Book of Abstracts

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Nigerian National Anthem

1. Arise, O compatriots, Nigeria's call obey
   to serve our fatherland
   with love and strength and faith.
   The labour of our heroes past
   shall never be in vain,
   to serve with heart and might
   one nation bound in freedom, peace
   and unity.

2. God of creation, direct our noble cause
   Guide our leaders right
   Help our youth the truth to know
   In love and honesty to grow
   And living just and true
   Great lofty heights attain
   To build a nation where peace and
   justice reign.

The National Pledge

I pledge to Nigeria, my country
To be faithful, loyal, and honest
To serve Nigeria with all my strength
To defend her unity
And uphold her honor and glory
So help me God.

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Huddle Room 1/Online Bioenergy & Green Chemical Technology

Modeling and Optimization of Biosurfactant Production Using Artificial Neural Network Training Algorithm and Response Surface Methodology

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ABSTRACT

Process optimization is germane in chemical and biological processes in order to enhance system operation and ensure peak performance. The aim of this study was to model and optimize the culture conditions for biosurfactant production by *Bacillus licheniformis* STK 01 using response surface methodology (RSM) and artificial neural network (ANN). Fermentation experiments were carried out for 24 h, while investigating the interactive effects of substrate concentration, pH and temperature on the system response. The biosurfactant produced gave a highest surface tension reduction of 30 mN/m at 42°C, pH 8 and substrate concentration of 4% (w/v). Experimental data was modeled by reduced quadratic model, while the model analysis showed a 99.8% significant level and the coefficient of determination (R^2) to be 75%. However, ANN model performance plot indicated the best validation of 6.9854 at epoch 1, with R^2 value of 91.02%. Furthermore, by numerical optimization, a surface tension reduction of 26.56 mN/m is achievable if the system is operated at optimum conditions of; pH 6.72, substrate concentration 4% (w/v) and temperature 44.74°C. This surface tension reduction is significant, which indicates the strength of RSM and ANN for process optimization.

Keywords: Artificial neural network; Biosurfactant; Optimization; Response surface methodology; Surface Tension

Estimation Of Energy Yield Of Biogas Produced From Anaerobic Digestion Of Organic Wastes

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Abstract

The study estimated and optimized the energy yield of biogas produced from the anaerobic co-digestion of organic wastes. The biogas was produced through co-digestion of kitchen wastes with poultry droppings, cow manure, and their mixture at 37 °C for 30 days. The result of the study showed 78.3% and 31.45% increase in the biogas yield when kitchen wastes were co-digested with poultry droppings and cow manure respectively, while a decrease of 42.4% in biogas yield was observed from the co-digestion of kitchen wastes with the mixture of poultry droppings and cow manure. Likewise, the co-digestion of kitchen wastes with poultry droppings, cow manure, and their mixture generated biogas with 2.7%, 4.1%,

and 3.6% reduction in energy yield respectively. The study concluded that kitchen wastes improved the biogas yield from poultry droppings, and cow manure, but generated biogas with reduced energy yield.
Key Words: Organic Wastes; Biogas; Anaerobic Co-digestion; Energy Yield

Prediction Of Higher Heating Value Of Biomass Based On Ultimate And Proximate Analyses

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ABSTRACT

High heating value (HHV) of biomass is important for the design and operation of biomass based processes. Experimental determination of this property is always time consuming and expensive. This paper compares existing empirical correlations based on proximate and ultimate analysis of biomass for the determination of the HHV. The correlations were validated from experimental data for twelve biomass that are typical to Nigeria. The correlation based on proximate analysis with the least error is $HHV = (354FC + 170.8VM)/1000$ *with a mean absolute error of prediction in the range 0.12 to 5.71 and average absolute error of 0.71 to 23.9%*

The Average absolute error of the correlation $HHV = 0.3897C + 0.2976$ *from ultimate analysis ranges from 0.09 to 28.9% and the Mean absolute error ranges from 0.015 to 4.71. The predictions from the correlations are not showing good agreement with the experimental data. There is a need to develop correlations based on ultimate and proximate analysis for biomass that are typical to Nigeria.*

Keywords: Biomass; High Heating Value; Proximate analysis; Ultimate Analysis

Huddle Room 2/Online Chemical Engineering Education & Covid-19 Impact

Design And Deployment Of A Student-Centered Mobile App For Solving And Grading Unconstrained Multidimensional Optimization Problems

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ABSTRACT
Digitalization can be used to make learning in chemical engineering curriculum more interactive and student-centered. In this work, POAST Suite 1.0 was developed using Microsoft Visual Studio 2019 as Integrated Development Environment, C# as programming language and Xamarin Forms as mobile platform.to solve multidimensional unconstrained optimization problems using two Search Methods (Hooke's and Jeeves and Nelder - Mead) and two Gradient Methods (Davidon Fletcher Powell and Fletcher – Reeves). The App was successfully deployed to Android phones and tested with ten 2-variable second order polynomials. All the problems used to test the application have the same level of difficulty. Also, the App comprises seven sections which makes it easy to understand the programming logic. The App gave correct answers for all problems solved. Feedback from the deployment of the App on different mobile phones showed that the app returns the correct scores for the users.

Keywords: max. *Student-Centered Learning; Digitalization; Numerical Optimization Methods; Mobile App*

Web Applications and Online Resources for 21st Century Chemical Engineering Education: A Review

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ABSTRACT
The chemical engineering profession has evolved over the years. The areas in which chemical engineering finds application has gone beyond the boundaries of the traditional chemical industry. The demands of the industry on new chemical engineering graduates have changed over the years and the Covid-19 pandemic brought an urgency on institutions of higher learning to move learning online. The use of web applications and online resources are not new and can be blended with in-class lectures to deliver some of the deliverables expected from chemical engineering programs including ability to handle experiments remotely. This paper explores the trend in teaching chemical engineering in a more digitized world and how these digital tools can be used effectively in chemical engineering education.

