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Research for Industry

Selected abstracts from the JNSF March 2023 Issue

Connecting academic research to industry

The Journal of the National Science Foundation (JNSF) is the only Sri Lankan journal indexed in the Science Citation Index Expanded (SCIE) having an impact factor of 0.682 as of 2021. The journal publishes scholarly articles of both Sri Lankan and foreign researchers, following a standard peer review process.

Recognizing the potential benefit to the industry this brochure presents selected abstracts of the articles published in March 2023 issue of the Journal.

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Temperature control in an exothermic continuous stirred tank reactor

Process Control Engineering

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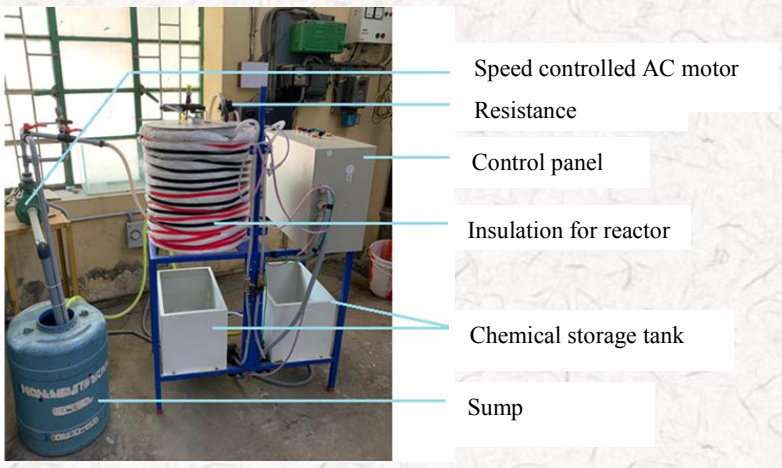
Abstract

A continuous stirred tank reactor (CSTR) is a batch reactor fortified with an impeller or additional mixing device to provide resourceful mixing. In chemical engineering, the name CSTR is often used to describe an idealised agitated tank reactor used to model manoeuvre variables necessary to achieve a specified output. Most chemical plants have a process involving a continuous stirred tank reactor (CSTR), and it has more nonlinearity in real-world implementation due to disturbances like change in surrounding temperature, non-uniformity in mixing, and change in the temperature of the coolant. The aim of the work is to study the dynamic behaviour of a continuous stirred tank reactor with coolant flow rate as input and reactor temperature as output and to design a suitable controller to control the temperature of the continuous stirred tank reactor by conducting an exothermic reaction in real-time. A continuous stirred tank reactor was modelled with the help of a transfer function model in the MATLAB environment. For controlling the temperature of the reactor fluid, the design of proportional integral derivative (PID), proportional integral derivative – particle swarm optimization (PID-PSO), proportional integral derivative – artificial bee colony optimization (PID-ABC) and model predictive control (MPC) controller were carried out. The simulation results show that model predictive control has better tracking performance compared to conventional PID, PID–PSO or PID–ABC.



Experimental set up of continuous stirred tank reactors

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Removal of methylene blue from aqueous solution using raw laterite: an adsorption study

Environmental Science

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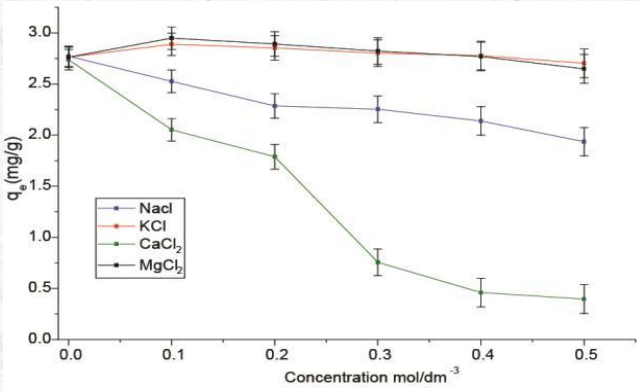
Abstract

Existing methods for dye removal have their limitations and can be expensive and not very effective. Therefore, the search for efficient, effective, less expensive, and environmentally-friendly ways to remove industrial dyes from water remains open. Methylene blue (MB) removal from aqueous solutions is studied using raw laterite soil as a low-cost adsorbent. The physico-chemical properties and surface area were determined. Effects of parameters such as contact time, laterite dosage, pH, and ionic salts on MB adsorption by raw laterite were examined. The results showed that the maximum removal efficiency of MB adsorption was observed at pH values above 10, after 60 min of contact time, and with an adsorbent (raw laterite) dose of 1.00 g in 100 mL of dye solution. Increasing the salt concentration decreased the absorption of dye from solution. Ionic salt media containing, $CaCl_2$ and KCl have shown maximum and minimum influence, respectively, on the adsorption of MB by raw laterite soil. At the optimum conditions, the experimental adsorption capacity of raw laterite was 2.930 mg/g. The experimental data fitted the pseudo-second order kinetic model (R^2 = 0.99). The Freundlich adsorption isotherm model (R^2 = 0.99) showed the best fit to the experimental adsorption data. According to the Freundlich isotherm model, the calculated adsorption capacity of raw laterite was 2.949 mg/g. Desorption studies with several solvents revealed that the adsorbent could successfully retain MB, up to 33.89%. Therefore, it can be considered that raw laterite soil is effective in removing MB from aqueous solutions.



