Scientific Day

On

Methanization and Waste Valorization

Boumerdes - Algeria, December07, 2025

Book of Abstracts

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Content

The growing challenges related to environmental protection, energy transition, and sustainable waste management have placed methanization and waste valorization at the heart of global scientific and industrial priorities. Methanization, as a biological process that converts organic waste into biogas and digestate, represents a strategic pillar for the development of renewable energies and the reduction of greenhouse gas emissions. At the same time, the valorization of municipal, agricultural, and industrial waste offers major opportunities for creating circular, low-carbon systems that contribute directly to regional and national development. This Scientific Day aims to bring together researchers, professionals, industrial actors, and decision-makers to discuss the latest advances, share innovative practices, and promote collaborative approaches for sustainable waste management and efficient bioenergy production.

Themes of the scientific day:

1. Anaerobic Digestion & Methanization Processes

Focus: Biological breakdown of organic matter in the absence of oxygen to produce biogas (primarily methane and CO2) and digestate..

2. Biogas Production, Upgrading, and Energy Valorization

Focus: From raw biogas to usable energy and applications; upgrading to biomethane (CH4-rich) by removing CO2 and impurities.

3. Waste Valorization & Circular Economy

Focus: Turning waste streams into valuable products to close resource loops.

4. Policies, Regulation & Socio-Economic Aspects

Focus: The policy, legal, and social environment shaping deployment of bioenergy and waste valorization.

5. Digitalization & Smart Monitoring

Focus: Data-driven management of biogas and waste valorization systems for performance, reliability, and optimization.

The scientific committee and the organizing committee will spare no effort to ensure that the scientific aspects are beneficial: adhering to presentation time limits, providing explicit answers to questions raised, clarifying any unresolved points with the moderators and experts present, continuing discussions during coffee breaks, and engaging in in-depth deliberations on the works presented.

Objectives of Day

*The Organizing Committee is pleased to announce the **Scientific Day on Methanization and Waste Valorization**, an event dedicated to the latest scientific, technological, and industrial advancements in the fields of bioenergy and sustainable waste management. Researchers, engineers, professionals, and experts are warmly invited to submit their contributions for presentation.*

Moreover, the doctoral students will undoubtedly find in this day one of the privileged spaces to gather information that will help them successfully complete their theses. Finally, contacts will be established between academics and industry professionals, potentially leading to mutually beneficial agreements.

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LISTE OF ABSTRACTS

Plenary 1

Dr. Issiakhem Mourad, Commissariat aux énergies renouvelable et à l'efficacité énergétique (CEREFE)

Dr. Mourad Issiakhem is an Algerian expert in energy efficiency, serving as Director of Energy Efficiency at the Commission for Renewable Energies and Energy Efficiency (CEREFE). He is recognized as a state-certified energy auditor and an international trainer in this field, advocating for the updating of regulations on energy management and efficiency.

Energy recovery from waste in Algeria

Energy recovery from waste represents a strategic opportunity for Algeria to address multiple challenges simultaneously, including waste management, energy diversification, and environmental protection. With rapid urbanization, population growth, and changing consumption patterns, Algeria generates increasing amounts of municipal solid waste, agricultural residues, and industrial by-products. Most of this waste is still disposed of in landfills, often without energy valorization, leading to environmental pollution and greenhouse gas emissions.

Algeria's strong dependence on fossil fuels for electricity and heat production highlights the importance of exploring alternative and sustainable energy sources. Waste-to-energy (WtE) technologies—such as anaerobic digestion, landfill gas recovery, incineration with energy recovery, and biomass conversion—offer viable solutions to convert waste into useful energy in the form of electricity, heat, or biogas. In particular, organic waste, which represents a significant fraction of Algerian municipal waste, has high potential for biogas production through anaerobic digestion.

The recovery of energy from waste can contribute to national energy efficiency and renewable energy goals by reducing primary energy consumption and lowering methane emissions from uncontrolled landfills. It also supports the circular economy concept by transforming waste into a valuable resource rather than an environmental burden. Furthermore, decentralized waste-to-energy systems could be especially beneficial for remote or rural areas, where access to centralized energy infrastructure is limited.