Keywords: *Covid-19; flipped classroom; chemical engineering education; virtual lab; digital tools*

Owner's Cost Controls & Cost Optimization Processes And Practices –NOC COVID 19 Dimensions

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ABSTRACT

Covid-19 dealt a serious blow on the global economy including National Oil Companies' (NOC) bottom lines. The revenues of several National Oil companies nose-dived to near zero while costs of operations and maintenance persisted. This particular NOC deployed some cost controls and cost optimization techniques that enabled it not only to weather the storms but also enabled it to turn the curves. Today, those techniques are continued to be deployed and is helping the NOC to gain wider stakeholder acceptance than ever before. The paper underscores the checklists and significant cost reduction cum cost optimizations initiatives deployed by the NOC. Finally, the paper identifies a number of issues and offer best practices for the benefit of the NSChE community, other NOCs and industry in general

Virtual Room 1(Online alone) Waste Processing & Resource Recovery

Development Of A Novel Biosorbent From Groundnut Shell For Treatment Of Industrial Wastewater

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ABSTRACT

The treatment of wastewater to meet the environmental standard is a challenge due to rising cost of treatment materials; hence the need for cheaper and renewable options. This study deals with the preparation and testing of low-cost adsorbents produced from groundnut shell (GS) for industrial waste water treatment. The study involves the modification of groundnut shell using HCL and NaOH. The modified biosorbents were characterized using Fourier transform infrared (FTIR), Scanning Electron Microscopic (SEM) and Brunauer-Emmett-Teller (BET). FTIR was carried out in order to identify functional group present in the GS. The SEM analysis reveals that the morphological exterior surfaces of the adsorbent were large, well developed and shallow honey comb like structures were discovered in the modified GS with NaOH. The energy dispersive X-ray analysis showed the elemental composition of the GS. The BET results showed that the adsorbent had a pore size of 6.503 nm and 6.552 nm, pore volume of 0.381 cc/g and 0.250 cc/g and Surface area of 1068 m^2/g and 712.6 m^2/g for modified GS with HCL and NaOH respectively. In general, the developed biosorbents exhibited recommendable characteristics suitable for industrial wastewater treatment for removal of oil and suspended solids.

Secondary Gold Recovery From E-Waste Using Aqua Regia Hydrometallurgy Process

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ABSTRACT
This research involved extraction of gold in solution using a more environmentally friendly hydrometallurgical process as against the commonly used pyro-metallurgical process. The materials utilized were sourced locally in Bauchi metropolis in a bid to reduce the exportation of E-waste out of Nigeria. Upon completion of the extraction process, using C1 (65% HNO_3 and 35% HCl), C2 (65% HNO_3 and 40% HCl) and C3 (65% HNO_3 and 45% HCl) concentrations of Aqua regia, it was discovered using Energy dispersive X-Ray Florescnce (XRF-ED) analysis that the most efficient in the extraction was C3 concentration. The kinetic study carried out on the obtained result suggested that the reaction of C1 and C2 were second order reactions which implies that the rate of the reaction is directly proportional to the square of the concentration of the reactant. However, rate of reaction in C3 could not be adequately represented by the tested irreversible kinetic models. These conclusions were arrived at due to the calculated coefficient of determination value.

Keywords: *Electronic waste; gold concentration; reaction kinetics; R-squared; XRF-ED.*

The Design, Fabrication and Evaluation of a Pyrolysis Reactor for Plastic Wastes

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ABSTRACT

Plastic wastes are geometrically increasing with the global population growth as they have found application in many human activities. This study designed and fabricated a pyrolysis system for the pyrolysis of low-density polyethylene (LDPE) and Polystyrene (PS). Based on the design considerations, engineering drawing and equipment fabrication were done using AutoCAD software and locally sourced materials, respectively. The process feed was prepared and loaded into the reactor in line with the start-up operations standard, and subsequently followed by shutdown procedures. The pyrolysis of the two plastic wastes generated a great volume of pyrolysis oil per kg of plastic wastes. It was observed that the volume of oil generated increased with temperature and time. The conversion efficiency of the pyrolysis reactor was 82.5 and 90.5% for LDPE and PS, respectively. The oil recovery for LDPE and PS were 1.05 mL of oil/kg of LDPE and 1.10 mL of oil/kg of PS, respectively. It was concluded from the study that the pyrolysis reactor was not only effective for the pyrolysis of plastic wastes but also the recycling of solid wastes.

Keywords: Conversion Efficiency; Design; Low-density polyethylene; Polystyrene; Pyrolysis.

Virtual Room 2 (Online alone) Nanotechnology & Raw Mineral Processing

Hydroxyapatite scaffolds constituting varying crystal morphologies derived from two natural sources: a crack behaviour and biological insight

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ABSTRACT

In this contribution, variants of hydroxyapatite (HAp) derived scaffolds characterized by different unique morphologies were fabricated through a direct mechano-chemical conversion of catfish and non-separated animal bone. This was done through the regulation of reaction temperatures during the sintering process. The representative scaffolds were prepared by cold compaction and sintered at 900, 1000 and 1100 °C. The fabricated scaffolds produced distinct crystal morphologies with a composite of micro and nano dimensional structures in the shape of rods and flowers. Energy dispersive spectroscopy (EDS) analyses was used to calculate the calcium to phosphate ratios, while acoustic emission was used to detect the crack propagation behaviour of the scaffolds. Porosity evaluation was conducted, while the antimicrobial properties of comparatively better scaffolds were investigated using the disc diffusion method. The obtained results showed that at 900 °C, optimum properties were obtained with a Ca/P ratio of 1.53 for CB-900 sample, representing a calcium deficient scaffold. The crack propagation data showed relatively lowest activity for the CB-900 sample with notable activity for two bacterial strains.

