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International Conference & Expo on

Biofuels and Bioenergy

April 11-12, 2024 | Rome, Italy

Our Exhibitors

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Conference Programme

Conference Programme

Day 1: April 11, 2024

Meeting Hall: Parioli 2

8:00-8:45	**Registrations**
8:45-9.00	**Introduction**

Keynote Presentations

9:00 - 9.40	Benoit Villiers, Global Bioenergies, France

Title: IBN-SPK, A New Technology to Produce Sustainable Aviation Fuel

9.40 - 10.20	Erica Bhasin, Worley Consulting, United Kingdom

Title: The Bio-Economy Supply Chain

Exhibitor Presentations

10.20 - 10.40	Jasper Nillesen, Refuels N.V, United Kingdom

Refuels N.V Introduction

10.40 - 11.00	Kristjan Relvik, Gaznet, Estonia

Gaznet Introduction

Networking & Refreshments @ Bar: 11.00 - 11.30

Oral Presentations

Session Chair:	**Metin Duran, Villanova University, USA**
Session Chair:	**Kozma Naka, Alabama A&M University, USA**

Sessions: Biofuel | Bioenergy Governance and Climate change | Biohydrogen | Biodiesel | Biomass | Green Energy | Energy Storage and Conversion | Waste to Energy | Renewable Energy | Biogas | Sustainable Energy | Biorefineries | Green Chemistry | Bioenergy

11.30 - 12.00	Jayant Khambekar, Jenike & Johanson, USA

Title:Jen-Zero Technology for Reliably Feeding High Pressure Reactors

12.00 - 12.30	Viktoriia Betina, Ernst & Young GmbH, Germany

Title: Establishing Transition Strategies for Countries that are Depending on Gas & Oil Sector with a Focus on Biofuels, Biobased SAF

12.30 - 13.00	Michael Koettner, IBBK Fachgruppe Biogas GmbH, Germany

Title: Production of Solid Carbon and Hydrogen from Biomethane using Non-thermal Plasma

Group Photo: 13:00 - 13.15

Lunch @ Seguimi 13.15 - 14.00

14.00 - 14.30	Metin Duran, Villanova University, USA

Title: Hyperthermophilic Biohydrogen Production from untreated Animal Manure

14.30 - 15.00	Zainab Afailal, University of Zaragoza, Spain

Title: Bio-Based Antioxidant Additives for Biodiesel

15.00 - 15.30	Armin Brandner, Air Liquide Global E&C Solutions GmbH, Germany

Title: Enlarging HVO Feedstock Basis to Create Value from Low Carbon Waste Streams

15.30 - 16.00	Agnieszka Drobniak, University of Silesia, Poland

Title: Enhancing Quality of Solid Biomass Fuels: “PL-US BIO” - Poland’s Innovative Biofuel Certification Program

Networking & Refreshments @ Bar 16.00 - 16.30

16.30 - 17.00	Vera Marcantonio, University Campus Bio-Medico of Rome, Italy

Title: Modelling and Assessment of a HTC System Coupled with Biomass Gasification for Syngas Production

17.00 - 17.30	Anita Demuth, PtX Lab Lausitz, Germany

Title: Learning from Bioenergy: Sustainability Dimensions of Hydrogen-Based Fuels

Day 1 Concludes followed by Award Ceremony

Day 2: April 12, 2024

Meeting Hall: Parioli 2

Keynote Presentations

10:00-10:40 — Christian Beidl, Darmstadt University of Technology, Germany

Title: "It`s Time to Rethink – The Role of Renewable Fuels for the Future of Mobility and Mobile Machinery"

10:40-11:20 — Ishita Sharma, Port Esbjerg, Denmark

Title: Techno-Economic Analysis of Green Fuels-Based Fuel Cells in Maritime Sector

Networking & Refreshments @ Bar 11:20-11:45

11:45-12:25 — Caroline Braun, Landwärme GmbH, Germany

Title: Biomethane Next Level: Producing Climate Positive Fuel with Carbon Capture

Oral Presentations

Session Chair: **Metin Duran, Villanova University, USA**

Session Chair: **Kozma Naka, Alabama A&M University, USA**

Sessions: Waste to Energy | Renewable Energy | Biogas | Sustainable Energy | Bioenergy Biofuel | Bioenergy Governance and Climate change | Biohydrogen | Biodiesel | Biomass | Green Energy | Energy Storage and Conversion | Biorefineries | Green Chemistry

12:25-12:55 — Kozma Naka , Alabama A&M University, USA

Title: Forestry and Bioenergy: Transitioning to an Ecologically and Economically Diverse System for Biofuel Production

12:55-13:25 — Joao Fernando Pereira Gomes, Instituto Politecnico de Lisboa, Portugal

Title: Green Hydrogen and Synthetic Fuel Production with DC Microgrid Integration

Lunch @ Seguimi 13:25-14:30

14.30 - 15.00 — Edward Antwi, Hochschule Stralsund, Germany

Title: Technoeconomic Analysis of Decentralized Biomethanol Production from Biogenic CO_2 and Green Hydrogen

15.00 -15.30 — Andrzej Kopczynski, Gdansk University of Technology, Poland

Title: Application of Artificial Intelligence to Support Expert Knowledge in the AD Process for Food Waste Combined with Biodegradable Polymeric Materials

15.30 - 16.00 — Evanthia A. Nanaki, Helleniq Energy, Greece

Title: The Role of Industries in the Uptake of Sustainable Aviation Fuels

Networking & Refreshments @ Bar 16.00 - 16.30

Poster Presentations

Poster Judge — **Metin Duran, Villanova University, USA**

PP - 01 — Michael Koettner, IBBK Fachgruppe Biogas GmbH, Germany

Title: Production of Solid Carbon and Hydrogen from Biomethane using Non-thermal Plasma

PP - 02 — Noemi Gil-Lalaguna, University of Zaragoza, Spain

Title: Bio-Oil Separation into Homogeneous Families of Phenolic Compounds according to their Molecular Size

PP - 03 — Zainab Afailal, University of Zaragoza, Spain

Title: Phenolic Compounds Production via the Reductive Catalytic Fractionation

PP - 04 — Enrique Barrera, Universidad Autónoma Metropolitana, Mexico

Title:Carbon Dioxide Sink from Several Mexican Plants

PP - 05 — Aleksandra Grabowiec, Gdansk University of Technology, Poland

Title:Research on Anaerobic Degradation of Biodegradable Polymers

PP - 06 — Ebtihal Mohamed, The Australian National University, Australia

Title: Developing *Brassica Carinata* as a Biofuel Crop

PP - 07 — Mateusz Kotowski , Gdansk University of Technology, Poland

Title: Degradation of Polylactic Acid and Polypropylene in Pilot-Scale Twin AD Bioreactors

Day 2 Concludes followed by Award Ceremony and Vote of Thanks

Exhibitor

Gaznet

Gaznet offers advanced CNG and hydrogen storage and gas transportation solutions, uncompromising quality and highly competitive prices. We use mobile MEGC containers for filling solutions in addition to installing and maintaining gas appliances. All applications are ADR approved and inspected.

Exhibitor

ReFuels N.V.

"By bringing together the industry-leading renewable biomethane supplier, RTFS, and the UK's leading alternative refuelling infrastructure provider, CNG Fuels, ReFuels will be Europe's first fully integrated, end-to-end renewable fuel supplier for commercial transport."

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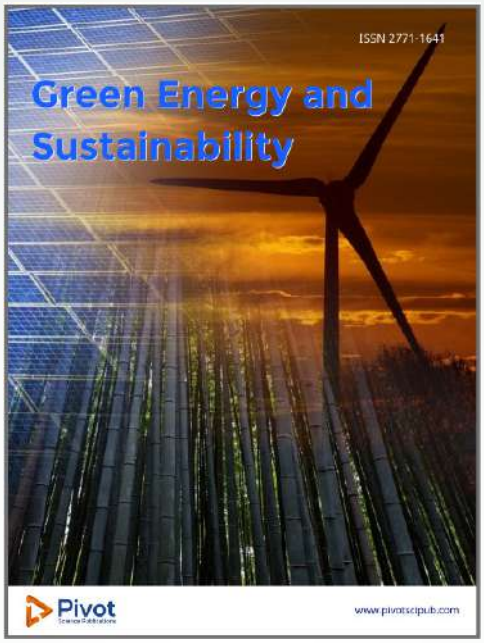

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Biogas World

BiogasWorld is a business generation network and project support platform, connecting the suppliers of products and services with project developers. Through our BiogasWorld and BiogasCommunity websites, we help industry professionals grow their businesses in the biogas and biomethane/RNG sector. Our services include online promotion, market intelligence, project and business leads, and industry networking.

European Biogas Association

The European Biogas Association (EBA) fully believes in the future potential of renewable gas in Europe. Founded in February 2009, the association is committed to the expansion of sustainable biogases production and use across the continent. EBA counts on a well-established network of 300 national associations, research bodies and companies active in the biogases value chain throughout Europe and further afield.

Day 1

Biofuels Expo 2024

Keynote Presentations

IBN-SPK, A NEW TECHNOLOGY TO PRODUCE SUSTAINABLE AVIATION FUEL

Benoit Villiers
Global Bioenergies, France

Abstract:

Everyone has already heard of Sustainable Aviation Fuel and how it could be key to decarbonize air transportation, but when it gets to specifics it is often hard to grasp an overall picture of those new products. Its development relies on break-through technologies, new players and new regulations that differs from Europe to the US. Global Bioenergies is a French company whose SAF technology, based on the direct microbial production of hydrocarbons, just got certified by ASTM International. After years of technology development, the company is now building plants of increasing size.

Global Bioenergies is a great case study to understand all these ongoing changes and how they will impact your decisions regarding air transport sustainability.

In this lecture, we will describe in details the unique technology developed by our company. We will also paint an up-to-date picture of the SAF technologies and markets. At last, we will present an overview of the impacts that this new product will have on air business travel, from carbon emissions reduction to potential cost increase.

Biography

Benoît Villiers holds a Ph.D in biochemistry. He joined the company Global Bioenergies in 2014 as a project leader in enzyme engineering, and became the head of the strain construction department in 2023.

THE BIO-ECONOMY SUPPLY CHAIN

Erica Bhasin
Worley Consulting, United Kingdom

Abstract:

The bioeconomy, including biorefineries, biofuels, and bioplastics, has gained significant traction in the previous decade as a key element of the energy transition. The use of biogenic and natural feedstock, to produce chemicals and fuels, allows for Scope 3 carbon neutrality and, in some cases, negative emissions, supporting the global journey to Net Zero. The conversion of biomass into fuels has a high TRL[1] and CRI[2] ; there are over 800 biorefineries identified in the EU alone. Whilst this may seem like a fool-proof solution to challenges faced when abating fossil emissions, the complete bioeconomy supply chain is not without its own obstacles. These limitations include feedstock availability, feedstock preparation and transport, regulations / legislation, and competitive business models. Through this presentation, I will share Advisian's findings on the various moving parts of this economy and the steps required to align them for successful project development. I will dive deeper into the categorisation of biofuels, the implications of Fit-for-55 (RED III), the current state of the biofuels industry, and emerging technical and commercial trends. The presentation will elaborate on refinery conversions, alternate feedstock sourcing, and future proofing of assets in line with upcoming legislation.

Biography

Erica graduated with a Meng (Hons) Chemical Engineering degree from the University of Bath. She is a core member of the Worley Consulting decarbonization team and has a background in Chemical Engineering. She has three years' experience with Worley Consulting specializing in technology reviews, decarbonisation roadmaps, and green hydrogen. Erica chaired green hydrogen discussions at COP26 on behalf of Worley and is a vocal supporter of the energy transition. She has worked on a variety of projects helping with market research, configuration and feasibility studies, licensor selection, decarbonization technologies, business development and sales. She led a refinery of the future project, looking at decarbonisation options for traditional and biorefineries in the US, Europe, GCC, and Singapore.