Despite its potential, the development of energy recovery from waste in Algeria faces several barriers, including insufficient waste sorting at the source, limited technical expertise, high initial investment costs, and an incomplete regulatory and institutional framework. Strengthening policies, updating regulations, and encouraging public–private partnerships are essential steps to overcome these challenges. Capacity building, awareness campaigns, and pilot projects are also crucial to demonstrate the technical and economic feasibility of waste-to-energy solutions.

In conclusion, energy recovery from waste in Algeria is a promising pathway toward sustainable development. By integrating waste management strategies with energy planning, Algeria can reduce environmental impacts, enhance energy security, and promote a more sustainable and resilient energy system.

Plenary 2

Dr. Boudraa Akila, Agence nationale des déchets (AND)

Dr. Akila Boudraa is an official at the National Waste Agency (AND) in Algeria, specializing in the recovery of household and similar waste. She actively promotes the circular economy, emphasizing the high economic potential of recycling and the national objective of recovering 30% of waste by 2035.
Role: Head of the Household Waste Department at the AND.

Circular Economy In Algeria

The market value of valued municipal and similar waste in the first half of 2022 stands at 243 billion dinars, announced by a official at the National Waste Agency (AND).

Akila Boudraa, head of the municipal waste department at the AND, stated that "the sector of valorization of municipal and similar waste has recorded significant progress since 2022, as the market value rose from 151 billion DA in the second half of 2021 to 243 billion DA in the first half of 2022."

According to the same official, "this qualitative leap was achieved thanks to the increase in revenues of the plastic recycling sector." She recalled the incentive measures and benefits offered by the AND to operators in the waste valorization field, notably through its information bank, which facilitates coordination among them and access to market indicators to implement their projects with the possibility of obtaining waste prices on the market.

Regarding the waste exchange, "it is a digital platform allowing operators and stakeholders in the valorization field to publish their ads related to the sale of recycled waste and to benefit from the AND's technical support to obtain solutions to on-the-ground problems they encounter."

The number of operators registered with the National Center for Commerce Register (CNRC) active in the field of waste management and valorization stands at 32,000 enterprises for the year 2022.

The CNRC, Ms. Boudraa clarified, currently has 18 activity codes related to valorization and recycling of all types of waste, adding that "a new code will be established soon in coordination with the Ministry of Environment and Renewable Energy and the Ministry of Commerce and Export Promotion." Algeria aims to valorize 30% of municipal and similar waste by 2035, which will create 18,000 direct jobs.

Plenary 3

Pr hachemi Madjid, Director of the Laboratory Energetic, Mechanical and engineering (LEMI), M'hamed Bougara University of Boumerdes, Algeria .Lead of the PNR Project Biogas

Pr. Madjid Hachemi is a lecturer at the University of Boumerdès, specializing in turbomachinery, CFD, and renewable energies (solar, wind, biomass). He actively participates in research in the fields of energy engineering and sustainable development.

Dr Mougari Nour Elislam, Member of the LEMI Laboratory, M'hamed Bougara University of Boumerdes, Algeria. Member of the PNR Project Biogas

Dr.Nour Elislam Mougari is a lecturer at M'Hamed Bougara University of Boumerdès, specializing in energy and environmental engineering. She defended a thesis on farm-scale micro-methanization, Her work is part of research on renewable energy and the valorization of agricultural waste. Her research relies on advanced computational methods, potentially integrating AI tools for simulation or analysis of thermal data.