Keywords: *Microstructure; Sintering, Bio-ceramics; Grain boundaries; Defects.*

Preliminary Characterization Of Locally Sourced Iron Sand As Raw Material For Development Of A Potential Catalyst For Chemical Processes

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ABSTRACT

Nigeria is a country that is endowed with various natural resources. Some of these have been under-utilized. Iron sand is one of the abundant natural magnetic materials. Iron sand which is rich in Fe content is generally oxidized and forms iron oxide, such as Fe_3O_4 magnetite, hematite (α-Fe_2O_3), and maghemite (γ- Fe_2O_3). But so far the utilization of natural iron sand is limited. Naturally occurring iron sand was collected from Michika local government area of Adamawa State, Nigeria. The sample was characterized using Fourier Transform infrared spectroscopy (FTIR), Energy Dispersive X-ray Fluorescence (EDXRF), X-ray diffraction (XRD), and BET surface area analysis. XRF result showed that the sample contain mostly Fe (38.86%) followed by Si (13.56%). FTIR revealed the presence of multiple phases of iron while XRD revealed high level of crystallinity. The raw sample was mesoporous with BET surface area of 12.99 m^2/g and average pore size of 5.61 nm. Data presented shows that the sample has high amount of iron which can be utilized for diverse applications. Iron sand could be used in electronics, energy, chemistry, ferofluid, catalyst, and medical diagnosis.

Keywords: Crystallinity, Iron sand, Magnetite, Mesoporous.

Lab-Scale Continuous Fixed Bed Adsorptive Separation Of Cd (Ii) Ion From Aqueous Effluent Using Magnetic Nanocellulosic Adsorbent Derived From *Costus Afer*

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ABSTRACT

Haphazard disposal of industrial effluents into the environment has negatively impacted the global water security sector. Some of the accompanying chemical pollutants are reported to be carcinogenic when ingested or inhaled. Cadmium had been linked with several cancers in humans. Batch-wise adsorption technique is the commonly practiced separation procedure due to its lack of ambiguity and the potential for sorption of low concentration pollutants from effluent streams. Frequently used activated carbon adsorbent can be restricted by excessive sludge generation. Nowadays, research is in the development of sustainable, renewable and environmentally friendly adsorbents based on advances in nanotechnology. In this study, 91.31 % recovery of Cd^{2+} was recorded when 2.63 mg of the solute was treated using novel magnetic nanofibrilated cellulose in fixed bed adsorption process.

Key words: *Breakthrough curve, Environment, fixed bed, Nanoadsorbent, wastewater*

Huddle Room 1/Online Waste Water Processing

Design, Construction and Performance Evaluation of a Pilot Scale Activated Sludge Process Plant for the Treatment of Petroleum Refinery Wastewater

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ABSTRACT
Pilot scale study of chemical and biochemical processes is very crucial for process evaluation, control, optimization and scale up. In an activated sludge process, organic matters in wastewater are degraded biologically into simple molecules such as water and carbon dioxide with the formation of new cell mass. In this study, a pilot scale activated sludge process plant was designed and constructed for the treatment of petroleum refinery wastewater, which upon performance evaluation achieved a biological oxygen demand (BOD) reduction from 90 mg/L to 7 mg/L (92.22 %) after 10 hours of hydraulic retention and chemical oxygen demand (COD) reduction from 270 mg/l to 50 mg/L (81.48 %) after 10 hours. The BOD correlates the COD reduction by an R^2 value of 0.8695. Evaluation of the process biodegradability index (B. I) shows highest B.I of 0.43 at 6 hours hydraulic retention, 0.31 B. I was obtained as least at 10 hours of hydraulic retention, indicating near complete degradation of the organic pollutants in the wastewater at 10 hours.

Removal Of Alizarin Red S Dye Using Powdered Biosorbent Formulated From Orange Peel

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ABSTRACT
Adsorption is potentially an attractive methodology for removing hazardous dyestuff from industrial wastewater laden with impurities including dyes. On the other hand, treatment of such wastewaters with conventional adsorbents such as activated carbon is not economical to industries, hence the need to formulate alternative adsorbent materials. The aim of this research therefore is to investigate the potential of orange peel (an agriculturally based waste) as a low-cost powdered sorbent in the removal of synthetic dye (Alizarin Red S) from aqueous solution. The formulated Orange peel was prepared for the removal of Alizarin Red S from aqueous solution. Important parameters such as pH, contact time, effect of concentration and effect of amount of adsorbent dosage were analysed and the maximum percentage removals were found to be 76.81% at pH 9, 55.16% at contact time of 60 minutes, 60% within initial concentration of 40 mg/L and 60.55% removal was achieved at dosage of 0.1 g. In addition, Kinetic studies reveal that the removal of Alizarin Red S dye on orange peel powder followed a Pseudo-first-order kinetic model. Orange peel powder can therefore be said to be a good biosorbent for wastewater treatment for dye removal.

Keywords: *Alizarin red; Biosorbent; Kinetic studies; Orange peel;Wastewater*

Simultaneous Biosorption of Lead and Copper Ions using Orange (Citrus Sinensis) Peels

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ABSTRACT
The efficacy of orange peel as a biosorbent for simultaneous removal of Pb^{2+} and Cu^{2+} ions from aqueous solutions was investigated. Batch adsorption experiments were performed with varying pH, adsorbate concentration and contact time. The residual metal ion concentrations were determined using an Atomic Absorption Spectrophotometer (AAS). The results indicated that in a solution of Pb^{2+} and Cu^{2+} ions, the adsorption of Pb^{2+} by the orange peel was stronger than Cu^{2+}. High Pb^{2+} and Cu^{2+} ions removal were achieved with contact time of about 130 minutes, pH of around 7 and adsorption increased with adsorbate concentration. The best fitness of adsorption isotherm models was obtained with Langmuir with a correlation coefficient (R^2) value of 0.9999 and 0.8562 for Pb^{2+} and Cu^{2+} respectively. The pseudo second order kinetics model gave the best fit in both cases with R^2 values of 0.9954 and 0.9647 for Pb^{2+} and Cu^{2+} respectively. Orange peel performed as a suitable adsorbent for the adsorption of Pb^{2+} and Cu^{2+} ions from aqueous solution with higher affinity for lead. This is useful in waste water treatment processes.