Day 1

Biofuels Expo 2024

Oral Presentations

JEN-ZERO TECHNOLOGY FOR RELIABLY FEEDING HIGH PRESSURE REACTORS

Jayant Khambekar
Jenike & Johanson, USA

Abstract:

Production of advanced biofuels may use feedstocks such as agricultural residue, forest residue or municipal solid waste. Typically, these feedstocks need to be sent to a gasifier or pyrolysis unit or other high-pressure reactor for producing biofuels. Given the nature of these feedstocks, many flow issues can occur. Furthermore, the difficulties in reliably pressurizing these feedstocks create additional flow and operational issues. Jenike & Johanson has developed patent-pending JENZERO technology for reliably feeding various feedstocks into high pressure environments. This presentation will discuss how our technology can overcome common issues associated with feedstock pressurization and reliable delivery to the reactor.

Biography

Jayant joined Jenike & Johanson in 2006. He is heavily involved in consulting, particularly within the power and pharmaceutical industries, with projects ranging from coal bunker retrofits to portable bin design to solving solid dosage form content uniformity problems. He has published several papers and lectures on the storage and flow of bulk solids. Jayant received his Bachelor's degree in Mechanical Engineering from University of Pune in Pune, India, and his Master's and Doctorate degrees in Mechanical Engineering from Worcester Polytechnic Institute in Worcester, Massachusetts.

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ESTABLISHING TRANSITION STRATEGIES FOR COUNTRIES THAT ARE DEPENDING ON GAS & OIL SECTOR WITH A FOCUS ON BIOFUELS, BIOBASED SAF

Viktoriia Betina

Kherson National Technical University, Ukraine

Abstract:

Background: Countries that heavily depend on gas & oil face several challenges and opportunities, as the global energy landscape evolves. The push towards decarbonization and the increased adoption of renewable energy sources are likely to lead to a decline in demand for fossil fuels. Still high utilization of gas & oil will peak by 2030. After, the demand will dramatically drop, as net-zero goals will limit its use and renewable technologies might become more cost-effective and efficient, also playing a larger role in the global energy mix. Having that in mind, there are number of countries that already look for a transition strategy towards green energy, where the existing gas & oil infrastructure can also be potentially reused. A reduction in the contribution of gas and oil to GDP, especially for developing countries in Africa, will create economic difficulties. These may include reduced government revenues, budget deficits, currency depreciation, and potential fiscal constraints. At the same time, looking at the global southern region, such as Angola, Nigeria can seize the opportunity to clearly define its future potential for the production of biofuels. Saying that, biofuels, compare for example to green hydrogen, have a longer value chain and can create more benefits for locals. In order not to compete with food, the focus of biofuels should be on the second generation using various waste streams into the production pathways. One option could be biobased SAF produced in African regions with dense forests. The use of forest waste can benefit the protection and cleanup of forests by creating a circular waste management, producing attractive SAFs at affordable prices for offtakers in Europe who currently lack of this product for their decarbonization goals. For this a clear strategy with a bankable business case must be created. European regulations, price models and investors risks to be considered. The increase in demand for this type of biofuels can gradually compensate for the loss of GDP from gas & oil and will create a completely new market with stronger intercontinental partnerships.

Objective: To examine potentials of developing countries with a focus on Africa to produce bio SAF

Methods: Based on EY project data, professional experience and internal calculations of bio SAF global production capacity, market price projections and demand.

Results and Conclusion: Share knowledge on bio SAF market development and how to support developing countries with their transition strategies towards bioenergy sources. Overview on how to make SAF projects bankable.

Biography

Betina has more than 10 years of experience working in a sustainability sector in Europe, Asia and Africa. She implemented number of projects

for global financial institutes like EU, EBRD, WB, AfDB, GIZ, KfW etc. Within the last years she was working on the energy sector with a focus on developing strategies, analyzing investors risks, assessing EU regulations and its future needs, infrastructure development, establishing business cases with financial models. She has knowledge in biofuels including not only economic focus, but also understanding various production technology and their impact on a domestic market (ESG).

Looking at the African region she led the project for Namibia hydrogen strategy and created financial and political tools in Europe to make Mega projects bankable, and she developed a national biofuels strategy for Angola by 2050 within the last year.

Currently she is working on a global EY Study for biobased SAF and synthetic fuels together with Fraunhofer and Lufthansa.

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PRODUCTION OF SOLID CARBON AND HYDROGEN FROM BIOMETHANE USING NON-THERMAL PLASMA

Michael Köttner, Remya Ravindran Nair, Katrin Kayser and Terje Hauan

IBBK Fachgruppe Biogas GmbH, Germany

Abstract:

Background: ColdSpark® will develop and validate a novel advanced technology based on a nonthermal plasma process to produce H2 from methane without producing CO_2. The main objective of ColdSpark® is to develop, test and validate a novel plasma reactor at the laboratory and demonstration scale in combination with a power supply.

Objective: Three lab-scale prototype plasma reactors have been designed and constructed for methane cracking based on corona discharge and gliding arc discharge. The tests were performed with a methane flow rate of 20 l/min at < 3 bar and < 200°C.

Methods: Methane cracking is performed using a non-thermal plasma (NTP) to produce turquoise hydrogen and solid carbon at low temperatures and ambient pressure, without the need for catalysts and water. The process therefore has lower operating costs for catalyst management. This approach makes the ColdSpark® technology the most cost-competitive, environmentally friendly, and less complex to implement.

Results: A critical factor limiting the industry-scale applications of NTP reactors is the lack of the proper interaction between the power supply and the plasma reactors. The overall energy efficiency of the system depends on the type of plasma discharge such as gliding arc, microwave or corona discharge but is also directly related to the performance of the power supply. Several experiments are carried out to determine a relation between the methane cracking performance and the electron parameters mainly the electron energy distribution and the density. This is based on the optimum matching between the plasma reactor and the power supply with the fine-tuning of the electron density in the plasma reactor.

Conclusion: Methane is a very stable molecule with strong carbon-hydrogen bonds and a balanced molecular structure. NTP contain highly energetic electrons and can easily break most chemical bonds. The methane fed into the reactor is therefore subjected to a high-voltage electric field, which causes the methane molecule to split into solid carbon and hydrogen.

Biography

With a Masters Degree as an Agricultural Biologist and as a trained Master Farmer, Michael Köttner is professionally involved in Biogas and Bioenergy Technologies for over 30 years. His portfolio ranges from professional services as a scientist, expert trainer and consulting engineer in the field of biogas, biomethane, organic waste treatment in Germany, Europe, Canada and South Africa, to being the founding member and CEO from 1991 to 2000 in Europe's biggest organisation the German Biogas Association with almost 5000 members today. Since 2000 he is CEO and senior expert consultant of the International Biogas and Bioenergy Center of Competence IBBK and Vice-chairman of the German Society for sustainable Biogas and Bioenergy Utilisation GERBIO. The main focus of his work is expert, consulting and training work in all aspects of biogas and bioenergy technology as well as ecological sanitation in a regional, national and international context.In the ColdSpark project his tasks are the input of biogas/biomethane knowledge, contact and dissemination of the results within the biogas industry.

HYPERTHERMOPHILIC BIOHYDROGEN PRODUCTION FROM UNTREATED ANIMAL MANURE

Metin Duran, Yasemin Dilsad Yilmazel and Buse Naval
Villanova University, USA
Middle East Technical University, Turkey

Abstract:

Background: According to Environmental and Energy Study Institute (2020), about 80% of the world's energy demand depends on the limited and non-renewable fossil fuels, which are responsible for greenhouse gas emissions associated with global warming. Since fossil fuels are non-renewable and have limited reserves, sustainable approaches should be developed to meet the global energy demand. Biohydrogen is promising alternative energy sources to fossil fuels because of its high energy capacity, 122 MJ/kg, three times more energy capacity than any known hydrocarbon fuels, and zero greenhouse gas emissions since only water vapor is released from hydrogen combustion.

Objective: The objective of this study was to investigate the biohydrogen production capacity of untreated chicken manure. It is the first study using chicken manure as feedstock in hyperthermophilic (~80°C) dark fermentation.

Methods: Chicken manure was obtained from a farm which has an anaerobic digester located in Nizip, Gaziantep, Turkey. The farm has about 650.000 chicken and collected manure was stored in a partially sun-exposed, closed structure. Anaerobic digestion and co-digestion (with crystalline cellulose) of various concentrations of chicken manure by the hyperthermophilic, anaerobic cellulolytic bacteria *Caldicellulosiruptor bescii* were investigated and subsequent biohydrogen production were determined.

Results: Overall, the highest biohydrogen generation was 91 mL H_2 (at standard temperature and pressure) per gram volatile solids (VS) equivalent of untreated chicken manure fed. Negative control reactors operated in the absence of *C. bescii* did not produce any hydrogen indicating that the presence of native microorganisms did not cause any risk of methane production. The results show that codigestion of chicken manure with crystalline cellulose had no beneficial effect in biohydrogen yield.

Conclusion: This study shows that the chicken manure is very promising feedstock for biohydrogen production with high yields up to 91 mL H_2 (at standard temperature and pressure) per gram VS equivalent of untreated chicken manure. Even though a pure culture was used in this work, the reactor operation was done under non-sterile conditions. High reactor temperature is a selective factor eliminating contamination by methanogens. Thus, the operation of a *C. bescii* bioreactor is a viable option for hydrogen production from raw chicken manure.

Acknowledgements: This work was supported by the World Academy of Sciences (TWAS) grant number 18-302 RG/REN/AS_C – FR3240305798 and the Science Academy through BAGEP award.

Biography

Metin Duran received his undergraduate degree in Environmental Engineering from Technical University of Istanbul, Turkey. He went to graduate school at Vanderbilt University where he earned a Ph.D. in 1996. Currently he is a professor in the Civil and Environmental Engineering Department at Villanova University. His research interests lay on the interface of applied microbiology and engineering. He uses microbiological principles to understand, design, and control biological processes for wastewater treatment, bioremediation, solid and hazardous waste management, and waste to energy systems. He has 86 publications including 39 peer-reviewed journal articles, a book (in Turkish) and a book chapter. His student working on microbial source tracking received the Best Masters Thesis Award from the Association of Environmental Engineers and Science Professors. Lately, he has been making use of genomic tools such as PCR and gene expression to better understand the biological processes of environmental engineering.

BIO-BASED ANTIOXIDANT ADDITIVES FOR BIODIESEL

Afailal Z, Gil-Lalaguna N, Gonzalo A, Arauzo J and Sánchez JL
University of Zaragoza, Spain

Abstract:

Biodiesel is essentially composed of fatty acid monoalkyl esters (FAME), and it tends to be less resistant to oxidative degradation than fossil diesel due to the instability of the unsaturation of fatty acid chains. The main role of the antioxidant additives is to prevent the formation of peroxyl radicals by substituting them with new and less reactive radicals to stop the chain degradation. Phenolic compounds (from lignin depolymerization or bio-oil) have previously been shown to be effective sustainable antioxidants for biodiesel. Several studies of lignin depolymerization have demonstrated that hydrothermal processes could be a potential way to produce monomers, dimers and oligomers containing phenolic groups, this being a promising and sustainable mode to produce additives with potential antioxidant activity.

In this work, the lignin-rich fraction extracted from argan nutshells (AS, agricultural waste rich in lignin), as well as bio-oil from the pyrolysis of the same residue, has been tested to produce sustainable antioxidant additives for biodiesel. The lignin-based additives were obtained from lignin extracted from AS by the semi-chemical soda pulping followed by hydrothermal treatment for depolymerization. While bio-oil based additives were obtained from bio-oil produced by AS pyrolysis.

Doping biodiesel with these additives has significantly improved its oxidation stability regardless of the operational conditions or if it was produced from depolymerized lignin or bio-oil. Oxidation stability improvement rates between 281% and 400% were obtained when comparing neat biodiesel with doped one (the dosage of the antioxidant additives was less than 1 wt.% in all the cases).

Biography

Zainab Afailal is a Postdoctoral Researcher at Universidad de Zaragoza. She is passionate about developing and implementing innovative bioenergy solutions that address the global challenges of climate change, resource scarcity, and environmental sustainability. She has over six years of experience in the thermochemical processing of biomass waste, advanced biofuels, and textile residues, using various laboratory techniques and analytical skills. She holds a Ph.D. in Chemical Engineering and Environmental Technologies from the University of Zaragoza. She has published several research papers in reputable journals and participated in international conferences.

ENLARGING HVO FEEDSTOCK BASIS TO CREATE VALUE FROM LOW CARBON WASTE STREAMS

Armin Brandner
Air Liquide Global E&C Solutions GmbH,Germany

Abstract:

Renewable diesel - also known as hydrotreated vegetable oil, HVO - has become a recent trend in the biofuels industry. It is a premium, fossil free fuel made of renewable waste oils, such as used cooking oil, animal fats or fatty acid distillates.

