conditions on the proposed systems in terms of water consumption, determining which of them is the most favorable. The Data Center used must dissipate 713 kW, which is composed of: CRAH, Chiller and a heat dissipation system, using wet cooling towers (Marley NCF8402) and dry condensers (MECALOR DC-400). In the last stage, two hybrid cooling systems are modeled, whose difference is the spatial distribution of the subsystems that compose it, which are: series hybrid cooling system and parallel hybrid cooling system. The thermodynamic equations are solved in the Engineering Equation Solver (EES) software. Preliminary results show the average percentage decrease of a typical year of make-up water by climate, with respect to a conventional wet cooling system, which are: Desert Climate 56.2% and 55.8%; Mediterranean Climate 57.5% and 56.4%; Temperate Rainy 56.9% and 56.1%; Tundra 60% and 56.3%, corresponding to the series and parallel system respectively. It is expected to select technologies for each of the study locations, which are competitive in comparison to the most used technologies, minimizing the use of hydric resources in Chile.

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WMU04:
Sustainability and Clean Energies in illegal settlements, Valparaíso region, Chile

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Poverty levels in Chile increased to 4.3% in the pandemic period, according to the report of June 2021 by the Ministry of Social Development and Family, which had an impact on the reactivation of illegal settlements in the periphery of the main cities, as a result of the loss of jobs or their precariousness, causing among other problems: household wastewater discharges without any treatment, in addition to irregular connections to the electricity system, a "camp" settlement in the city of Viña del Mar, through a survey on the ground and contact with the communities, 50 families, their requirements, emergencies and pains were established, which translated into concrete proposals for self-sufficiency, reuse of their wastewater, incorporation of renewable energies in a solidarity scale, accompanied by instances of community relations with instruction in environmental sustainability and energetic, taking 35 homes as an example, giving them easily understood technical tools, so that they can carry out their maintenance themselves and can work collaboratively, promoting good practices in the existing circularity paradigm, in this way the presence of sanitary vectors would be reduced, also minimizing the electrical risks of overload, also including energy efficiency strategies, improving the quality of life, in a precarious environment and social inequity.

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WMU05:
Property rights: are they a good idea for water policies addressing climate change effects? A comparative analysis of Australia and Chile

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Property rights applied in water governance are now at the center of the debate over natural water resources allocation against a backdrop of dramatic climate change. Water resources thus have been significantly altered in terms of their geographical distribution and availability due to climate change and human activities. In this context, property rights have been widely criticized by allegedly causing water scarcity through unfair and inefficient allocations of this natural resource. This review explores two countries where property rights have been applied by national states to regulate water usage: Australia and Chile. I used a comparative social research analysis to investigate the reasons for differences or agreements between those two cases, drawing on secondary qualitative and quantitative data. Both Australia and Chile have similar climatic challenges for water management and most of their water usage is for agricultural purposes: between 50-70% per annum in the former case and more than 80% per annum in the latter. The evidence so far shows that while severe droughts have increased conflicts over water resources and political instability in some cases, agricultural investments and food security have been greatly benefited from establishing water property rights. The quality of institutions related with water governance, however, remains as an important barrier to the efficient access of water resources and the development of a credible water market, particularly in the Chilean case. Overall, poor institutions and climate change effects combined can overmine such a credibility, triggering counterproductive populist pressures from politicians and activist groups.

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