Keywords: *Adsorption; biosorbent; copper; lead; orange.*

Huddle Room 2/Online Research & Development

Surface Mining Activities: Impacts On The Water Quality Of Ikpeshi, Edo State, Nigeria

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ABSTRACT

The impact of surface mining activities on the water quality of Ikpeshi, Edo State, Nigeria was carried out on the three major sources of water. They included water from mine pit, flowing stream and borehole. Physicochemical characterization of the water samples was carried out and their results were compared with World Health Organization (WHO) permissible guidelines for drinking water. The water quality parameters included pH, electrical conductivity (EC), turbidity, dissolved oxygen (DO), biological oxygen demand (BOD), chemical oxygen demand (COD), dissolved iron (Fe), manganese (Mn), chromium (Cr), cadmium (Cd) and lead (Pb). The result showed dissolved Cr, Cd and Pb to be 0.085, 0.093 and 0.09 mg/L in mine pit water, respectively, 0.011, 0.002 and 0.007 mg/L in flowing stream, respectively, 0.0, 0.0 and 0.005 mg/L in borehole water, respectively, and 0.05, 0.003 and 0.01 mg/L as WHO limits, respectively. Similarly, dissolved Fe and Mn were 0.95 and 0.167 mg/L in mine pit water, respectively, 0.37 and 0.061 mg/L in flowing stream, respectively, 0.24 and 0.018 mg/L in borehole water, respectively, and 0.3 and 0.05 mg/L as WHO limits, respectively. Therefore, water from mine pits and flowing stream are unsafe for domestic use without treatment because their contaminant level IS higher than those of WHO.

Key words: Mining, quarry, mine pit, flowing stream, WHO, borehole, characterization

Physicochemical Properties of Synthesized Nitric Acid Modified Activated Carbon Adsorbent from Bamboo Culms

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Physicochemical Properties Of Synthesized Nitric Acid Modified Activated Carbon Adsorbent From Bamboo Culms

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ABSTRACT
This study evaluated the synthesis of low cost activated carbon adsorbent from waste bamboo culms collected at a construction site around Auchi Polytechnic, modified with environmentally friendly nitric acid for enhanced pore structures and improved adsorption versatility. The material was characterized by Fourier transform infrared (FTIR), Brunauer-Emmett-Teller (BET), energy dispersive X-ray (EDAX) and nickel adsorption.The FTIR result showed the characteristics O–H stretching of free hydroxyl and strong hydrogen bond group on the activated carbon surface. The BET surface area of the activated carbon displayed high specific surface area of 1.087×10^3 m^2/g and 71.41% mesoporosity, despite the lower activation temperature of 600°C. The adsorption efficiency of the activated carbon for nickel at concentration of 0.196 mol/L was higher at adsorbent dosage of 0.5 g as it decreased from 71.94% at adsorbent dosage of 0.5 g to 68.37% at adsorbent dosage of 1.0 g and 60.71% at adsorbent dosage of 2.0 g. The adsorption mechanism may be surface adsorption due to textural properties of the activated carbon or ionic interaction between nickel molecule and the functional groups. Nitric acid modified activated carbon is a promising adsorbent candidate for heavy metal removal and cationic dyes from water.
Keywords: Bamboo culms, nitric acid, adsorbent, modified, characteristics.

Evaluation of the Sugar Content of Selected Coke Drinks

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ABSTRACT
This research work is aimed at the Evaluation of sugar contents of Selected Coke Drinks. The study was motivated by the increasing global concern of reported cases of sugar-related ill health. Three different Coke drinks namely; RC, Pepsi and Coca-cola were tested to determine the amount of sugar present in the drinks. The selection of these three products was justified by the fact that they are the most commonly consumed coke drinks (amongst others), as reviewed. The soft drink bottles were purchased from "Everyday" supermarket in Owerri, Imo State; analysis was conducted on the samples at the New Concept Laboratory, Obinze Owerri. The parameters tested include pH, Total soluble sugar, Reducing sugar, Total reducing sugar, Sucrose, Glucose and Fructose. The results of the analysis showed that the pH of the three samples were 2.19, 2.21 and 2.27 for RC, Pepsi and Coca-Cola respectively. The Total Soluble Sugar was 8.50%, 10.20% and 7.20% for RC, Pepsi and Coca-cola products respectively. Also in that order, the Reducing sugar was gotten as 8.22%, 11.75%, and 10.18% respectively, while the Total reducing sugar was found to be 18.27%, 17.97% and 15.16% respectively. The sucrose content was 154.56% for RC, 148.53% for Pepsi and 125.06% for Coca-Cola. The glucose and fructose were 1.13%, 0.82%, 1.03% and 7.09%, 10.93% and 9.15% both for RC, Pepsi and Coca-Cola products respectively. Generally, RC was found to have the highest percentage of sugar content amongst the three samples examined. It is, thus, recommended that there should be prudent check in the rate of soft drink consumption, especially those that contain high sugar and phosphoric acids value (as are obtainable in our locality); also drinking plenty of water, instead of sugary drinks like soft drink, is better due to its high sugar and acidic contents.

Keywords: *Coke, Drinks, Evaluation, Sugar Content*.