In order to protect the hydrotreating catalyst from impurities, the waste oil feedstock needs to be pretreated by purification steps originally known from the edible oil refining industry. These steps for conventional base pretreatment include degumming, bleaching and polyethylene removal, which is also offered by Air Liquide Engineering & Construction under its Lurgi Technology trade name.

One of the disadvantages of the conventional base pretreatment in combination with the HVO process is the full hydrogenation of the glycerin backbone of the glyceride molecules into bio propane. Although bio propane itself is a valuable green fuel gas or feedstock, e. g. for steam cracking, the glycerin molecules with its distinct functionality is lost.

Air Liquide Engineering & Construction in addition offers its adapted and patented oil splitting process. In this process a simple degumming step reduces the phosphatides content in the feedstream before glycerides are split into fatty acids and glycerin in a common splitting tower.

The oil splitting process has significant advantages over the base pretreatment:

- Glycerin is retained as a valuable byproduct of the HVO process
- 30% less hydrogen is required compared to base pretreatment and HVO
- Improved purity of the HVO feed leading to extended HVO catalyst lifetime
- No solid waste as the bleaching step is not necessary
- Total cost of ownership is reduced with a short payback period

Biography

Armin Brandner is Product Director of the Green Chemicals and Fuels Product Line at Air Liquide Engineering & Construction. He joined Air Liquide in 2012 as a Process Engineer. Over the past 10 years within the company, he has gained a wealth of knowledge and experience in process technologies for mainly fatty acids, fatty alcohols, glycerin, methyl ester, bio propylene glycol, sorbitol and new technologies such as supercritical biodiesel and soap carbonate technology solutions. Dr Brandner holds a Degree and PhD in Industrial Chemistry from Darmstadt University of Technology. In his scientific work, he has focused on glycerin chemistry.

ENHANCING QUALITY OF SOLID BIOMASS FUELS: "PL-US BIO" - POLAND'S INNOVATIVE BIOFUEL CERTIFICATION PROGRAM

Agnieszka Drobniak[1,2], Zbigniew Jelonek[1], Maria Mastalerz[1,2] and Iwona Jelonek[1]
[1]*University of Silesia in Katowice, Poland*
[2]*Indiana University, USA*

Abstract:

Background: The global biomass industry has been experiencing unprecedented growth as renewable energy targets, innovative technologies, and favorable policies drive the market. However, the growth and success of the biomass industry can be jeopardized by customers' apprehension toward using solid biomass fuels. This reservation can come from a lack of stable fuel prices, interrupted supply, and negative experiences of using low-quality biomass pellets.

Objective: To enhance quality of solid biomass fuels.

Methods: Since 2017, our team has analyzed more than 1,000 samples of solid biomass fuels from nine countries using a novel, reflected light microscopy technique. The research shows that fuels can be contaminated to various degrees, and in some extreme cases contain up to 26 vol. % of impurities. Therefore, there is a need for implementing stricter fuel quality standards and policies, which in turn, would lead to their safer utilization and a cleaner environment.

Results: Our research led to establishing the first solid biomass fuels certification scheme in the world that implements optical microscopy analysis as part of the fuel quality assessment. This proprietary certification program "PL-US BIO" is designed for the quality assessment of pellets and briquettes of woody or herbaceous origin manufactured for energy generation in non-industrial settings in Poland. The tests performed combine the requirements of current standards and the innovative petrographic analysis, to provide a comprehensive assessment of fuel quality.

Conclusion: Our research has shown that petrographic analysis of solid biomass in reflected light can quickly and reliably provide information on fuel composition and contamination. With growing interest in the use of solid biomass for energy purpose, adding petrographic analysis to currently used quality testing will complement and enhance the physico-chemical assessment, leading not only to improvements in fuels quality, but most importantly to improving human safety and lowering air pollution.

Biography

Agnieszka Drobniak is a research scientist with over 20 years of professional experience. She has been working with scientists from all over the world on a variety of collaborative geoscience projects focusing on energy research, quality of biomass fuels, and biomass utilization emissions. She is a founding member of the Centre for Biomass Energy Research and Education at the University of Silesia in Katowice, Poland.

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MODELLING AND ASSESSMENT OF A HTC SYSTEM COUPLED WITH BIOMASS GASIFICATION FOR SYNGAS PRODUCTION

Vera Marcantonio, Mauro Capocelli, Marcello De Falco and Enrico Bocci

University Campus-Bio-Medico of Rome, Italy

Abstract:

The recent scientific research is focusing on sustainable alternatives to fossil fuel as renewable energy sources due to concerns about energy security, energy prices and climate change. Biomass gasification gained significant interest since it offers the possibility to produce low cost energy, hydrogen, and carbon negative emissions from a huge variety of accessible organic wastes. Upstream pre-treatments were investigated to increase hydrogen yield and to decrease the content of organic and inorganic contaminants. Hydrothermal Carbonization (HTC) is expected to be a promising upstream biomass pre-treatment, but over the past years only few HTC process modelling was done in literature and the most of them are techno-economics models, not taking into account kinetic reactions and suffering from oversimplification. Since modelling is the first approach for the optimization of an industrial plant, the present research aimed to fill the lack encountered in literature developing a trustable and accurate HTC process simulation coupled with biomass gasification by means of Aspen Plus software. The model is validated for different biomass against experimental data and the plant performances was optimized by investigating the most significant operating parameters. The most promising configuration tested is the one with out-of-use wood as biomass feedstock and whey as medium (1:4 weight ratio), at 195°C and autogenous pressure of 13 bar. This configuration has the advantage of reusing two biomass wastes at the same time, allowing to avoid environmental impact. It was found that HTC increases the cold gas efficiency by about 10%. Results indicated that HTC and dewatering are responsible for an increase of CO_{2eq} emission by about 50%. This means that HTC pre-treatment is not always recommendable, and each case must be evaluated according to the goal of the plant (e.g., if the aim is the reduction of electricity the HTC-pretreatment is indicated since allows to increase energy efficiency even if with a worse syngas composition)

Biography

Vera Marcantonio graduated in Chemical Engineering in 2016 at University Campus Bio-Medico and achieved her PhD in Engineering for Energy and Environment, at the Department of Mechanical Engineering of Tuscia Univerisity in 2021. Currently she is an Assistant Professor at the University Campus Bio-Medico of Rome and she is the author of more than 20 scientific papers published in international journals in the field of renewable energy, she devotes her research activity to the study and modeling of thermochemical processes for the valorization of biomass wastes, with a focus on gasification. She has also participated, as a global plant simulation manager, in the European projects BLAZE and GICO, both focused on gasification.

LEARNING FROM BIOENERGY: SUSTAINABILITY DIMENSIONS OF HYDROGEN-BASED FUELS

Anita Demuth, Felix Schmermer, Sebastian Voswinckel and Harry Lehmann
PtX Lab Lausitz, Germany

Abstract:

Sustainability has been a pre-occupation of the public with regards to bioenergy for a long time. The sector found answers to them to a certain extent by formulating sustainability criteria preferably in roundtable settings and casting them into standards, labels and certification schemes. The learnings from policy makers, industry representatives, scientists, fuel consumers and other stakeholders help to set up sustainability criteria for new products such as hydrogen-based synthetic fuels.

Energy-intensive industries and the transport sector hope for these power-to-x applications to solve their difficulty of reaching greenhouse gas neutrality by the mid-century. But, if the global community wants this development to happen in a just and environmentally-sane way, these electricity-based green fuels will not be available infinitely in the next 20 to 30 years, even with the announced billions of Euros and US-Dollars to be invested by the public and private actors. Looking at power-to-liquid (ptl) for aviation, so-called drop-in fuels, it is to say that their value chains can be long, complex and resource-intensive and therefore, involve numerous environmental, economic, social and political risks.

Therefore, PtX fuels have to be used in a smart way. Firstly, the regulator has to make sure that these precious new, but certainly not the most energy-efficient fuels are consumed in the first place where direct-electrification is not feasible. Secondly, appropriate, credible and agreed sustainability requirements have to be the basis for PtL production from the start.

The presentation will illustrate how a set of sustainability criteria are derived from two main frameworks: the concept of planetary boundaries and the UN Sustainable Development Goals. In order to guarantee the highest possible degree of sustainability for drop-in PtL kerosene, the PtX Lab Lausitz has developed a sustainability standard that reflects the highest and most achievable degree of sustainability at the current state of knowledge.

Biography

Anita Demuth is Deputy Director of the PtX Lab Lausitz, a Think-and-do-tank for fuels and basic materials from green hydrogen. In current role, her focus lies on developing sustainability criteria for PtX as well as policy instruments for a climate-neutral aviation and shipping industry. Before, she worked for the Gesellschaft für Internationale Zusammenarbeit, GIZ, in different international development projects and countries. Her last post was in Vietnam as technical advisor promoting the market ramp-up of bioenergy from agricultural residues and supporting a German-Vietnamese scientific project on aqua-photovoltaics. She holds a Diplom in Economics (equ. M.Sc.) from the University of Potsdam. She wrote her Diplom thesis in collaboration with the 'Biofuel as Social Fuel' project from the Potsdam-Institute for Climate Impact Research. Furthermore, she studied political sciences at SciencePo Lyon and international cooperation at the Center for Rural development of Humboldt-University Berlin.

Day 2

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Keynote Presentations

IT'S TIME TO RETHINK – THE ROLE OF RENEWABLE FUELS FOR THE FUTURE OF MOBILITY AND MOBILE MACHINERY

Christian Beidl
Darmstadt University of Technology, Germany

Abstract:

Especially in the field of mobility, the current EU-regulations are clearly prioritizing electric energy. Renewable fuels are only accepted in limited areas like aviation. In the public communication, this all-electric technology path is motivated by the need to achieve the climate goals as formulated by the green deal. But do physical and sustainability considerations support this approach?

Actually, in the past 5 years we have learned a lot. Science based systemic analysis have to deal with multiple aspects like efficiency, systemic effectiveness, infrastructure, time to market, market acceptance and finally sustainability and have to be based on Life-cycle-analysis approaches. There will be no silver bullet, but obviously an optimum mix of technologies in a resilient and increasingly "Green" energy system. How fast can this be ramped up, which boundary conditions do we need to be successful? How can we come across thinking traps, which currently influence regulatory decisions?

The presentation will show that renewable fuels as distributable, storable and light-weight energy carriers play a decisive role in these evaluations and will be mandatory to reach climate goals in a stable society. If we really want to achieve our climate goals, it is time to rethink!

Biography

The author has 40 years of experience in automotive R&D and is heading the Institute for Internal combustion engines and powertrain systems at the Darmstadt University of Technology since 2008. The research expertise includes advanced future propulsion system technologies in a renewable energy system as well as methodologies for LCA assessment and zero impact emissions. The author is member of several German and international scientific advisory boards. Before joining the university, he was active in leading positions at AVL List GmbH, the world`s largest independent engineering company in automotive engineering and engaged in numerous industrial projects.

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TECHNO-ECONOMIC ANALYSIS OF GREEN FUELS-BASED FUEL CELLS IN MARITIME SECTOR

Ishita Sharma

Port Esbjerg, Denmark

Abstract:

The world economy relies heavily on shipping as a mode of freight, with 90 % of the overall load being enabled by maritime transportation, with very large ships moving 82 % of the marine cargo. However, international marine traffic accounted for 2.89 % of global GHG emissions in 2018, experiencing a 10 % growth since 2012. The growing emissions from the marine industry have raised concerns with IMO establishing targets and international shipping companies focusing on alternative fuels for the shipping industry to reduce GHG emissions and the environmental impact, with expanding emission control areas. The primary focus of research in this area has revolved around fuels for propulsion. However, considerable amounts of energy are delivered for auxiliary purposes.

Objective: Therefore, this paper investigates the feasibility of integrating fuel cells for auxiliary power in very large ships and the use of fuel cells in port area for port operations.