Dr Himrane Nabil , Head of the Sustainable Energy Systems Team, LEMI Laboratory, M'hamed Bougara University of Boumerdes, Algeria, Member of the PNR Project Biogas

Nabil Himrane is a teacher in the field of energy, mechanics, and engineering, with work focused on the numerical study of thermal comfort in housing. His expertise includes the application of numerical models to optimize the energy efficiency of buildings. Proficiency in artificial intelligence is also expected

National Research Project (NRP) Biogas production from biomass for the autonomy of isolated sites

In a global context marked by the energy transition and the need to diversify renewable energy sources, biogas production stands out as a sustainable and efficient solution. This technology, based on the anaerobic digestion of organic biomass, enables the valorization of agricultural, industrial, and household waste into a renewable energy source.

The NRP project entitled “Biogas Production from Biomass for the Autonomy of Isolated Sites” fits within this dynamic by offering an alternative to fossil energy sources. In Algeria, particularly in the southern regions, energy supply essentially relies on diesel plants or gas turbines, which incur high costs and a large carbon footprint. Transporting fossil fuels to these isolated areas also poses a major logistical challenge.

The work carried out in the framework of the project’s first stage, dedicated to the preliminary study. This phase includes a synthesis on methanization and biogas valorization, the assessment of the resource base and methanogenic potential of organic waste. It aims to establish a solid foundation for the project development by identifying existing technologies, the challenges to be addressed, and opportunities for innovation.

The results of this first phase will guide the subsequent steps, notably the technical design and the implementation of an optimized methanization demonstrator to supply isolated sites with clean and sustainable energy.

Paper ID: 01

Valorization of Algerian Alfa Fibers into High-Performance PLA Biocomposites for a Circular Economy

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Abstract

The valorization of alfa fibers (Stipa tenacissima), a lignocellulosic resource abundantly available in Algeria, offers a promising strategy to support circular economy initiatives. In this study, these fibers were incorporated into a poly(lactic acid) (PLA) matrix to develop fully biodegradable biocomposites. A natural surfactant was applied for surface modification to improve fiber–matrix compatibility. FTIR analysis confirmed successful functionalization through characteristic ester absorption bands near 1700 cm^{-1} and 1200 cm^{-1}. Thermal analyses revealed significant modifications in PLA behavior after reinforcement. DSC results showed accelerated crystallization and a reduction in crystallinity (χc) at low fiber contents, while TGA indicated a slight decrease in degradation temperatures due to the lignocellulosic nature of the fibers. Mechanical testing demonstrated a pronounced increase in stiffness, with the flexural modulus rising from 4800 MPa for neat PLA to 29,000 MPa for treated composites. SEM observations confirmed improved fiber dispersion and stronger interfacial adhesion. Overall, this study demonstrates the potential of Algerian alfa fibers as a renewable resource for producing high-performance biodegradable composites, contributing to agricultural waste reduction and promoting a sustainable circular economy.

Keywords: *Waste valorization, Alfa fibers, PLA, Thermal analysis, Mechanical reinforcement, Circular economy..*

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Paper ID: 02

A review of AI-Driven Solutions for Enhanced Waste Management and Recycling in Urban Areas

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Abstract

The world today recognizes the importance of modern smart technologies in improving the quality of urban life, within the framework of what is called the sustainable smart city model. These technologies offer numerous opportunities in the field of resource conservation and achieving environmental sustainability in smart ways, including improving and streamlining urban waste management, which was previously largely done manually and traditionally. However, artificial intelligence, machine learning, computer vision, robotics, and other technologies have allowed for a reduction in the need for manual labor, lowering costs, and saving time and effort, while also increasing efficiency. With the burdens of a growing population and the depletion of landfill sites, smart waste management is becoming essential for addressing waste disposal, recycling, and achieving a 360° circular economy. This is necessary to create a healthy and sustainable environment for present and future generations, as well as to change how other types of waste are managed. Therefore, it is crucial for governments to be aware of the technical and commercial benefits of these solutions to promote their adoption and implementation. Leveraging artificial intelligence in waste management will offer significant advantages in improving and streamlining city management. It is therefore essential to promote the integration of smart systems with waste management systems, support startups in adopting these innovative solutions, and encourage scientific and academic research in this field. This article presents the various methods, strategies, and solutions proposed by different researchers worldwide. This literature review will allow us to apply these different solutions to our country, Algeria.