Virtual Room 1(Online alone) Waste Processing & Resource Recovery-II

Modeling and Optimization of Particleboard from Rice Husk Waste Using R7AD2 Adhesive

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ABSTRACT
This paper seeks to determine the best formulated particleboard produced from rice husk (RH) using R7AD2 adhesive via modeling and optimization process. Particleboards was formulated from waste rice husk using Design-Expert, Version 6.0.8 which generated eight (8) formulations of rice husk particleboards coded RHPs based on 2 factorial designs with 3 responses. The responses water absorption (WA) and density data were modeled and optimized to determine the best fit from all the particleboards produced using the statistical tools: analysis of variance (ANOVA) and sequential model sum of squares (SMSS). The analyzed data for percentage water absorption (%WA) at 2hours, 24 hours and density were best described with Cubic models based on the following factors: precision adequacies of 19.347, 19.238 and 3.454; standard deviations of 1.81, 1.47 and 33.78; F-values of 25.94, 49.50 and 1..84, Prob > F values of 0.0070, 0.0019 and 0.246 respectively. The numerical model found a solution with high desirability factor of 0.979 suggesting formulation RHP8 with 0.32A (rice husks) to 0.68B (R7AD2) adhesive as best fitted model from the optimization.

Keywords: Modeling, optimization, particleboard, Waste, Adhesive

Thermal and Chemical Reactivation of De-Oiled Spent Bleaching Earth: Optimization using Response Surface Methodology

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ABSTRACT
In this study, the feasibility of treating spent bleaching earth (SBE) was examined in a bid to reduce its disposal into the environment. The SBE samples were de-oiled using the Soxhlet extraction method, using n-hexane for 1 hour at 60°C; treated at temperatures ranging from 300 – 500°C; at varying carbonization time, between 30 – 45 minutes; and with hydrochloric acid, using concentrations between 1M and 2M, at a constant stirring time of 30 minutes respectively. The operating conditions for the experiment were according to the experimental design (Central Composite Design) which was recommended on Design Expert software version 10. The software was also used to optimize the re-activation of SBE. The optimum condition obtained was re-activation of de-oiled SBE at 500°C for 45 minutes and reaction with 2M HCl - bleachability of 71.15%. The obtained model gave a R^2 value of 88.33%.

Keywords: Spent Bleaching Earth (*SBE); Virgin Bleaching Earth (VBE); Bleachability; Central Composite Design; Response Surface Methodology*

Characterization of Physical Properties of Particleboard Produced from Sawdust Using R7AD2 Adhesive

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ABSTRACT

This study produced particleboard from sawdust using resin seven adhesive two (R7AD2) adhesive. Design-Expert, version 6.0.8 was employed for the experimental design using mixture design with 2 factors and 3 responses, which generated 8 formulations. Sawdust was processed mixed with R7AD2 adhesive based on the formulation ratios to form homogenized phase, compressed at a pressure of 3 MN/m^2, ambient temperature of 25 ^{0}C for 8 minutes and allowed to stack and cured. The produced sawdust particleboards formulations coded SDP1 to SDP8, were further characterized at environmental conditions for: water absorption and thickness swelling at 2 and 24 hours and density respectively. The results showed that curing days was maximum at 8 and minimum of 7 days, with percentage water absorptions of 112.58 and 151.24% maximum and 20.53 and 96.65% minimum at 2 and 24 hours respectively. Thickness swellings were 3.72 and 6.86% maximum, 1.15 and 1.33% minimum at 2 and 24 hours respectively. Densities varied between 669.64 and 907.14 kg/m^3 respectively. Based on these results the trend followed that SDP1 > SDP8, thus SDP8 being the best fit. The potentials of using sawdust and R7AD2 adhesive in particleboard production is high with underutilized waste off-cuts from wood materials.

Keywords: Characterization, Particleboard, Properties, R7AD2 Adhesive, Sawdust

Virtual Room 2 (Online alone) Research & Development -II

Bitumen Upgrading Using Hierarchical Mo/Zsm-5 Catalyst

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ABSTRACT
Hierarchical ZSM-5 catalysts were produced from microporous ZSM-5 using the top-down post synthesis method of desilication at two molar concentrations of NaOH (0.35 and 0.45M). The two hierarchical ZSM-5 supports (HZ0.35 and HZ0.45) were impregnated with molybdenum (Mo). the catalysts were characterized using BET/BJH, XRF, XRD, FTIR and XPS). The characterization results revealed successful formation of mesopores with significant reduction in relative crystallinity of the zeolite supports after metal impregnation but with a good homogeneous dispersion of the metals. The conversion of hexadecane with these catalysts HZ0.45, H0.35, Mo/H0.35, Mo/HZ0.45 and HZSM-5 were 98, 96, 92, 91 and 79 % respectively. on the other hand, Mo/H0.35 gave highest gasoline yield of 50.4% when compared to HZ0.35, H0.45, HZSM-5 and Mo/HZ0.45 with 46, 38, 37 and 46 % yield toward gasoline, respectively. This good yield achieved can be attributed to pore widening, metal loading and preserved intracrystalline mesoporous nature of Mo/H0.35.

Key words: Bitumen; ZSM-5; Hierarchical ZSM-5; Mo; Characterization

Liquid-Liquid Equilibrium Process in the Purification of Castor Oil Biodiesel/Methanol/Glycerol System: Phase System Analysis

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ABSTRACT
Knowledge of liquid-liquid equilibrium of components involved in the purification of biodiesel is vital in establishing the optimum composition of the final product. Liquid-liquid equilibrium data for phase separation and purification of castor oil biodiesel system at temperatures of (25 and 35) °C and withdrawal time intervals of (2 – 32) mins was investigated in this paper. The castor oil biodiesel was produced via alkaline transesterification of castor seed oil. Ternary phase system diagrams were constructed based on experimentally determined tie lines and binodal solubility composition data at the different temperatures and time interval using modified cloud point titration procedures under isothermal conditions. Gas chromatographic (GC) method was employed in the analysis of the data to provide the phase composition of the mixture components. Distribution coefficient, K, and selectivity, S, analysis were performed. Two phases existed for the ternary mixture. The sizes of the phases were dependent on the temperature and withdrawal time intervals. At the investigated conditions, $K < 1$, implying higher concentration of raffinate (glycerol) in the raffinate-phase and $S > 1$, indicating the ability of methanol to promote phase separation. The research results can be utilized in the design of efficient and effective biodiesel purification processes.