Materials and Methods: The study is divided into four sections: First, seven fuel cell technologies are compared in a weighted parameter analysis, rating the fuel cells on eleven parameters weighing from 1 to 5. Finding HT-PEMFC to be the most suitable fuel cell technology. Moreover, an economic analysis yields that HT-PEMFC, LT-PEMFC, and SOFC are most likely the cheapest options from a total cost of ownership perspective. Secondly, HT-PEMFC is sized alongside batteries as energy storage systems to fulfill the auxiliary demands of the most demanding voyage while fulfilling the set requirements of the energy management system. The cheapest configuration is a 1200 kW fuel cell with a 900 kWh battery at a levelized cost of energy at 0.295 $/kWh. The third section compares the fuel cell battery auxiliary power unit to a conventional ICE generator fueled by methanol and diesel. Here at fixed methanol and diesel prices, the levelized cost of energy is 0.295 $/kWh, 0.391 $/kWh, and 0.246 $/kWh. Effectively this yields that if ship operators integrate fuel cell battery solutions in this scenario, they will incur an extra cost of 0.049 $/kWh, seen as the green premium. Moreover, the fuel cell battery option is 0.096 $/kWh cheaper than the methanol-fueled ICE, indicating that fuel cell battery solutions as APUs in VLS have excellent prospects as competitive replacements for conventional solutions to reduce GHG emissions from shipping. Finally it is emphasized along with its use in ships how can fuel cells be used in the port premises onshore to run several port operations that today are using heavy fuel and contributing to the greenhouse gas emissions.

Biography

Ishita Sharma is currently working as a Research and Project Manager at Port Esbjerg and is a scientific researcher at Aarhus University, Denmark. She holds a background in transportation and logistics. Ishita is currently researching on decarbonizing of transport sector, in particular-The Maritime Ecosystem. The focus is how the befitting technology and digitalization advance the process of decarbonization.

BIOMETHANE NEXT LEVEL: PRODUCING CLIMATE POSITIVE FUEL WITH CARBON CAPTURE

Caroline Braun
Landwärme GmbH, Germany

Abstract:

The increasing concentration of carbon dioxide (CO_2) in the Earth's atmosphere has prompted urgent global action to mitigate climate change. The CO_2 value chain encompasses the processes involved in capturing, storing (CCS) and/or utilizing (CCU) CO_2, offering a comprehensive approach to reducing greenhouse gas emissions or even generating net negative emissions.

This presentation focuses on Biomethane produced while integrating Carbon Capture and Usage/Storage (BECCUS), into the process. During the conversion process from biogas to Biomethane, CO_2 can be captured from a very highly concentrated exhaust gas stream and used or permanently stored. It therefore substitutes fossil CO_2 sources or can be chemically integrated into projects as a petroleum replacement, achieving even greater defossilization. The biogenic CO_2 value chain offers multiple environmental and economic advantages. First and foremost, it enables timely and significant CO_2 reductions and removals, contributing to global efforts to combat climate change. Storing biogenic CO_2 from biogas upgrading is one of the most cost- and energy- efficient technical carbon removal solutions. Additionally, it promotes renewable energy production and efficiency by encouraging cleaner energy sources and the adoption of carbon capture technologies. Moreover, carbon utilization technologies provide new revenue streams and job opportunities, fostering innovation and economic growth. However, challenges persist within the CO_2 value chain that require attention. Technical and economic feasibility, infrastructure for captured CO_2 and the need for supportive policy frameworks are among the key considerations. We will present current capture projects at biogas upgrading plants and highlight key learnings and challenges along the way.

Biography

Caroline Braun graduated with a master's degree in Industrial and Network Economics from the Technical University in Berlin. With a strong passion for the energy sector, she proactively engaged in working at 50hertz, one of Germany's prominent transmission system operators, during her studies. After moving to Munich, she further honed her expertise in the natural gas industry through her role at PGNiG Supply and Trading. Starting in business development and later transitioning into a natural gas trader position, she garnered invaluable insights that solidified her understanding of the market. At Landwärme, Caroline Braun is the Team Lead for Business Development and Carbon Removal, driving the implementation of innovative solutions in the area of green gases. Her team's and Landwärme's key priority is to establish a value chain for biogenic CO_2 and generate the negative emissions urgently needed to achieve carbon neutrality.

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Oral Presentations

FORESTRY AND BIOENERGY: TRANSITIONING TO AN ECOLOGICALLY AND ECONOMICALLY DIVERSE SYSTEM FOR BIOFUEL PRODUCTION

Kozma Naka
Alabama A&M University, USA

Abstract:

With the concerns for diminishing fossil fuel supply and greenhouse gas emission problems, there is a growing interest in creating long-term diverse bioenergy cropping systems integrated into an economically stable and viable biomass processing system. Soybean and corn have been the feedstock of choice for biodiesel and ethanol production in the southeastern US. However, fast-growing trees, like hybrid poplar, loblolly pine, and sweetgum, can provide considerable biomass for biofuel production. Paper mill closures in the last decade have left landowners in the region with an excess of pulpwood material. We will discuss the recent development of sustainable technology for direct conversion of forest biomass to cellulosic fuel, which will help revitalize local industry, improve forest health, provide income for forest landowners, and mitigate the adverse environmental consequences of forest fires. Through a partnership among our university, private companies, and state governments, we are creating a diverse biomass supply system by supplementing agronomic biofuel crops within the existing wood supply chain. In addition to the production of biomass resources, other integral to biofuel productions are the cost of processing (oil extraction, diesel conversion, and ethanol production), utilization and management of byproducts, and efficient use of water resources. Federal and state government incentives for the production of biomass energy that can benefit US landowners will also be discussed.

Biography

Kozma Naka is currently an Associate Professor of Forest Operations and Measurements at Alabama A&M University (AAMU) and the Coordinator of the Forestry, Ecology, and Wildlife Program. He teaches Forest Mensuration, Forest Operations, Wood Products, and Forestry Field Techniques. His research includes forest operations, forest recreation, forest disturbances and climatic change impacts, hardwood management, forest ecosystem restoration, and agroforestry. He is a member of the Society of American Foresters, Forest Products Society, Alabama Forestry Council, and Alabama Forestry Association. He has traveled to China for five summers (2014-2018) to conduct forestry and wildlife habitat research and as a faculty mentor for the AAMU REU (Research Experience for Undergraduates) program. He is a member of the curriculum committee in a USAID-funded project for coordinating efforts to co-create forestry program curricula and provide capacity-building assistance consistent with the needs of Liberian education institutions in the establishment of the Center of Excellence for Forestry, Biodiversity, and Conservation Leadership and Green Enterprise Development in Liberia.

GREEN HYDROGEN AND SYNTHETIC FUEL PRODUCTION WITH DC MICROGRID INTEGRATION

João FP Gomes, Ricardo Luís, Jaime Puna, João Lagarto, Teodoro Trindade, Jorge Sousa and Armando Cordeiro

Instituto Superior de Engenharia de Lisboa,Portugal

Abstract:

Green hydrogen (H_2) systems have the potential to foster the energy transition and decarbonise the economy in several sectors for a clean and low-carbon future. To increase the efficiency of H_2 production, storage and re-electrification, this work considers the use of an electrolytic DC microgrid that allows the use of renewable energy sources (RES), such as wind and photovoltaic (PV) generation, to supply the electricity demand of a given installation (typically a building). When it occurs, the excess of RES production will be used for electrolytic production of syngas, which can be stored or used in mobility applications, mixed with traditional fuels in internal combustion engines. In the deployed system, the H_2/syngas production uses an alkaline electrolysis process with added liquefied biomass, which brings an added bioenergy value, due to the possible carbon capture and storage. Also, the use of liquefied biomass contributes to the reduction of the risks related to the ignition of forest fires by reducing the biomass load, mainly composed by infestant species such as Acacia trees which are quite common in Mediterranean forests. The project also comprises a full technical and economic feasibility study, where the main economic indicators will be computed, such as the levelized cost of hydrogen (LCOH), the levelized cost of energy (LCOE), and the return on investment (ROI).

Acknowledgement: This work is supported by IPL under Project IPL/2022/SOLAR H2_ISEL.

Biography

João Gomes was awarded a BSc, PhD and Habilitation in Chemical Engineering, from the Technical University of Lisbon, and is a full Professor of Chemical Engineering at ISEL – Lisbon Polytechnic, since 2006, and a researcher of CERENA-Centre for Natural Resources and Environment from the University of Lisbon. He is also Vice-President of ISEL for R&D. Previously he was a research assistant in the Technical University of Lisbon, a research fellow at National Laboratories for Engineering and at the R&D Department of ISQ, where he was also Deputy Director, managing the Environmental Division.

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TECHNOECONOMIC ANALYSIS OF DECENTRALIZED BIOMETHANOL PRODUCTION FROM BIOGENIC CO_2 AND GREEN HYDROGEN

Edward Antwi, Martin Hayduk, Romy Sommer and Johannes Gulden

Hochschule Stralsund, Germany

Abstract:

The conventional approach to produce methanol is very carbon intensive making it unsustainable. To decarbonize the methanol production process, hydrogenation of biogenic carbon dioxide has been proposed as a viable and sustainable alternative pathway. However, several biogenic carbon dioxide generation points exist such as CO_2 from biogas plant, biomass gasification and or pyrolysis and thermal combustion of biomass with CO_2 capture. On the other hand, the required hydrogen can be either generated through steam reforming of methane produced from biogas plant or through electrolysis of water using green electricity. Decentralized biomethanol production plant has been proposed an alternative solution to large scale biomethanol production plants to reduce cost. The study sought to carry out a technoeconomic assessment of coupling a biomethanol plant to a 75 kWe and 500 kWe biogas plant.

Objective: To assess the technoeconomic indicators of producing biomathanol using biogenic CO_2 produced from different sized biogas plant and different hydrogen production routes for the biomethanol synthesis.

Materials and Methods: Using Aspen Plus 14, a model was developed for the production of methanol from biogenic sources. Biogenic CO_2 obtained from two different sized agricultural biogas plants in Germany (75 kWe and 500 kWe) were used in the analysis. Two different hydrogen production routes were also considered – electrolysis of water using solar energy and steam reforming of methane. The economic indicators were carried out in Aspen to determine the least production cost of biomethane.

Results and Discussion: The results showed that the cost of biomethanol depended to a large extent on the production route of the hydrogen rather than on the size of the decentralized biogas plant. There was not much difference between the production cost of biomethanol from a 75 kWe and 500 kWe agricultural biogas plant in Germany using current indices when the same hydrogen source was used. However, when the hydrogen source was changed, a significant difference in the production was determined. This could be due to the size of the size of the biomethanol plant and its requirement of hydrogen or more importantly the cost of electricity. While steam reforming of bio methane provided a less costly and reliable hydrogen source, hydrogen generated from electrolysis of water was expensive and was mainly mainly weather dependent.

Conclusion: To decarbonize the production of methanol, biogenic carbon dioxide and carbon monoxide will play a major role moving forward. The technoeconomic analysis shows that biomethanol produced from both the 75 kWe and 500 kWe biogas plants were very competitive in terms of production cost. Further research into other sources of biogenic carbon dioxide and green hydrogen sources could be explored to gain a deeper understanding into the technology as well as economics and environmental effects of producing biomethanol.

Biography

Edward Antwi holds a PhD in waste and resource management from the University Rostock and a Bachelor and master's degree in chemical and mechanical engineering respectively from the Kwame Nkrumah University of Science and Technology in Ghana. Over the past 10-15 years, Edward has been involved in several groundbreaking research activities and several projects in the renewable energy space with emphasis on technology development, deployment and dissemination. He has developed a keen research interest in low carbon technologies with the aim of finding alternative fuels to replace fossil fuels globally. Antwi has published about 30 peer reviewed scientific articles, 4 books and 2 book chapters. He has also served as consultant for several international bodies such as the SNV on Carbon Development Mechanism and biogas construction, UNPD on renewable energy technology deployment among others. On the international front, he has served as consultant for the European Union on North-South project of developing an Integrated Waste Solid Management System for Western Africa and more recently was part of the implementation of the novel hybrid waste to energy project in Ghana where a 400 kWe waste to energy power plant was designed and constructed. Currently Edward's research is on the production and optimization of green methanol from biogenic carbon dioxide and green hydrogen at the Institute of Renewable Energy Systems in the University of Applied Science - Stralsund. The project seeks to design and construct a decentralized biomethanol plant which can be coupled to a biogas plant in Germany. This research, apart from being innovative, could also be a game changer in decarbonizing agriculture and opening up new revenue streams or cost savings pathways for farmers.