The effect of ionic strength on the MB removal efficiency

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Mechanically exfoliated graphene from Sri Lankan vein graphite for field effect transistor application

Materials Science

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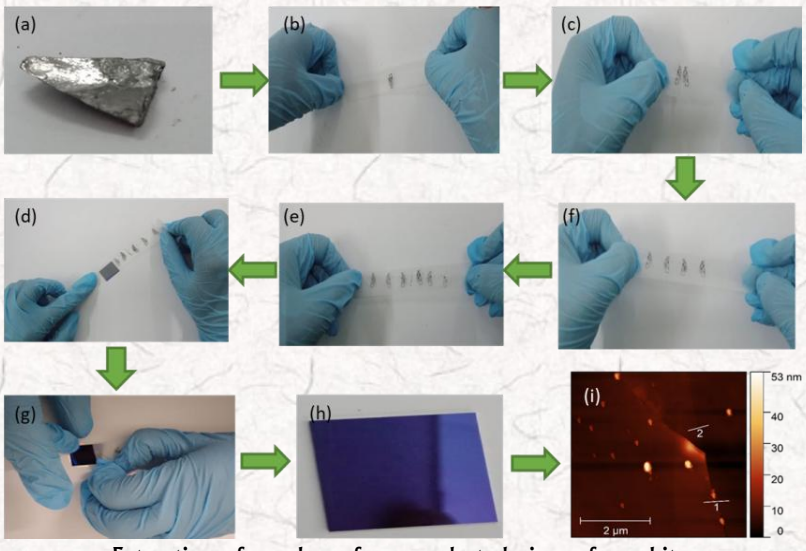
Abstract

In this work, a single layer of graphene was exfoliated from Sri Lankan vein graphite obtained from the Kahatagaha graphite mines, and field effect transistors (FETs) were fabricated to study their electronic properties. Graphite pieces were carefully examined, and a small piece of graphite was separated with possible large graphene sheets. A simple Scotch tape technique was used to transfer graphene from the selected graphite pieces onto a 300 nm SiO_2 coated Si (SiO_2/Si) substrate for FET fabrication. The thickness and the uniformity of the graphene layers were tested using atomic force microscopy (AFM). The thickness of the transferred single layer graphene was confirmed to be 0.4 nm. The AFM images also confirmed the presence of double layer graphene with thickness of 0.9 nm. FETs were fabricated by creating electrical contacts using successive thermal evaporation of chrome and gold on the transferred graphene layers with a channel length of 5 µm. Results showed that the graphene FETs showed an ambipolar current response with a positive Dirac voltage. The calculated average electron and hole mobility in the graphene channel were 252 (±57) and 592 (±125) $cm^2V^{-1}s^{-1}$ respectively. The positive Dirac voltage could be attributed to the sulphur content in the graphite obtained from Kahatagaha graphite mines. Our study suggests that the Sri Lankan graphite can be used as a raw material for graphene exfoliation and device application.



Extraction of graphene from a selected piece of graphite

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Comparison of physicochemical and sensory properties of African butter seed (*Pentadesma butyracea*) and cocoa fats for potential use in future food applications

Food Technology

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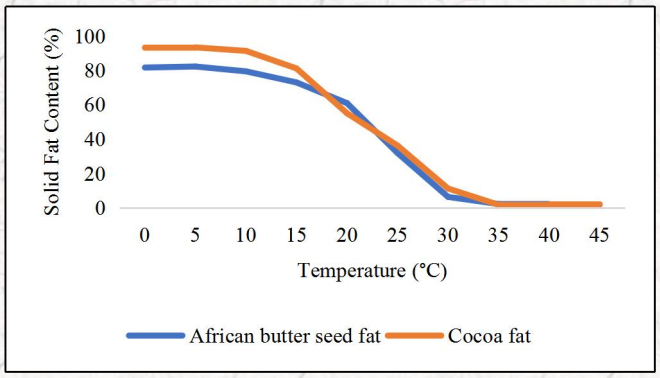
Abstract

African butter (*Pentadesma butyracea*) seeds are rich in edible fat, while cocoa butter is an expensive product obtained from fermented and dried cocoa beans. The aim of our study was to analyze the physicochemical and sensory properties of African butter seed fat and cocoa fat while determining their potential food applications. Chemically extracted fat was utilized for determination of physicochemical properties according to AOCS guidelines. Physically extracted fat was utilized for preparation of cookies and determination of sensory properties. Acid value, free fatty acid value and iodine value of African butter seed fat and cocoa fat were 1.05 ± 0.17 vs. 2.06 ± 0.14 mg KOH/g, 0.53 ± 0.09% vs. 1.14 ± 0.07% and 48.65 ± 3.03 vs. 34.31 ± 0.97 g I_2/100g respectively. Saponification values of African butter seed fat and cocoa fat were 177.0 ± 0.6 mg KOH/g and 194.2 ± 1.1 mg KOH/g respectively. Between 25 and 30 °C, the solid fat content ranged from 31.8 ± 0.05% to 6.85 ± 0.07% for African butter seed fat and 36.14 ± 0.87% to 11.15 ± 0.11% for cocoa fat. The contents of stearic and oleic acids which are abundant in African butter seed fat were 39.05 ± 0.16% and 56.97 ± 0.27% respectively while those of in cocoa fat were 37.75 ± 0.06% and 34.12 ± 0.14%. Results of hedonic test performed for cookies prepared by incorporating the two kinds of fats highlighted that there was a significant difference relative to the preference ($p < 0.05$) for colour, while there was no significant difference with respect to the preference for flavour, texture and overall acceptability ($p > 0.05$). There is a high potential to develop African butter seed fat as a fat spread, a cocoa butter alternative and in preparation of cookies.



SFC curves for African butter seed fat and cocoa fat

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