Keywords: *Binodal solubility composition; Distribution coefficient; Selectivity; Ternary phase diagrams; Tie lines.*

Performance Evaluation of Tetrabutylammonium Bromide-Based Deep Eutectic Solvents in Enhanced Oil Recovery of Nigerian Heavy Oil

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ABSTRACT

Deep eutectic solvent (DES) is used as a green solvent in science due to its benefits over ionic liquids, such as biocompatibility and biodegradability, chemical stability with water, ease of preparation, and non-toxicity.DES 1 was successfully synthesized in a 1:2 molar ratio of Tetrabutylammonium bromide (TBAB) and polyethylene glycol 400 (PEG 400), while the novel DES 2 and DES 3 were synthesized in a 1:6 molar ratio of TBAB/ dimethyl sulfoxide (DMSO), and TBAB/N,N-dimethyl formamide (DMF) respectively. The performance(s) of the three DESs in the enhancement of heavy Nigerian crude oil recovery at ambient temperature was investigated. DES 1 recovered additional 16.07 % oil from core flooding using Berea sandstone core sample, resulting in an overall recovery of 53.44 %. DES 1 also resulted in an incremental recovery of 35.94 % from Niger-Delta sandstone, with a high ultimate recovery of 85.94 %. The presence of DES 2 and DES 3 were also shown to result in additional oil recovery. A drastic IFT reduction from 5.19 to 2.46mN/m was observed between the oil and the DES2 phase. Thus the study confirms that the presence of TBAB-based DES promotes reduction in the viscosity of the heavy oil and results in more oil recovery.

Keywords: *Deep eutectic solvents (DES), enhanced oil recovery, interfacial tension, tetrabutylammoniumbromide (TBAB)*

Huddle Room 1/Online Research & Development -III

RIWAMA Municipal Wastes To Wealth Of An Economy

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ABSTRACT

The environmental pollution facilitated by wastes disposal have been the greatest challenge to man for decades. And, the technological research efforts have been on the increase to tackle its menace to humanity. The present research mainly subjected the potpourri of wastes to fermentation cum pyrolysis processes to generate biofuels, minerals and petrochemical feed stock as resources for further applications in chemical processes. The relevance of this research is the ability to achieve complete conversion of RIWAMA municipal wastes into resource recovery as biofuels from wastes. The resources achievable are fuels which include C_1 to C_5, gasoline, kerosene, diesel, petrochemicals such as: aromatics, polyethylene, and some minerals such as zinc, iron, lead, potassium, copper and non-metals of carbon, hydrogen, nitrogen, oxygen, Sulphur. Accordingly, the products were characterized of thermal conductivities and specific heat capacities. The Atomic Absorption Spectroscopy (AAS) results analysis for constituent minerals elements gave carbon 2.617%, hydrogen 5.781%, oxygen 1.955%, nitrogen 0.789%, and sulphur 0.127%. The 232kg feed wastes when estimates of the financial contributory effects gave Naira and dollars #787018.6502 $1, 574.0373 respectively. *Finally, the recoveries of resources of biofuels serve for energy potential from wastes. The energy can serve for vehicles, power generation, and the minerals contributing to the metallurgical content of an economy*

KEYWORDS: RIWAMA-municipal solid-wastes; fermented; pyrolysis; resources recoveries; petrochemicals; economics.

Modelling and Optimization of Eucalyptus Oil Production

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ABSTRACT
This study aimed to extract essential oil from Eucalyptus leaves at optimum conditions of particle size, temperature, time and solute to solvent ratio. To achieve this, a central composite design was used to generate twenty-one experimental runs comprising sixteen factorial and five central points with the aforementioned four factors as independent variables and oil yield as the response. Before each extraction process, the Eucalyptus leaves were dried, pulverized and later sieved using a sieve shaker with particle size indicated in the design matrix. Thereafter, the experimental data were analysed using a quadratic model. The empirical model was maximized numerically. Design-Expert 13.0.5.0 was employed for all the statistical aspects of this study. The results of analysis of variance showed that the model developed was significant with p-value of less than 0.0001 and mostly affected by particle size as a single factor. The interaction of solute to solvent and time also affected the oil yield significantly. The numerical optimization results suggested the optimum conditions of 10.3, 67 °C, 0.2 mm and 1.4 hours for extraction temperature, particle size, solvent/solid ratio and time, respectively with maximum Eucalyptus yield of 14.34%.

Keywords: *Eucalyptus leaves; Face centred CCD; extraction; n-hexane; Soxhlet Extractor.*

Huddle Room 2/Online Modeling, Simulation and Optimization

Modelling, Simulation and Energy Integration of a Liquefied Natural Gas Production Process Using Aspen Plus

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ABSTRACT
This research was carried out on simulation and energy integration of a liquefaction plant model having an acid gas removal unit, a dehydration unit and a liquefaction unit. The energy integration was accomplished using Aspen Energy Analyser on the model developed with the aid of Aspen Plus. From the results obtained, it was discovered that 99% of the carbon dioxide content of the gas was removed in the acid gas removal unit, 99% of the water content of the gas was removed in the dehydration unit and the gas was successfully converted to liquid phase at a temperature and a pressure of -161 °C and 1 bar, respectively. For the energy integration scenario, data were extracted from each of the simulated units, utilities were selected and several heat exchanger networks (HEN) were generated. The most suitable HEN design from the generated ones was found to be the one with the lowest total annual cost, and it was obtained that the total annual cost of the acid gas removal was reduced from 3.206×10^{-2} \$/s to 3.182×10^{-2} \$/s while that of the dehydration unit was reduced from 8.908×10^{-4} \$/s to 7.228×10^{-4} \$/s.