APPLICATION OF ARTIFICIAL INTELLIGENCE TO SUPPORT EXPERT KNOWLEDGE IN THE AD PROCESS FOR FOOD WASTE COMBINED WITH BIODEGRADABLE POLYMERIC MATERIALS

Andrzej Kopczyński and Ryszard Arendt
Gdansk Univeristy of Technology, Poland

Abstract:

The anaerobic fermentation process cannot be fully formalized. The main participants in this process are bacteria - living individuals - that occur in various consortia and whose behavior is not entirely predictable. Monitoring of ongoing processes should be used and appropriate control decisions should be made, depending on the process state. In this case, it is advisable to use artificial intelligence and machine learning methods to obtain more effective (efficient) methods of conducting the process and obtaining the final product.

For data acquisition automatic monitoring and analytical investigations are carrying out. The following process parameters are most frequently monitored: biogas volume, bioferment dose, reactor temperature, bioferment pH, Redox potential, VFA/ALK ratio (volatile fatty acids/alkalinity), the composition of biogas, the composition of volatile fatty acids.

The knowledge describing anaerobic fermentation process is summarized in the form of rules: IF (premise) THEN (conclusion). The compiled set of rules creates a knowledge base of the expert system, which is used to conduct the fermentation process and gives instructions to the operator. Knowledge rules are updated and developed as the process is conducted. The use of artificial intelligence in the process ensures that operators' knowledge is maintained during changes in reactor maintenance personnel.

The paper presents the construction of a laboratory stand for anaerobic fermentation of kitchen and food waste, the technical devices used, IT tools and selected rules of knowledge.

Acknowledgements: This research leading to these results has received funding from the Norway Grants 2014-2021 via the National Centre for Research and Development.

Biography

Andrzej Kopczyński was born in Gdansk, Poland in 1978. He received the M.Sc. and Ph.D. degrees in control engineering and robotics from the Gdansk University of Technology, in 2002 and 2015, where he is currently an Assistant Professor in the Department of Control Engineering. His current research interests include expert systems, artificial intelligence, mathematical modeling, computer aided design systems and actually anaerobic digestion of food waste.

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THE ROLE OF INDUSTRIES IN THE UPTAKE OF SUSTAINABLE AVIATION FUELS

Evanthia A Nanaki[1], Spyros Kiartzis[1], Silvia Morales-delaRosa[2] & Jose M Campos-Martin[2]

[1]*Helleniq Energy, Greece*
[2]*Instituto de Catálisisy Petroleoquímica, Spain*

Abstract:

The sustained growth of global aviation emissions has highlighted the urgent need for using Sustainable Aviation Fuels (SAFs) to replace traditional aviation fuels to mitigate emissions. SAFs can potentially reduce greenhouse gas emissions by 50%–90% compared to conventional jet fuels. In this direction, novel methods of advanced liquid fuels (ALF) production from different CO_2 emissions streams of energy intensive industrial sectors play significant role. FUELGAE project presents innovative ALF production pathways, which are assessed in terms of industrial market scale up. The role of an energy industry, such as a refinery, which constitutes a major component of the "SAF" ecosystem is highlighted as well as the effort needed to increase the technology competitiveness and transform the energy system on a fossil-free basis by 2050.

The above mentioned are aligned with the EU goals for energy independence as well as to achieve climate neutrality by 2050 by developing green technologies, establish sustainable industry and reduce pollution and new ReFuelEU aviation requirements which is part of the Fit for 55 legislative package, which aims to reduce the EU's greenhouse gas emissions by at least 55% by 2030 Aviation represents 14.4% of EU transport emissions and to reduce these emissions ReFuelEU aviation will regulate the minimum participation in the supply of sustainable aviation fuels by 2030 at 6% and by 2050 at 70%.

Acknowledgments: "This project has received funding from the European Union's Horizon Europe\ Research and Innovation Programme under Grant Agreement No. 101122151"

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Poster Presentations

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PRODUCTION OF SOLID CARBON AND HYDROGEN FROM BIOMETHANE USING NON-THERMAL PLASMA

Michael Köttner, Remya Ravindran Nair, Katrin Kayser and Terje Hauan

IBBK Fachgruppe Biogas GmbH, Germany

Abstract:

Background: ColdSpark® will develop and validate a novel advanced technology based on a nonthermal plasma process to produce H2 from methane without producing CO_2. The main objective of ColdSpark® is to develop, test and validate a novel plasma reactor at the laboratory and demonstration scale in combination with a power supply.

Objective: Three lab-scale prototype plasma reactors have been designed and constructed for methane cracking based on corona discharge and gliding arc discharge. The tests were performed with a methane flow rate of 20 l/min at < 3 bar and < 200°C.

Methods: Methane cracking is performed using a non-thermal plasma (NTP) to produce turquoise hydrogen and solid carbon at low temperatures and ambient pressure, without the need for catalysts and water. The process therefore has lower operating costs for catalyst management. This approach makes the ColdSpark® technology the most cost-competitive, environmentally friendly, and less complex to implement.

Results: A critical factor limiting the industry-scale applications of NTP reactors is the lack of the proper interaction between the power supply and the plasma reactors. The overall energy efficiency of the system depends on the type of plasma discharge such as gliding arc, microwave or corona discharge but is also directly related to the performance of the power supply. Several experiments are carried out to determine a relation between the methane cracking performance and the electron parameters mainly the electron energy distribution and the density. This is based on the optimum matching between the plasma reactor and the power supply with the fine-tuning of the electron density in the plasma reactor.

Conclusion: Methane is a very stable molecule with strong carbon-hydrogen bonds and a balanced molecular structure. NTP contain highly energetic electrons and can easily break most chemical bonds. The methane fed into the reactor is therefore subjected to a high-voltage electric field, which causes the methane molecule to split into solid carbon and hydrogen.

Biography

With a Masters Degree as an Agricultural Biologist and as a trained Master Farmer, Michael Köttner is professionally involved in Biogas and Bioenergy Technologies for over 30 years. His portfolio ranges from professional services as a scientist, expert trainer and consulting engineer in the field of biogas, biomethane, organic waste treatment in Germany, Europe, Canada and South Africa, to being the founding member and CEO from 1991 to 2000 in Europe's biggest organisation the German Biogas Association with almost 5000 members today. Since 2000 he is CEO and senior expert consultant of the International Biogas and Bioenergy Center of Competence IBBK and Vice-chairman of the German Society for sustainable Biogas and Bioenergy Utilisation GERBIO. The main focus of his work is expert, consulting and training work in all aspects of biogas and bioenergy technology as well as ecological sanitation in a regional, national and international context.In the ColdSpark project his tasks are the input of biogas/biomethane knowledge, contact and dissemination of the results within the biogas industry.

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BIO-OIL SEPARATION INTO HOMOGENEOUS FAMILIES OF PHENOLIC COMPOUNDS ACCORDING TO THEIR MOLECULAR SIZE.

Noemí Gil-Lalaguna, Isabel Fonts, Cristina Lázaro, Alfonso Cornejo, José Luis Sánchez and Jesús Arauzo

University of Zaragoza, Spain

Abstract:

Pyrolysis emerges as a technology brimming with promise for biomass valorization, owing to its end-use adaptability and the potential high worth of its products, particularly bio-oil. Approximately 75% by weight of pyrolysis bio-oil derived from lignocellulosic biomass consists of organic compounds generated through the processes of devolatilization, cracking, and thermal degradation of the principal biomass constituents (cellulose, hemicellulose, lignin, and extractives), along with secondary reactions of primary pyrolysis products. These compounds belong to diverse chemical families, such as aldehydes, ketones, acids, furans, phenols, methoxyphenols, sugars, and oligomers. Among the products that can be obtained directly separated from bio-oil or produced after some reactions are fertilizers, pesticides, wood preservatives, resins, antioxidants, carbon fiber, alkylphenols, food additives, asphalt emulsions or specific compounds that can be used as base chemicals such as acetic acid, hydroxyacetone, hydroxyacetaldehyde, methanol or levoglucosan.

This study investigates the fractionation of bio-oil resulting from the fast pyrolysis of lignocellulosic biomass, aiming to segregate more homogeneous families of phenolic compounds based on molecular size. The fractionation process employs liquid-liquid extraction (water and dichloromethane) to separate the fractions according to their solubility, followed by flash liquid chromatography (of each main fraction), facilitating molecular size separation through gel permeation resin. The acquired fractions undergo inclusive analysis using various characterization techniques, including gas chromatography-mass spectrometry (GC/MS/FID) for the identification and quantification of volatile compounds, size exclusion chromatography (SEC) for assessing molecular weight distribution, and nuclear magnetic resonance spectroscopy (NMR) for elucidating functional groups, molecular structure, and the chemical composition of the nuclei within the molecules.

Biography

Chemical Engineer (2009); Official Master's Degree in Initiation to Research on Chemical Engineering and Environment (2010); PhD in Chemical Engineering (2015) (University of Zaragoza, Spain). From my Ph.D. thesis, my scientific career has always been related to the valorization of biomass waste via thermochemical processes either for energetic or chemical-obtaining purposes. More specifically, my Ph.D. dealt with sewage sludge gasification for syngas production and upgrading; more recently, I have been working on the production of antioxidant additives for biofuels from high-content lignin residues, as well as on the circular economy of livestock areas by evaluating the potential of this type of waste to be used as raw material in gasification for ammonia-obtaining, or as adsorbent materials after a pyrolysis stage. As a result of these investigation lines, I have published almost 20 papers in JCR journals, some of them relevant in terms of valuable contributions for other authors or in terms of internationalization by collaborating with foreign institutions (Université de Sherbrooke (Canada), DTU (Denmark)).

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PHENOLIC COMPOUNDS PRODUCTION VIA THE REDUCTIVE CATALYTIC FRACTIONATION

Z Afailal[1], N Gil-Lalaguna[1], M Høj[2], A Cornejo[3], JL Sánchez[1] and AD Jensen[2]

[1]Universidad de Zaragoza, Spain
[2]Technical University of Denmark, Denmark
[3]Universidad Pública de Navarra, Pamplona, Spain

Abstract:

Replacing fossil-based products with more sustainable resources, such as lignocellulosic biomass, for producing sustainable chemical products has become a universal challenge. In this field, reductive catalytic fractionation appears as a promising biorefinery strategy for efficiently utilizing lignocellulosic biomass components. In this work, this concept of biomass valorization was used to study the potential of an unexplored feedstock, argan shells (unexplored agricultural waste generated in Morocco from the production of argan oil). This material was processed in a non-catalytic route and over a Pd/C catalyst in two different reaction media. The effects of the treatment temperature (250, 275 and 300°C), as well as the catalyst loading (catalyst/argan shells mass ratio of 0.05 and 0.1 g/g), were also studied. The main product (lignin-derived oil) was thoroughly characterized using GC/MS/FID, SEC, and NMR. The highest monomer yields of 48-49 wt.% based on the lignin content were obtained for n-butanol/water reaction medium at 300°C using a Pd/C catalyst load of 0.1 g/g and for methanol reaction medium at 275°C and 0.05 g/g. Significantly lower monomeric phenols yields were obtained in the non-catalytic route (4-19 wt.% for n-butanol/water and 9-16 wt.% for methanol). The main phenolic monomers in the catalytic pathway were 4-n-propanolguaiacol, 4-n-propanolsyringol and 4-alkyl guaiacols and syringols, with some differences in the selectivities from one solvent to another.

Biography

Zainab Afailal is a Postdoctoral Researcher at Universidad de Zaragoza. She is passionate about developing and implementing innovative bioenergy solutions that address the global challenges of climate change, resource scarcity, and environmental sustainability. She has over six years of experience in the thermochemical processing of biomass waste, advanced biofuels, and textile residues, using various laboratory techniques and analytical skills. She holds a Ph.D. in Chemical Engineering and Environmental Technologies from the University of Zaragoza. She has published several research papers in reputable journals and participated in international conferences.

CARBON DIOXIDE SINK FROM SEVERAL MEXICAN PLANTS.

Enrique Barrera Calva, E Rosas CR and Barrera VEZ
Universidad Autónoma Metropolitana, Mexico

Abstract:

In this work 5 Mexican several plants with a quite similar biomass weight, were monitored in relation to the CO_2 sink in order to evaluate the photosynthesis rate, when that plants were submitted at different solar irradiation levels.