Keywords: *Waste Management, IA, Recycling, Smart Technologies.*

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Paper ID: 03

Date By-Products: A Promising Resource for Vinegar Production

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Abstract

Algeria is one of the world's largest producers of dates, with an annual production of approximately 710,000 tones. A significant portion of this production (around 28%) consists of low-market-value varieties. The valorization of these by-products is a major challenge, offering a way to reduce both the economic losses for the Saharan agricultural sector and the environmental impact. Fermentation processes, particularly the production of acetic acid (vinegar), offer a promising pathway for this valorization. This biochemical process, driven by microorganisms, is influenced by multiple factors: physicochemical conditions, the nature of the substrate, and the nutritional requirements of the microbial strains used. This study aims to optimize the parameters for producing acetic acid from date by-products. The results showed that a maximum ethanol production (33.288 g/L) by Saccharomyces cerevisiae was achieved at 35°C, with a pH of 4 and 0.4 g/L of ammonium sulfate. By applying a Box-Behnken experimental design (BBD), the optimal conditions for acetic acid production by Acetobacter sp. were identified: a temperature of 25.33°C, a pH of 4.28, and an initial ethanol concentration of 1.02% (v/v). This research demonstrates the potential of date by-products as a substrate for acetic fermentation. This valorization could leverage the development of specialized SMEs, generating additional revenue for both farmers and industrials.

Keywords : *Date ; Acetic acid; Fermentation; Box-Behnken.; Valorization.*

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Paper ID: 04

Gas retention measurement for bubbles flow in vertical annulus volume in methanization process

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Abstract

The measurement of gas retention in bubbles evolving within a vertical annular space is a key variable for understanding the flow dynamics in these systems and, consequently, the overall efficiency of methane production processes. Indeed, gas retention directly influences the mass transfer mechanisms between the gaseous and liquid phases, as well as the residence time of the bubbles in the reactor or study zone. This residence time is decisive: it determines the time available for heat and mass exchanges, thereby affecting the rate and magnitude of the metabolic reactions associated with methane production.

From an empirical perspective, the available data on gas–liquid flow maps in vertical rings are numerous and provide a rich set of observations. For example, one can reference a corpus of 3,947 revised experimental points that document the flow configurations and gas–liquid regime states in these annular, vertical geometries.

These datasets offer valuable opportunities to characterize transitions between flow regimes (for example, bubbly, capillary, annular, or pseudo-liquid, depending on the definitions used in the literature) and to establish correlations between gas retention and geometric and operational parameters (inner/outer annulus radius, height, flow velocity, gas volumetric flux, fluid properties, presence of surfactants, etc.).

Keywords: *gas retention; bubble rise/residence time; vertical annulus flow map; methane production; biogas reactor; gas holdup*

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Paper ID: 05

Use of deep eutectic solvents (DES) for green extraction from agricultural waste

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Abstract

This study aims to valorize plant waste, particularly pomegranate peels, as natural sources of bioactive compounds with strong antioxidant and antibacterial potential. A comparative study was carried out using two maceration extraction methods: conventional ethanol extraction and green extraction using a natural deep eutectic solvent (DES) composed of glycerol and lactic acid. Phytochemical analysis by HPLC revealed the presence of polyphenols, tannins, coumarins, and triterpenes, highlighting the chemical richness of the extracts obtained by both methods. Antioxidant activity tests (DPPH and FRAP) showed that the DES extracts exhibited comparable or even superior activity to ethanolic extracts. Antibacterial assays performed on Escherichia coli and Staphylococcus aureus demonstrated the high efficacy of DES extracts. This work highlights the value of natural deep eutectic solvents as sustainable alternatives to conventional solvents and underlines the potential of bioactive compounds derived from agro-industrial waste.