Keywords: *Aspen Plus; Energy Integration; Liquefied Natural Gas; Modelling; Simulation.*

Integrated Modelling of Sugar Manufacturing Plant for Nigeria Cane Plantation

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ABSTRACT
Nigeria is a major importer of brown sugar, an important food source that can be manufactured from locally available sugarcane. To serve the purpose of designing a sugar manufacturing plant, this paper develops a plant-wide model for obtaining brown sugar from sugarcane. This model comprising material balance equations accounts for various processes involved in the manufacturing such as milling, filtration, evaporation, crystallization and drying. GAMS, an algebraic modelling tool, was employed to solve the model. From a basis of 100 tonnes of cane per day, a simulation result of 2000 tonnes of brown sugar per year compared excellently with literature. Therefore employing the model with a basis of 13 million tonnes of sugarcane, Nigeria's sugarcane plantation potential capacity, showed that the country can produce 500,000 tonnes per year, compared to the current capacity of less than 10,000.

Keywords: *GAMS, integrated modelling, sugarcane, sugar plant.*

Optimization of Energy Consumption of a Synthetic Ammonia Process

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ABSTRACT
Ammonia can be produced from a wide range of raw materials. Coal gasification is a process that converts biomass or fossil fuel-based carbonaceous materials into CO, H_2 and CO_2. The energy consumption of cryogenic air separation occupies a great proportion for an ammonia synthesis process using pure oxygen gasification. The aim is to reduce energy consumed in the ammonia plant. Aspen Plus has been used to develop the process models. Of the three simulations carried out, simulation 3 was found to produce oxygen with the highest purity of 0.979. The energy consumed on the total utilities in Simulation 1 was 5.626×10^{10} Btu/hr with an energy savings of 1.55%, that of Simulation 2 was 5.286×10^{10} Btu/hr with an energy savings of 1.53%. The least energy was consumed in Simulation 3, which was 1.425×10^{9} Btu/hr with an energy savings of 74.90%. Simulations 1, 2 and 3 have total operating costs of 42.083 billion USD/year, 41.9615 billion USD/year and 918.841 million USD/year, respectively. It was observed that the higher the energy consumed in a plant, the higher the total cost of the plant. Simulation 3 was discovered to be the air separation plant that optimised the energy consumption in a synthetic ammonia plant.

Keywords: *Cryogenic air separation; economic analysis; energy consumption; oxygen purity; sensitivity analysis.*

Virtual Room 1(Online alone) Bioenergy & Green Chemical Technology-II

Modelling, Simulation and Optimization of Bioethanol Production from Lignocellulose Materials

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ABSTRACT
Bioethanol production from lignocellulose biomass has gained a lot of traction over the last two decades because it is a viable alternative energy source to fossil fuel and does not compete with the food supply like first-generation bioethanol does. In this study, previous research is used to generate mathematical models for enzymatic hydrolysis, and co-fermentation operations, which are then improved to include the decomposition of hemicellulose to xylose sugars. Two case studies are defined and modelled in the open-source Scilab platform and R software: the first is to investigate how the simultaneous saccharification and co-fermentation (SSCF) operation responds to control variables (namely cellulose loading, hemicellulose loading, enzyme loading, yeast loading, temperature and time represented by A, B, C, D, E, & F respectively). From the analysis of variance, only the terms A, C, F, AF, A^2, C^2, F^2 are significant model terms. Major parameters of the SSCF unit are then optimized in the second case study using the APMonitor modelling package in Python to give 0.1263kg/kg minimum enzyme adsorbed per substrate loading, maximum cellulose conversion as 26.26% and a 47.9% maximum ethanol yield. These results show that these models will be powerful tools for process design, optimization and scale-up of bioethanol production.

Keywords: *bioethanol; optimize; simultaneous saccharification and co-fermentation; dynamic modelling*

Mathematical Modelling and Parametric Optimization of Biomethane Production with Response Surface Methodology (RSM): A Case of Cassava Vinasse from a Bioethanol Distillery

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ABSTRACT

Cassava vinasse (CV) has serious anti-environmental characteristics which pose major concern to distillery operators. In this study, production of biomethane via anaerobic digestion (AD) of CV was modelled/optimized with response surface methodology (RSM). This was with a view to establish AD as a treatment option and benchmark the optimum conditions for its conversion to biomethane.

Central composite design with mixture design produced 27 batch digestion experiments randomly executed to investigate the effects of CV (55-100%), poultry dropping, PD (0-45%), organic loading rates, OLR (2-10 gVS/L.d), inoculum to substrate percentage, ISP (10-30%) and hydraulic residence time, HRT (20-30 days) on methane yield (MY). A quadratic model was developed, assessed via ANOVA/Lack of fit test and experimentally validated.

Results showed high chemical oxygen demand (62-74 g/L), volatile solids (72.25 g/L), carbon-to-nitrogen ratio (43.5:1) and a biochemical methane potential, BMP of 247.1 NmL/gVS for the CV. Optimum conditions for biogas production were CV (55%), OLR (10%), ISP (30%) and HRT (30 days) with a MY of 254.4 mL/gVS. Coefficient of determination (0.9925), standard deviation (4.91) and p-value (<0.0001) respectively indicate high model predictive accuracy and ability to navigate the design space. The model validation result was only 4.8% less than predictions, at 242.83 mL/gVS.