There are interesting the CO_2 sinks and the CO_2 evolution at night for each plant, and due the temperature and relative humidity also measured during the experiment, it is proposed a novel method to produce a natural air conditioner in the inner house in the cities.

Several graphs from the CO_2 sink during the day and the CO_2 evolution at night are presented and also the external temperature and the relative humid as a function of the hours of the day. Results are discussed and then an environmental and air conditioning to the inner houses strategy, at big cities, is proposed.

Biography

Enrique Barrera Calva holds a Degree in Chemical Engineer and he is currently working as a full Professor at Metropolitan Autonomous University.

RESEARCH ON ANAEROBIC DEGRADATION OF BIODEGRADABLE POLYMERS

Aleksandra Grabowiec, Beata Szatkowska, Renata Tomczak-Wandzel, Wiktoria Konopka, Robert Aranowski, Anna Dołęga, Anna Ciborska, Mateusz Kotowski, Stanisław Cytawa and Jan Hupka

Gdansk University of Technology, Poland

Abstract:

Biodegradable polymers gain increasing share as manufacturing material which can be easily blended with food waste and kitchen waste. Wheat bran plates, cellulose bags, and polylactide disposable cups impact on quasi-continuous anaerobic digestion (AD) process was studied in a battery of two laboratory bioreactors (10 dm^3 each) with respect to pH, total solids, and volatile solids in the digestate, as well as to gas composition and yield.

Paper bags used to collect organic waste and bran trays as disposable plates subjected to methane fermentation after grinding showed the highest biogas potential when were co-fermented with the kitchen waste separated from municipal solid waste (MSW). Both, the kitchen waste and shredded bioplastics subjected to methane fermentation separately emitted together less biogas than combined waste. Waste derived from cellulose and bran did not have a negative impact on the methanogenesis process, taking into account both the formation of volatile fatty acids, alkalinity and the final composition of biogas. Polylactide biopolymers (PLA), unlike cellulose-based biopolymers, did not show biogas potential and even had an inhibitory effect on the methane fermentation process.

Thermal pre-treatment and mechanical pre-treatment was applied to evaluate the biogas production rate from the organic fraction of MSW with bioplastics. This was done at 55°C and 95°C for 3h, and 24h at each temperature (4 different time-temperature conditions). The Automatic Methane Potential Test System (AMPTS II) was used to determine the highest Specific Bio-Methane Production (SBP).

It was expected that pre-treatment of bioplastics will increase the degradation rate during the AD thus biogas production will be enhanced, however, performed tests showed that PLA biopolymers did not decompose under AD and pre-treatment did not improve their decomposition. Polyhydroxyalkanoates (PHA) gave positive results regarding methane yield, but thermal pre-treatment decreased production. FTIR spectroscopy confirmed only minor chemical changes in PLA resulting from exposition to the fermenting slurry.

Acknowledgments: This research leading to these results has received funding from the Norway Grants 2014-2021 via the National Centre for Research and Development.

Biography

Aleksandra Grabowiec graduated from the Gdansk University of Technology in 2004 with M.Sc. degree in technical and industrial analytics. Ph.D. degree received in 2014 in chemical technology. Presently is employed as Project Manager in the Department of Process Engineering and Chemical Technology, Chemical Faculty at Gdansk Tech. Her research interests pertain to environmental aspects in water and biogas chemistry and technology.

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DEVELOPING BRASSICA CARINATA AS A BIOFUEL CROP

Ebtihal Mohamed, Caitlin Byrt, Julian Greenwood, Spencer Whitney, Harsh Raman, Tony Millar and Xue-Rong Zhou

The Australian National University, Australia

Abstract:

Renewable fuel oils are needed to replace fossil fuels to improve environmental sustainability and human health outcomes in the future. Crop bioengineering approaches have the potential to be applied to the challenge of changing the properties of the oils that crops produce so that agriculture can deliver oils with the properties needed to meet future fuel needs. *B. carinata* (*A. Braun*.) is of interest as a non-food oilseed with great potential as a feedstock material for producing renewable fuels. This project tackles the challenge of optimizing crop oil properties using two approaches. One approach involves testing the oil properties of a collection of *B. carinata* material to assess the variation in oil properties that diverse *B. carinata* lines naturally produce. A panel of diverse *B. carinata* accessions and a double haploid population panel were grown in the field and pots in Wagga Wagga, supported by the New South Wales Department of Primary Industries, Australia. Seeds were harvested at maturity and will be used for analysis of oil quantity and quality. Accessions of interest for further research will be identified based on accessions having high and low erucic acid. The second approach involves bioengineering *B. carinata* to introduce gene fragments that code for key enzymes that modify the chain length of fatty acids. This direction requires having an established transformation system. A transformation protocol for *B. carinata* is being tested which is based on a Brassica napus transformation protocol. There is potential to genetically reprogram Brassicas such that they can produce oils with desired fatty acid chain lengths. However, the first step is to understand which combinations of molecular mechanisms will be required to program Brassicas for this purpose. Plant species such as nasturtiums and meadowfoam display the potential to make long-chain fatty acids with desirable properties. We are testing whether molecular mechanisms of interest from nasturtiums and meadowfoam can be used in *B. carinata* to modify oil properties.

Objective of the Study: This study aims to (1) assess *B. carinata* oil quantity and quality in a diverse set of lines; (2) Optimize *B. carinata* transformation and (3) Manipulate *B. carinata* long chain fatty acids.

Materials and Methods:

Aim 1 involves growing a collection of diverse *B. carinata* lines (88 lines) from different geographical locations as well as a double haploid population (188 lines) in the field in a complete randomized block design. The seed is then harvested and assessed for oil traits to determine if there is material relevant for further study of genetic loci influencing oil properties.

Aim 2 involves optimizing a transformation protocol for *B. carinata* based on previous protocols developed for canola (Brassica napus) and cambe (*Crambe abyssinica*) transformation protocols.

Aim 3 involves reducing the expression of FAD2 (Gene ID: 820387) and introducing a gene that encodes the lysophosphatidic acid acyltransferase gene from Limnanthes douglasii (Ld-LPAAT) as well as introducing genes encoding Fatty Acids Elongases (FAEs) from two candidate plants; nasturtium (*Tropaeolum majus*) and

meadowfoam (*Limnanthes douglasii*) into *B. carinata*. The FAEs, Ld-LPAAT and FAD2 fragment expression will be driven by the Napin promoter. Arabidopsis thaliana will be used as a model species for introducing the constructs designed to alter fatty acid chain length as a short-term proof of concept in advance of attempting *B. carinata* transformation using the planned constructs.

Results and Discussion: A transformation protocol has been optimised for *B. carinata* based on canola (B. napus) and cambe (*C. abyssinica*) transformation protocols, and 72 plants have been taken through the process of tissue culture and 35 plants regenerated.

Acknowledgement: This research was funded partially by the Australian Government through the Australian Research Council.

Biography

Ebtihal Mohamed is an agronomy researcher who works for the Agricultural Research Corporation, Ministry of Agriculture, Sudan. She is working towards completing a PhD in plant sciences at the Australian National University, Australia, and is part of the Australian Research Council Training Centre for Future Crops Development. She has an M.Sc. and B.Sc (Honors) in Agriculture in (Horticulture) with (First Class), from the University of Khartoum. Ebtihal published two research papers and contributed to writing a book chapter. Ebtihal was awarded the following awards: *Crawford Fund student award, Crawford Fund for Food Secure World (June 27, 2023). *The Australian National University, University Research Scholarship (International) (738/2018) Stipend (9 June 2022). The Australian National University Higher Degree by Research Fee Merit Scholarship (744/2018) covering International Student Fees and Overseas Student Health Care (9 June 2022). *The 2018 Organization of Women in Science for Developing World (OWSD), Innovative Research Award in the field of innovative technologies, Trysta, Italy30 October 2018. *University prize for the best final year student in Horticulture option in the Faculty of Agriculture, University of Khartoum, 2015.

DEGRADATION OF POLYLACTIC ACID AND POLYPROPYLENE IN PILOT-SCALE TWIN AD BIOREACTORS

Mateusz Kotowski, Jan Hupka, Aleksandra Grabowiec, Ihor Oshchapovskyy, Stanisław Cytawa, Anna Dołęga and Anna Ciborska
Gdansk University of technology, Poland

Abstract:

Degradation rate of granulated polymers during AD of selectively collected kitchen and food waste, containing intentionally added PLA and PP, was evaluated. The process was conducted in a battery of twin 1000dm^3 bioreactors operated continuously under mesophilic conditions (temperature of 37°C). 1000 g PLA and 1000 g PP 3 mm granules were added to one bioreactor - while the other one served for a reference. The granules remained there for one year i.e. the entire time of operating the AD system.

Due to different density PP and PLA polymers remained separated during the process. PP resided in the top layer of the fermenting slurry, while PLA granules remained mainly below the stirrer zone near the bottom of the reactor. The PLA granules were drained when sample of digestate was being taken for analysis. After being screened-off from the digestate and brief characterization, the granules were returned readily to the reactor trough a lock. PLA was in the shape of flatted spheres while the polipropyle granules had cylindrical shape. The granules were weighed before experiments and the average mass of a single granule was determined.

The extent of plastic degradation was assessed basing on changes in granule mass, topographical analysis under optical and SEM microscopies, as well as using FTIR spectroscopy. Despite minute share of the plastic in the dry mass of the slurry and low specific surface of the granules, the abrasion combined with biodegradation of the PLA resulted in ca. 30% mass loss. As expected, the PP granules remained intact with a slight indication of mass gain. Eventual micro-plastics resulting from the PLA degradation were not much evident as indicated by FTIR spectroscopy search including FTIR microscope

Acknowledgements: This research leading to these results has received funding from the Norway Grants 2014-2021 via the National Centre for Research and Development.

Biography

Mateusz Kotowski graduated from the Gdansk University of Technology in 2021 with the M.Sc. degree in process engineering. Presently is employed as Research Assistant in the Department of Process Engineering and Chemical Technology, Chemical Faculty at Gdansk Tech. His research interests includes magnetic separation, instrumental analysis and size reduction of biomass.

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INFLUENCE OF OXIDATION-REDUCTION POTENTIAL ON HYDROGEN PRODUCTION BY DARK FERMENTATION USING GLUCOSE AND SYNTHETIC DEPACKAGING FOOD WASTE AS SUBSTRATES

Ana-Rosa Fleitas García

Université Clermont Auvergne, France

Abstract:

Background: Dark Fermentation (DF) holds great potential for bio-hydrogen production. There are many parameters that affect yields and productivities in these processes. Some of them, such as temperature, stirring or substrate concentration have been extensively studied. However, the impact of Oxidation-Reduction Potential (ORP) remains unclear.

Objective: To study the influence of the initial ORP on the hydrogen production by DF using two different inoculum and substrates.

Methods: DFs were carried out on two media containing either glucose or Synthetic Depackaging Food Waste (SDFW) as substrate. Two different types of inoculums, one coming from a biogas plant and one from Depackaging Food Waste (DFW) were used to inoculate, respectively. Batch fermentations were performed in Stirred Tank Reactors (4.3L) utilizing different initial ORPs. Real-time monitoring of the ORP, pH, temperature and gas flow was performed. Moreover, metabolites and hydrogen produced, hydrogen yields and productivities, and kinetic parameters were determined, and a bacterial population analysis was conducted.

Results: Results on SDFW and DFW exhibited an increase of 36% and 27% in yield and productivity, respectively, at -326 mV compared to -166 mV. Also, at lower ORPs, butyrate and acetate type fermentation were favored, limiting propionate accumulation. Likewise, in glucose and mineral solution medium with the inoculum coming from the biogas plant, the yield and productivity improved by 70% and 69% at -286 mV in contrast to -219 mV, with a preference for butyrate-type fermentation. Furthermore, in both sets of experiments, a higher relative abundance of *C. butyricum* was observed at the peak of production when working with the initial ORPs that allows to have the highest productivities and hydrogen production yields.

Conclusion: The initial ORP is a parameter to be considered when optimizing H_2 production by DF, as it can favors the development of *C. butyricum*, affecting the H_2 yields and productivities.