Keywords: *Green Extraction, Valorization of Plant Waste, Deep Eutectic Solvents (DES), Biological Activities*

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Paper ID: 06

Social, Technical and Cost Evaluation of a Pilot Selective Waste Management System in Algeria

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Abstract

Selective solid waste management has gained increasing attention in Algeria, supported by national legislative and regulatory frameworks promoting waste sorting, recovery, and recycling. This study presents the first city-level evaluation of a pilot Polyethylene Terephthalate (PET) selective waste collection and recovery system implemented in two cities in eastern Algeria. An integrated methodology combining social perception assessment, technical performance analysis, and cost evaluation was applied to a voluntary selective sorting program. Social survey results revealed strong public engagement, with 88% of respondents expressing willingness to sort PET waste using dedicated containers. Younger age groups (under 30 and 30–55) showed the highest level of acceptance for the new system, while individuals with higher education demonstrated greater environmental awareness. Technical and cost analyses showed that amortization, personnel costs, and general expenses accounted for 29%, 31%, and 40% of total management costs, respectively. Considering the value chain's outputs, PET sales covered only a limited portion of operational expenses, underscoring the economic challenges inherent in formal PET collection and recovery systems. The results contribute new scientific evidence on selective waste management in Algeria and offer guidance for improving municipal waste strategies, optimizing resource recovery, and aligning national waste policies with sustainable development goals.

Keywords: *PET; Selective Collection; Waste Sorting; Circular Economy; Recovery.*

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Paper ID: 07

Phosphating Reinforcements as Efficient Corrosion Inhibition Method of metals

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Abstract

The corrosion of metals constitutes a major problem which affects the durability of structures. The protection against corrosion can be achieved by means of methods. In this study we focused on the use of bath phosphating method to provide protection of metals against corrosion. Phosphating has been successfully used as a method of protecting metal products and structures from corrosion. The main advantage of the phosphate film is its high resistance to corrosion in all types of fuels, lubricants and organic oils, benzene, toluene and all gases except hydrogen sulfide. In addition to protection against corrosion, phosphating of metals serves as a basis for the application of varnishes, paints, adhesives, oils, waxes, etc. In this optic, we explore the process of bath phosphating which can be of various compositions depending on the nature of the metal and the study environment in order to obtain a resistant layer and durable phosphating coating. Thus, it was concluded that the application of phosphate coatings remains one of the effective means of protecting metals against corrosion.

Keywords: *Phosphating Method, Corrosion, Coating, Metals.*

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Paper ID: 08

Acoustic Emission Technique for inspecting Corrosion in Concrete Reinforcements

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Abstract

The use of non destructive methods have many advantages, it was communally used for detecting the evolution of cracks or deteriorations in structures, besides, these methods can be used to evaluate the state of corrosion is a means of protection and preservation of the strength and durability of reinforced concrete structures, because early detection of the disease serves to avoid damage with the least possible material loss. Corrosion detection methods are necessary to assess the condition of structures in service and act in time before corrosion begins. In this research work; we are interested to the acoustic emission technique for the monitoring of corrosion in existing building. Among the different techniques for evaluating corrosion in structures, and more precisely those linked to the detection of corrosion, the application of the acoustic emission technique in reinforced concrete structures as part of the control of the evolution of corrosion with its advantages and disadvantages. Although this technique has the advantage of providing direct in situ information on the condition of reinforced concrete structures, several disadvantages are reported in this research study.

Keywords: *Monitoring, Corrosion, Acoustic emission Methods, non-destructive*

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Paper ID: 09

Valorization of Lavandula angustifolia Mill Solid Waste: Optimization of Bioactive Compound Extraction