Keywords: anaerobic digestion, cassava vinasse, modelling, optimization, RSM

Current Trends and New Perspectives in Biodiesel Production: A Focused Review on Interesterification Reaction

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ABSTRACT

The consumption of energy has risen to 12 billion tons/year due to the ever-increasing population and urbanization which has directly led to more energy demand. Hence, there is an obvious need for an alternative source of fuel energy. One of the best alternatives is the use of renewable fuel energy. Biodiesel is an example of a renewable fuel energy which is produced from biomass by different technologies such as direct blending of oil, emulsification, pyrolysis, and transesterification. However, the drawback of these methods has propelled research experts to persistently search for better technologies. Over the years, transesterification reaction methods have been globally identified for in biodiesel production. Nonetheless, its by-product named glycerol has limited its utilization in biodiesel production. Therefore, it has been reported that the integration of glycerol into biodiesel composition may be a better option. In this review, the latest biodiesel production technology discussed is the interesterification reaction. This method integrates the by-product (glycerol) by producing a glycerol free Fatty Acid Methyl Esters (FAME), triacetin which is a useful fuel additive is produced instead. After the production of biodiesel and triacetin through the interesterification reaction route, there is always no need to separate both products which makes this process interestingly more sustainable and economical. The current trends of this production technology are also expounded.

Keywords**:** Energy; FAME; Fuel; Interesterification; Triacetin

Virtual Room 2 (Online alone) Core Chemical Engineering

Thermal Analysis of a Pressure Vessel for Different Materials of Construction Using the Finite Element Analysis (FEA).

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ABSTRACT
The present study involves the heat transfer in a vertical pressure vessel which is subjected by the internal pressure which is generated by the fluid inside the vessel. Stress which is acted within the vessel is determined using finite element analysis technique such as ANSYS software. Conventional or theoretical equations which govern the vessel are used and a code is generated using software MathCAD. The calculations of stress distribution, strains, deformation & heat transfer rate are done. Carbon steel, Stainless steel and Aluminium alloy materials are considered and the heat transfer rate and the change in the dimensions for the fixed convective coefficient value are calculated. There was determination of deformation at various points and for the various materials considered via thermal analysis. An improvement in the performance is achieved by using the computational analysis software ANSYS CFX and the comparative techniques of numerical calculations and utilization factor capability and the results of this investigation show that the designed pressure vessel was safe within the specified operating condition for the considered materials.

Keywords: *Pressure vessel, finite element analysis, ANSYS, Design and Materials*

Justification of Order of Corrosion Inhibition Kinetics for Esters of Castor and Rubber Seed Oils

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ABSTRACT

The present study centres on the justification of order of corrosion inhibition kinetics for esters of castor and rubber seed oils. Inhibition of mildsteel corrosion was studied in the presence of sulphuric acid medium. The study was justified by the regular misprediction of order of chemical reactions (especially corrosion reaction), due to varying individual perceptions in this regard. While many researchers assume that corrosion reaction kinetics is of first order in most cases, others resolve that it is of zero or even second order. Experimental (gravimetric) data from the mildsteel corrosion inhibition process was used to generate the kinetic data at different experimental conditions of 10g/l (concentration), 40^{o}C (temperature) and 50% stroke (pressure), at different times of 4, 8, 16, 24 and 32hours. Equations of the lines were generated, and coefficient of determination, R^2 values for the different (derived) kinetic equations (zero, first and second orders) were obtained. While R^2 values for zero order curves fall between 0.9250 – 0.9790, those of first order fall between 0.9740 – 0.9880, and those of second order fall between 0.7820 – 0.9520, which indicates that the R^2 values of first order kinetics tend more towards unity than those of zero and second orders. This implies that the corrosion reaction, generally, is governed by the postulations of first order kinetics, followed by the zero order and, then, second order. The results, therefore, justify that kinetics of corrosion reactions is (always) of first order.

Keywords: *Corrosion inhibition, Justification, Kinetics, Order of reaction.*

Dispersion Modelling of Accidental Release of Chlorine Gas: Post Incident Analysis Case Studies of Some Locations in Nigeria

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ABSTRACT
This work is a post-incident analysis of the accidental release of chlorine gas in the surrounding areas of the Lamingo water treatment plant in Jos and Cross River State water board water treatment plant. The post-incident analysis is done using the Areal Location of Hazardous Atmospheres (ALOHA) software. The software allowed to quickly determine the field impacted by the release classified into red, orange and yellow displayed on google earth, which is important for emergency response purposes. The modeling was carried out for a hypothetical accidental release 15.74 kilogram of chlorine gas from a vertical cylindrical tank lasting for 60 minutes in the Lamingo water treatment plant, while 58.513 kilogram of chlorine gas lasting for 60 minutes in Cross River water board water treatment plant. In general, carrying out this kind of dispersion modeling and analysis is important for consequence analysis and risk assessment of hazardous chemical releases. If such analysis had been done, it could have served as a useful guide to create rescue plans, emergency responses, and neighbourhood warnings to ensure the safety of all the people in the areas where these incidents happened.

Keywords: Dispersion modelling, Chlorine, ALOHA, Google Earth, Threat Zones

NSChE Vision

The vision of NSChE is to be the center of excellence for Chemical Engineering profession in Africa and the prime mover for industrialization in Nigeria.

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"To organize the Nigerian Society of Chemical Engineers into a virile professional body capable of promotion the relevance and versatility of the profession, achieving better training and updating of Chemical Engineers through its activities.

Fostering of relationship with the academia, research institutes, industries, other professional bodies and government will be the basis for stimulating accelerated Industrialization of the country and improving the quality of life of the Nigeria people"

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The NSChE core values are

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2. **Commitment, dedication and loyalty to the cause of Chemical Engineers**
3. **Sustenance of professional ethics and standards**
4. **Integrity and accountability in all we do.**
5. **Care of members welfare.**
6. **Respect for the rule of law**