EXPERIMENTAL INVESTIGATION OF THE PERFORMANCE AND EMISSION CHARACTERISTICS OF A DIESEL ENGINE FUELLED BY BIO-ADDITIVES UNDER VARIABLE OPERATING PARAMETERS

Faisal Mahroogi
Islamic University of Medina, Saudi Arabia

Abstract:

Saudi Vision 2030 is a government program launched by the Kingdom of Saudi Arabia that aims to increase diversification economically, socially, and culturally. With a commitment to clean energy and sustainability, the Kingdom is leading the charge in tackling energy and climate challenges with innovative solutions such as the Circular Carbon Economy (CCE) and an increasingly diverse energy mix. Sustainability is vital to Saudi Arabia's Vision 2030 as the Kingdom strives towards a Net Zero future by 2060. Vision 2030 is becoming a global model on the journey towards a sustainable future by taking a responsible and creative approach to today's energy and climate challenges. As per the Ambitions of the National Environment Strategy of the Saudi Ministry of Environment, Agriculture, and Water (MEWA), raising environmental compliance across all sectors and reducing pollution and adverse environmental impacts are critical focus areas.

Therefore, the present paper introduces an experimental investigation of the performance and exhaust emissions of a variable compression ratio diesel engine operating with diesel and diesel-fuel additives. The engine type used is a one-cylinder natural-aspirated constant-speed direct-injection diesel engine. The main variables of the study were the load, the compression ratio, and the fuel type. The combustion, performance, and emissions characteristics were investigated.

The study results show that the engine emissions of carbon monoxide (CO), unburned hydrocarbons (UHC), and smoke opacity vary considerably with the operating parameters. Concerning engine performance, the cylinder pressure and heat release rate (HRR) are sensitive to the load, fuel type, and compression ratio variation.

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A RESEARCH ON THE UTILIZATION METHODS OF THE WORLD'S ONLY ECO-FRIENDLY RESOURCE CIRCULATION SYSTEM, BIO-BUNKER OIL FOR POWER PLANTS

Kihoon Lee

Sogang Univ Graduate School, South Korea

Abstract:

The core objective of this research is to propose a sustainable solution for addressing environmental issues and energy security concerns through the development of a global eco-friendly resource circulation system, with a focus on the utilization of bio-bunker oil. Bio-bunker oil, derived from renewable resources, possesses environmentally friendly characteristics, contributing to a reduction in carbon dioxide emissions. The efficient production process of bio-bunker oil is investigated to minimize environmental impacts and explore sustainable resource acquisition methods, emphasizing the use of agricultural products, marine vegetation, and waste materials.

Furthermore, from the perspective of power plant design and technology, the study aims to construct eco-friendly power plants efficiently. The goal is to minimize the environmental impact during the conversion of bio-bunker oil into eco-friendly energy and maximize environmental friendliness through the development of sustainable power plant technologies.

The research outcomes are expected to contribute to the establishment of a eco-friendly resource circulation system, centered around bio-bunker oil, thereby fostering sustainable development and contributing to the global transition towards eco-friendly energy. In the context of South Korea, the country currently operates two 240 MW-scale power plants utilizing bio-bunker, making it the only nation globally to employ bio-bunker for power generation. However, the eco-friendly nature of bio-diesel suggests that its use in power plants worldwide could significantly contribute to global carbon reduction policies.

Wärtsilä, a company producing power facilities using liquid biofuels, has installations of such facilities in various regions worldwide. Considering this, if research confirms the compatibility of South Korea's bio-bunker oil with Wärtsilä's liquid biofuel power facilities through collaborative research, it could open avenues for South Korea's eco-friendly bio-bunker oil to be utilized as fuel for Wärtsilä's generators globally. This, in turn, has the potential to support carbon reduction policies across nations, contributing to a more sustainable global energy landscape.

CHARACTERIZATION OF MOLECULES OF INTEREST FOR ALGAL BIO-FUEL

Hela Friha
IPSA, France

Abstract:

Microalgae are getting a lot of interest one of the best renewable resources for bioenergy and other high value-added products. These products can be successfully exploited in different industrial sectors. Today, there are a wide variety of commercial and industrial applications of the algal biomass produced from the cultivation of these microorganisms.

Given the alarming climate situation, it is necessary to reduce the emission of greenhouse gases. In addition to carbon dioxide (CO_2), greenhouse gases include vapor, methane, nitrous oxide, ozone and fluorinated gases. Carbon dioxide alone is responsible of 55% of the anthropogenic greenhouse effect (according to the GIEC), ejected mainly during the combustion of fossil fuels. It is proven that microorganisms are efficiently reducing CO_2 compared to plants.

In the factory-grown microorganisms, the inorganic carbon in the form of CO_2 is assimilated through light-induced photosynthesis resulting in the production of O_2 and value-added products such as lipids, sugars and proteins and other pigments.

The aim of this study is to provide a detailed analysis of the lipids and liquid hydrocarbons present in the biomass of green microalgae. To this end, we used Raman spectroscopy, which has proved useful for characterizing the composition of biofuels. We carried out two parallel studies – an experimental and a theoretical one. From our experimental study based on the Raman spectra of the biomass obtained from the microalga Nannochloropsis, we concluded that under the conditions of the experiment, little lipids and hydrocarbons are present in the biomass.

Using state-of-the-art tools for conformational analysis in combination with density functional theory (DFT), we computed the Raman spectra of multiple conformers of a prototype molecule, the myristic acid, which is known to be present in the algal biomass. Our first results show a dependence of the Raman spectra on the presence of solvent (water, in this case), as well as a strong dependence of the vibrational spectrum on the underlying molecular structure.

MODELING ENERGY TRANSITION OF SENEGAL IN THE CONTEXT OF CLIMATE CHANGE

Tine Andre Hyacinth Latyr
China University of Petroleum (CUPB), China

Abstract:

The energy transition towards sustainable and resilient systems is paramount for countries like Senegal, facing the dual challenge of energy access and climate change impacts. This study focuses on developing a comprehensive modeling framework to analyze and forecast the energy transition dynamics of Senegal in the context of climate change.

Objective: This research aims to provide insights into the complex interactions between energy systems and climate change in Senegal. By employing advanced modeling techniques, our objective is to assess various energy transition pathways, evaluate their socioeconomic and environmental implications, and identify strategies to enhance resilience and sustainability.

Materials and Methods: We adopt a multi-disciplinary approach that integrates data-driven modeling, scenario analysis, and stakeholder engagement. Utilizing the Long-range Energy Alternatives Planning (LEAP) software developed by the Stockholm Environment Institute (SEI), we develop a dynamic model to simulate the energy transition process, considering key factors such as renewable energy integration, energy access improvement, and climate change impacts. Three scenarios are constructed to explore different future trajectories for Senegal's energy transition.

Inclusion Criteria: Parameters such as relevance to Senegal's energy landscape, availability, and reliability.

Exclusion Criteria: Data that are outdated, inaccurate, or not applicable to the context of Senegal.

Results and Discussion: Preliminary findings highlight the significant potential of renewable energy sources, particularly solar and wind, in driving Senegal's energy transition. Scenario analysis reveals the trade-offs between different transition pathways in terms of energy security, economic development, and carbon emissions reduction. Moreover, our results underscore the importance of policy interventions and investment strategies to accelerate the transition while addressing socio-economic disparities and climate vulnerabilities.

Conclusion: In conclusion, this research contributes to the understanding of energy transition dynamics in the context of climate change adaptation and mitigation efforts in Senegal. The findings provide valuable insights for policymakers, energy planners, and stakeholders to design effective strategies and policies to achieve sustainable and resilient energy systems. By fostering interdisciplinary collaboration and knowledge exchange, we aim to support Senegal's journey towards a low-carbon, climate-resilient future.

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SYNTHESIS OF BIOFUELS AND BIOCHEMICAL PRECURSORS BY CHAIN ELONGATION OF ETHANOL AND ACETATE USING *CLOSTRIDIUM KLUYVERI*

Otálora Fabián, Suazo Andres, Martínez Jimmy, Pamela Cortes, Conejeros Raúl, González Ernesto and Aroca Germán

Pontifical Catholic University of Valparaíso, Chile

Abstract:

Background: Medium Chain Carboxylates (MCCs) are organic compounds that can replace fossil derivatives in renewable energy, biomaterials, and pharmaceuticals. Ethanol is the carbon and energy source for *Clostridium kluyveri* to produce them. The ethanol:acetate ratio (E:A) affects the MCCs production, growth rate, and product range. High ethanol or acetate concentration can cause inhibition or decrease growth rate. Therefore, it is essential to evaluate these variables and to find optimal E:A ratios.

Objective: The aim of this study was to elucidate the effect of different initial concentration ratios of ethanol:acetate on the production of medium-chain fatty acids, specifically the synthesis of butyrate and caproate.

Methods: Nine E:A ratios with low, midst and high ethanol concentrations were tested. *Clostridium kluyveri* DSM 555 was grown on DSMZ 52 medium at 37°C and 100 rpm, a pH 6.5 with a working volume of 250 mL in 500 mL serum bottles. The headspace had 27% CO_2 and 73% N_2 at 0.5 bar. Triplicate cultures were sampled for 62 h to measure biomass, substrates, and products.

Results: This study examines how *C. kluyveri* responds to ethanol:acetate ratio. High ethanol concentrations reduce biomass and products, due to ethanol toxicity, enzyme inhibition, and osmotic imbalance. However, *C. kluyveri* should tolerate higher ethanol levels than tested here. Caproate production depends on acetate concentration, which is the initial electron acceptor. The highest caproate concentration (9.80 g/L) was obtained at lowest acetate concentration (4.11 g/L). μmax increased with E:A ratio in each ethanol level but decreased with high ethanol and acetate concentrations.

Conclusion: Medium chain carboxylates biosynthesis depends on initial ethanol:acetate ratio. Optimal ratio was 1.12 (15.78:14.05) for chain-elongation. *C. kluyveri* can tolerate high ethanol and butyrate (26,9 g/L and 6,1 g/L respectively).

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GLOBAL BIOFUEL SUPPLY AND DEMAND OUTLOOK: IMPACT OF LEGISLATIVE DEVELOPMENTS AND FEEDSTOCK IMPLICATIONS

Ferrera Rojano and Gabriel

Stratas Advisors, Spain

Abstract:

This presentation delves into the global landscape of biofuel supply and demand, specifically focusing on Biodiesel (FAME), Ethanol, Hydroprocessed Vegetable Oil (HVO), and Sustainable Aviation Fuel (SAF). As the world transitions towards sustainable energy sources, understanding the dynamics of these biofuels is crucial for informed decision-making.

Despite the emergence of diverse decarbonization alternatives for the transport sector, the demand trajectory through 2050 is projected to be spearheaded by challenging-to-decarbonize transport sectors. Meanwhile, this trend unfolds in tandem with the progressive development of sustainable feedstock potential within key markets. The intricate interplay between regulatory dynamics and feedstock accessibility underscores the complex landscape of global biofuel adoption and its trajectory toward a more sustainable future.

The increasing emphasis on emission reduction obligations is emerging as a significant global driver, incentivizing the uptake of biofuels over conventional volumetric-based mandates. In addition, biofuel blending limits stand out as a pivotal factor influencing the adoption of road biofuels, while

SAF and shipping biofuel use incentives are becoming more palpable in strategic markets. Recent regulatory developments, such as the FuelEU maritime incentive and the RefuelEU Aviation initiative in Europe, alongside the US Inflation Reduction Act and emerging incentives in Asia and Latin America, are anticipated to catalyze the widespread deployment of biofuels on a large scale. The hard-to-electrify transport sector is forecasted to lead to global biofuel uptake growth, while alternative SAF production pathways provide a promising outlook.

Despite stagnant sustainable feedstock availability in major consuming regions such as Europe and North America, changing biofuel consumption patterns and improved feedstock collection rates in high-potential regions such as Asia will guarantee sufficient sustainable feedstock availability throughout 2050.

INNOVATING INDUSTRIES WITH SUSTAINABLE BIOMASS

Nicholas B. Dottino
Graanul Invest, Estonia

Abstract:

Delving into biomass's future growth trajectories, its enduring influence on the energy scene is evident, and yet, untapped sectors beckon. What new frontiers will biomass chart, and how can we steer towards the most promising horizons? Nicholas B. Dottino, CEO of Graanul Invest, invites you to explore the pioneering prospects of sustainable biomass in emerging domains such as Sustainable Aviation Fuel (SAF), cutting-edge biofuels, and a spectrum of other industries poised for transformation.