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Abstract

This study focuses on the sustainable valorization of residues generated from the processing of medicinal plants. It evaluates the potential of solid residues obtained during the hydrodistillation of Lavandula angustifolia M. essential oils, an underexploited raw material rich in phenolic compounds with antioxidant and antimicrobial properties. The extraction process was optimized by combining ultrasound-assisted extraction (UAE) with deep eutectic solvents (DES), a new generation of green solvents, to improve efficiency, selectivity, and sustainability. A Box–Behnken experimental design was employed to optimize key parameters, including solvent-to-solid ratio, temperature, extraction time, and DES concentration. Total phenolic content (TPC) and total flavonoid content (TFC) were measured, antioxidant activity was evaluated using the DPPH assay, and antimicrobial tests were performed to assess the bioactive potential of the extracts. The results indicate that higher temperatures and increased DES proportions significantly enhance the extraction of bioactive compounds. Under optimal conditions, the residues yielded high TPC and TFC values (130.54 mg GAE/g and 52.17 mg QE/g, respectively), confirming the efficiency of the method. These findings demonstrate that the solid residues of Lavandula angustifolia M. constitute a sustainable source for chemical and energy valorization, highlighting the potential of biotechnology to transform by-products into high-value resources.

Keywords : *Lavandula angustifolia M, Ultrasound-Assisted Extraction (UAE), Deep Eutectic Solvents (DES), Box–Behnken Design, Phenolic Compounds.*

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Paper ID: 10

Valorization of Plant Extracts for the Green Fabrication of Bioactive Hexagonal ZnO Nanoparticles

BRIKI Meryem[1], Benrahou Fatima[1]*, Younsi Ferroudja[1]* and Kheira Haiouani[2]**

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2- Department of Chemistry, Faculty of Exact Sciences and Informatics, Djelfa University, Algeria.

Abstract

The sustainable synthesis of zinc oxide nanoparticles (ZnO NPs) using plant-derived biomolecules offers a promising route for waste valorization within a circular economy framework. In this study, hexagonal ZnO NPs were successfully synthesized through a green approach employing combined extracts of Syzygium aromaticum (clove) and Thymus capitatus. By optimizing key synthesis parameters, particularly $ZnCl_2$ and extract concentrations, hexagonal ZnO NPs were obtained. The produced ZnO NPs exhibited a uniform hexagonal morphology. SEM–EDX analysis confirmed their elemental composition and revealed a substantial carbon content (63.9 wt. %), indicating effective surface functionalization by phytochemical constituents, thereby valorizing bio-extract residues as capping and stabilizing agents. UV–Vis spectroscopy showed a characteristic absorption peak at 370 nm and reduced band gap energy of 2.8 eV. The nanoparticles demonstrated outstanding biological activities, including a DPPH radical scavenging efficiency of 95.2% and strong antibacterial effects against both Gram-positive and Gram-negative strains. Overall, this work highlights the integrating plant-based extracts as renewable, low-impact resources for the synthesis of functional ZnO NPs. The findings emphasize the potential of such bio-enabled nanomaterial in supporting circular economy principles through reduced energy consumption, valorization of natural residues, and development of high-value antimicrobial and antioxidant agents for biomedical and environmental applications.

Keywords : *Antioxidant activity, clove oil, photocatalytic activity, zinc oxide nanoparticles.*

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Paper ID: 11

Mo-Doped NiAl Alloys for Advanced Energy Applications

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Abstract

Waste valorization and energy production are now major challenges for energy transition and sustainable development. The efficiency of energy-conversion processes strongly depends on the materials employed, particularly their ability to catalyze key reactions such as hydrogen production through water electrolysis. Nickel–aluminum (NiAl) alloys exhibit excellent electrochemical stability but generally show limited catalytic activity. In this study, a low molybdenum doping level (< 2 at.%) was introduced into the NiAl matrix to evaluate its impact on the structural, morphological, and electrochemical properties of the alloy. X-ray diffraction (XRD) analyses revealed that the overall phase composition of NiAl remained unchanged after Mo incorporation. Microstructural characterization showed a more porous and developed surface after activation, with the roughness increasing from 5 to 60 nm and the electrochemically active surface area (ECSA) rising from 23% to 91.6%. Electrochemical tests demonstrated a significant enhancement in catalytic activity, with a maximum current density of 120 $mA \cdot cm^{-2}$ at 2.5 V, compared to 50 $mA \cdot cm^{-2}$ for pure NiAl, along with improved long-term stability. These findings indicate that even a small amount of molybdenum effectively activates NiAl alloys, offering a promising approach to improving material performance for energy-related applications, particularly water electrolysis for hydrogen production.