SUSTAINABLE PRODUCTION SYSTEM FOR NYAMPLUNG TREES (*CALOPHYLLUM INOPHYLUM* LINN.) FOR REDUCTION OF CARBON EMISSIONS IN AGROFORESTRY SYSTEMS SUPPORTS CLIMATE CHANGE MITIGATION

Tri Martini, Hano Hanafi, Heru Susanto, Helena Lina, Tri Cahyono, Rahadian M, Tri Wahyuni, Meidaliyantisyah, Taupik Rahman, Catur O Indry and Elly K Purwendah

Research and Innovation National Agency, Indonesia

Abstract:

Indigenous tree species play an important yet underestimated role in tropical ecosystems' carbon sequestration, mitigating global climate change. Tamanu (*Calophyllum inophyllum* LINN), an indigenous tree species, is studied for its carbon sequestration capacity in Gunung Kidul, Yogyakarta, Indonesia, an environmentally diverse location. Our comprehensive investigation included aboveground and belowground biomass, soil carbon concentration, and understory carbon content in 6-years-old tamanu stands. The study found that tamanu stands can store carbon in their biomass, understorey, and soil, i.e., 54.2, 0.5, and 64 tons/ha, respectively. It was also shown that soil stores the most carbon because Tamanu planted in this study area are still relatively young with relatively large space. This study also revealed the understory plants' often overlooked role, increasing these ecosystems' carbon sequestration capability. The need for comprehensive conservation programs considering carbon storage above and below ground is highlighted. The above discoveries contribute to creating efficient local climate mitigation policies and the global effort to combat climate change.

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IN-SIU BIOMETHANATION IN HIGH-RATE ANAEROBIC WASTEWATER TREATMENT

PY Nguyen

University of Galway, Ireland

Abstract:

Background: The endogenous CO_2, one of the main compounds of biogas, can combined with injected exogenous H_2 and bio-transformed into CH_4 by in-situ biomethanation, using the capacity of the indigenous methanogens of the existing anaerobic digestion system. The technology can be employed in existing anaerobic digestion of wastewater treatment plants for production of biomethane, which can be used directly as vehicle fuel or injected into the natural existing gas grid, thereby contributing significantly to the transition from a fossil fuel-based economy to a more renewable energy based circular economy.

Objective: To evaluate the efficiency and stability of in-situ biogas upgrading in high-rate anaerobic wastewater treatment at high organic loading rate (OLR) during long-term continuous operation using different gas diffusion devices.

Methods: An expanded granular sludge bed system for treating biofuel condensate wastewater was operated over a year at different OLRs ranging from 10 to 15 gCOD/Lr/d to study the effect of different gas diffusion devices, i.e., ceramic fine and coarse diffusers, and silicone membrane gas exchangers, on the efficiency and stability of in-situ H_2 assisted biogas upgrading.

Results: An increase in H_2 utilization efficiency of >92% was obtained by applying membrane, compared to 81% and 75% with fine-bubble and coarse-bubble diffusers, respectively. With the membrane gas exchange application, a high CH_4 content in the biogas up to 85% and CO_2 concentration approximately 10% and H_2 content < 5% were achieved at a H_2 feeding rate of 4.18 NL-H_2/L_r/d and OLR of 10 gCOD/L_r/d. No accumulation of VFA in the effluent was observed during the operation.

Conclusion: The H_2 diffusion devices affect the gas-liquid mass transfer of H_2 and the biogas composition. The membrane gas exchanger exhibited best performance compared to coarse- and fine-bubble diffusers. In-situ biogas upgrading performance at long-term is resilient regardless of operational changes. Further optimization is still ongoing, targeting a higher OLR.

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OPTIMIZATION OF BIODIESEL PRODUCTION FROM HYBRID BLEND OF KARANJA AND *C. VULGARIS* OIL USING RESPONSE SURFACE METHODOLOGY AND ARTIFICIAL NEURAL NETWORK MODELING

Sujeet Kesharvani

Maulana Azad National Institute of Technology, India

Abstract:

Renewable and sustainable energy resources have been broadly used in the present scenario in order to reduce environmental pollution and accommodate world energy consumption. Biodiesel, an eco-friendly biofuel derived from non-edible and algae oil sources, holds promise for sustainable energy production. This study employs a response surface approach and an artificial neural network model to predict and optimize biodiesel yield. Specifically, a blend of Karanja and *C. vulgaris* oils at a volumetric ratio of 75:25 percent was used to reduce free fatty acid content by around 1%. The biodiesel production process involved a single-step transesterification process, with the following optimal conditions identified: 1.09% (w/w) catalyst amount, 91.47 minutes reaction time, 56.86°C reaction temperature, and an 8.46:1 methanol to oil molar ratio. Under these conditions, a remarkable biodiesel yield of 97.55% was achieved. Comparing experimental results to those predicted by the response surface methodology (RSM) revealed good agreement. Additionally, an assessment of the environmental factor (E factor) demonstrated a value of 0.0251 at maximum biodiesel yield. This lower E factor signifies minimal waste generation during biodiesel production, reaffirming the eco-friendly nature of the biodiesel synthesis process. Biodiesel, produced from a blend of Karanja and *C. vulgaris* oils through an optimized transesterification process, exhibits promising physicochemical properties, making it a viable alternative to conventional diesel fuel. The following key properties were assessed: density (862.25 kg/m^3), kinematic viscosity (3.82 mm^2/s), calorific value (41.82 MJ/kg), and cetane number (54.34). These values indicate that the obtained biodiesel closely matches the characteristics of diesel fuel, suggesting its suitability for use in diesel engines without significant modifications. This study underscores the potential of biodiesel as a sustainable and environmentally friendly substitute for conventional diesel fuel, contributing to reduced greenhouse gas emissions and a more sustainable energy future.

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CHEMICAL COMPOSITION AND BIOCHEMICAL EFFECTS OF STACHYTARPHETA CAYENNESIS ESSENTIAL OIL ON LIPID AND HORMONAL PROFILE OF ALBINO WISTAR RATS

Okonkwo, Chibuzor Onyinye Uyang, Glory Akomaye Okonkwo, Sunday Nnamdi

University of Calabar, Iran

Abstract:

This research evaluated the chemical composition of essential oil extracted from the leaves of *Stachytarpheta cayennensis via* Gas chromatography-Mass spectrometry (GC-MS) analysis. The effect of essential oil on some biochemical indices of Wistar rats was also analyzed. The major compound identified in the oil is 5-octadecane with concentration 37.69% followed very distantly by cyclopenta[c]pyran-4-carboxylic acid (7.77%). Others are tetracosane (4.46%), 2, ethyl-1 dodecanol (4.34%), 9 octadecenamide (3.51%), 1,2-benzene dicarboxylic acid (2.77%) and 2-(3,4-dimethyloxyphenyl)-2,3-dihy-(2.08%). Twenty-eight (28) albino Wistar rats weighing between 150-180g were divided into seven groups of four rats each. Group A served as negative Control, B1, B2, B3 were exposed to 500 mg, 300 mg and 150 mg respectively, of a household insecticide (BNC), while S1, S2, S3 were exposed to 5000 mg/kg, 3000 mg/kg and 1500 mg/kg body weight respectively of essential oil once daily for 28 days. Throughout the experiment, animals were fed ad libitum with standard feed and drinking water. After twenty-eight days of exposure, they were sacrificed after an overnight fast, with ketamine injection as anesthesia. Blood samples were collected by cardiac puncture for biochemical analysis. Testosterone, luteinizing hormone (LH), and estradiol concentrations were determined using enzyme-linked immunosorbent assay (ELISA). The result revealed significant decrease ($P<0.5$) in hormone levels in rats expose to BNC insecticide relative to the control. Lipid profile levels, TC, TG, LDL-C and VLDL-C increased while HDL-C decreased significantly ($p<0.05$) in the BNC exposed rats with no significant alteration in *S. cayennensis* essential oil groups relative to the control group. The observation from this study suggests that while synthetic household insecticide may be deleterious to human health following exposure, bio-insecticides present an affordable and effective alternative for pest management with less toxicity to non-target organisms.

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Biofuels and Bioenergy

April 11-12, 2024 | Rome, Italy

TAILORING THE TRANSESTERIFICATION ACTIVITY OF MGO/OXIDIZED G- C_3N_4 NANOCATALYST FOR CONVERSION OF WASTE COOKING OIL INTO BIODIESEL

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Abstract:

As a prospective heterogeneous catalyst for transesterification, magnesium oxide (MgO) has long been regarded as a possible candidate. Pure MgO, on the other hand, has a narrow range of applications because of its small surface area and short catalytic lifetime. To overcome these problems, in this work, graphitic carbon nitride (g-C_3N_4) with higher oxygen doping levels was applied to construct a noteworthy, persistent, and carbon-modified MgO catalyst. The molar ratios of urea to melamine and the mass ratios of oxidized g-C_3N_4 to MgO in the preparation step are two effective parameters, which were optimized with the Response Surface Methodology (RSM). The significant increase in oil conversion was attained by incorporating O@g-C_3N_4 nanoparticles composed of urea to melamine at a molar ratio of 2:1 in MgO at a mass percentage of 16.7. O@g-C_3N_4 had an outstanding effect on the immobilization of oxygen-rich functional groups on the MgO-based catalyst and an increase in the surface area. Also, the effects of transesterification parameters and their interactions on oil conversion were explored using the RSM, and then reusability tests were carried out using the fine-tuned parameters. The prepared catalysts were characterized using a variety of methods, including Field-Emission Scanning Electron Microscopy with Energy Dispersive X-ray Spectroscopy (FESEM-EDS), Fourier Transform Infrared (FTIR) spectroscopy, Temperature

Programmed Desorption of CO_2 (CO_2-TPD), Brunauer-Emmett-Teller (BET) analysis, and powder XRay diffraction, in order to determine their basicity, morphology, and composition. The optimum biodiesel yield of 98.80% was attained at 99.6°C for 133 min with a catalyst quantity of 5.9 wt.% and a methanol to oil molar ratio of 14.6. The stability and lifespan of the as-optimized catalyst ($OCN_2MgO_{(0.2)}$) were confirmed over four consecutive cycles. It can be concluded that this solid catalyst could be used to convert low-cost waste cooking oil into biodiesel in a single step.

BIODEGRADATION OF PETROLEUM HYDROCARBONS CONTAMINATED SOIL BY ALFALFA GRACE SPECIES (*MEDICAGO SATIVA L.*) PRELIMINARY EXPERIMENTS ON A GLASS HOUSE SCALE

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Abstract:

In recent year, biological remediation management options of contaminated oil and gas drilling waste, including bioremediation and phytoremediation has been used as environmental friendliness and cost-effectiveness techniques to remediate contaminated sites in oil and gas industry.

In Libya many challenges prevent execution of waste management solutions such as thermal or chemical and physical methods for treatment of drilling waste produced from oil and gas drilling operations. The main problems are the lack of appropriate infrastructure and technical experience needed for management and disposal for this type of waste.

In this study, phytoremediation of drilling waste contaminated soils was tested using Alfalfa grace (*Medicago sativa L.*) species. A glasshouse experiment evaluated the ability of grass to survive, degradation of petroleum hydrocarbons in contaminated soils. In this study, Alfalfa grace (*Medicago sativa L.*) was planted in soil comprising different ratios of soil: waste to examine the effect of petroleum hydrocarbons concentrations and heavy metals in growth of the grass. Biomass measurements including shoot biomass, grass height, leaf area, roots height and density were made, in addition to testing the efficiency of this grace in removal of petroleum hydrocarbon and heavy metals contamination, and the role of microorganisms and enzymes in the dissipation of petroleum hydrocarbons.

This research suggested that Alfalfa grace (*Medicago sativa L.*) is a useful species for phytoremediation of soils contaminated by drilling waste in Libya. Alfalfa grace also is shown to have the potential to remediate soils contaminated by petroleum hydrocarbons when the contamination level below 7350 mg kg^{-1} TOC. The grass offers an environmentally-friendly, cost-effective waste management option for some sites despite requiring a longer time. Results from this study are helpful for further field biodegradation treatments.

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Note:

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London, UK

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