Keywords : *NiAl alloys, molybdenum doping, electrocatalysis, energy valorization*

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Paper ID: 12

Numerical study on the effect of Hydrogen Addition to Methane on Swirled Premixed Combustion

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Abstract

Pre-mixed combustion stabilized by swirl has attracted considerable interest in the industrial sector. It is widely found in various thermal power engineering devices, including furnaces, boilers, engines, and gas turbines. This has prompted several researchers to improve how these burners work to enhance their efficiency and reduce their emissions. Furthermore, these emissions can be lowered in some cases through combustion techniques, particularly very lean combustion combined with renewable energy solutions. The gradual integration of hydrogen (H_2) into methane (CH_4) is being considered as a solution to reduce NOx and CO emissions while improving combustion performance. The objective of this work is to characterize the impact of adding 40% hydrogen to methane on the premixed combustion of an LSB burner on flame structure, maximum temperature, and pollutant emissions. The results show an improvement in flame stability as well as a reduction in NOx and CO emissions.

Keywords*: premixed combustion, methane, Hydrogen, low swirl burner.*

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Paper ID*:* 13

Hydrogen utilization in gas turbines

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Abstract

This study presents a numerical simulation of the effects of pressure on turbulent CH_4–H_2 flames. The burner under investigation is designed for gas turbine applications used in power generation. The geometry is cylindrical, featuring 9 radial vanes that generate a swirling flow. All simulations were conducted at an equivalence ratio of 0.55 and an inlet temperature of approximately 570 K.

A 3D approach was adopted, utilizing the realizable k-ε RANS model for turbulence modeling, the PDF (Probability Density Function) model for chemistry, and a NOx model for pollutants. The analysis focused primarily on the thermal and dynamic fields (velocity and temperature), as well as the formation of NOx and CO.

The results demonstrate that the increase in power induced by higher pressure did not significantly affect the flow or the flame structure. Variations in the size and position of the Central Recirculation Zone (CRZ) and the Outer Recirculation Zone (ORZ) were observed, though flame stability remained uncompromised. However, the increase in power naturally leads to a more intense heat release rate, resulting in higher NOx generation: rising from 5.5 ppm to 11.2 ppm for a power increase from 84 kW to 840 kW. These values remain acceptable given the power levels achieved. Conversely, this variation led to a decrease in CO emissions, dropping from 10 ppm to 4 ppm over the same power range, due to the intensification of the reaction rate.

The data obtained show that CH_4–H_2 reactive mixtures injected at high pressure (approximately 20 bars) represent a promising solution for hydrogen utilization and decarbonization. These results remain preliminary, and further testing is required to evaluate the feasibility of safe hydrogen use in gas turbines.

Keywords: *premixed combustion, turbulence, pollutants.*

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Paper ID: 14

Ammonia utilization in CH_4–H_2 flames

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Abstract

This work presents a numerical study of the premixed combustion of a methane (CH_4), hydrogen (H_2), and ammonia (NH_3) blend. The primary objective is to evaluate the effect of H_2 and NH_3 addition on CH_4 flame stability, combustion temperature, and the formation of nitrogen oxides (NOx).
Simulations were conducted using ANSYS Fluent for various ammonia proportions (ranging from 0% to 25%) with a constant hydrogen content of 50%. The results show that an increase in NH_3 leads to a slight decrease in the maximum flame temperature (from 1920 K to 1790 K) and a significant reduction in NOx emissions. Hydrogen, for its part, enhances combustion reactivity and stability.
Consequently, the CH_4–H_2–NH_3 blend enables cleaner and more stable combustion, representing a promising pathway toward the decarbonization of energy systems and the development of sustainable technologies.

Keywords: *Ammonia combustion, hydrogen enrichment, premixed flames, nitrogen oxides, CFD simulation.*

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