Design and Analysis of a Low-profile Microstrip Antenna for 5G Applications using AI-based PSO Approach

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Abstract — Microstrip antennas are high gain aerials for low-profile wireless applications working with frequencies over 100 MHz. This paper presents a study and design of a low cost slotted-type microstrip patch antenna that can be used in 5G millimeter wave applications. This research focuses on the effect of ground slots and patch slots which, in turn, affect different antenna parameters, such as return loss, VSWR, gain, radiation pattern, and axial ratio. The working frequency range varies from 24 to 28 GHz, thus falling within 5G specifications. A subset of artificial intelligence (AI) known as particle swarm optimization (PSO) is used to approximatively solve issues involving maximization and minimization of numerical values, being highly challenging or even impossible to solve in a precise manner. Here, we have designed and analyzed a low-profile printed microstrip antenna for 5G applications using the AI-based PSO approach. The novelty of the research is mainly in the design approach, compactness of size and antenna applicability. The antenna was simulated with the use of HFSS simulation software.

Keywords — 5G applications, high gain, low profile, microstrip patch antenna, PSO

1. Introduction

A low-profile micro strip or patch antenna (MPA) is created by mounting a metal patch plane over the ground level with a dielectric separator between them. Typically, the feed lines and the radiating patch are manufactured of a dielectric substrate using the PCB process. The patch is often square, rectangular, circular, triangular, or elliptical in shape to meet performance-related requirements. For a rectangular patch, length L of the patch is usually in the $0.33\lambda_0 \ldots 0.5\lambda_0$ range, where λ_0 represents the free-space wavelength. The patch must be very thin, hence the thickness of the copper foil used is less than λ_0. The dielectric substrate's height is in the $0.003\lambda_0 \ldots 0.05\lambda_0$ range, while the dielectric constant ranges between 2.2 and 12.

Due to their small size and low profile, microstrip patch antennas have become increasingly popular in smartphones and other consumer electronics devices relying on wireless communications. The benefits of microstrip patch antennas are in their compact size, simple manufacturing methods, low weight, and easy design. This has led to the replacement of traditional antennas used in mobile devices [1]. Selection of the substrate and determination of the patch proportions depend on the operating frequency and on the specification of the dielectric material used. Significant parameters, such as length and width of the patch and substrate, as well as the location and length of the feed network can be estimated employing equations given in [2]–[5]. The available dielectric materials have their unique conduction characteristics and vary in dielectric constants and other parameters that influence the fringing waves in the antenna patch [2]–[5].

Because of the cost factor, the most popular dielectric materials include bakelite, FR4 glass epoxy, Rogers RO4003, Taconic TLC, and Rogers RT/Duroid [6]–[8]. When feeding the signal to the antenna, many techniques, including proximity-coupled, inset feed, aperture-coupled, as well as coaxial probe feed methods, are used [3]–[4], [9].

2. Related Work

Many researchers have used various feeding techniques in recent years to develop MPAs of various shapes and used them in various applications. Sharma proposed, in [10], a small, high gain multiband antenna with a glass-shaped radiating patch and a rectangular ground plane. A unique rectangular-shaped, DGS-based effective multi-band frequency reconfigurable antenna was proposed by Sathikbasha *et al.* in [11]. A portable multi-band MPA with resonances at 23.9, 35.5, and 70.9 GHz, suitable for 5G mobile applications, was demonstrated by Punith *et al.* [12].

A graphene-packed dual band manWave antenna for 28.1 GHz and 37.4 GHz with a DC bias was proposed by Luo *et al.* [13]. A tiny, portable ultra-wideband microstrip antenna for 5G applications was developed by Araujo *et al.* [14], while a small and dual-polarized triple-band antenna for sub-6 GHz 5G applications was created by Alieldin *et al.* [15].

Ankan Bhattacharya.

A Review of the Latest Advances in Nanoparticle-Mediated Processes for Hexavalent Chromium Remediation from Water Bodies

Authors: Biswas, Subhadeep; Danish, Mohammad; Pal, Anjali

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Abstract References Citations Supplementary Data

Hexavalent chromium (Cr(VI)) is a well-known carcinogen, and hence its removal from aqueous media is an important area of research in the field of environmental engineering. Adsorptive removal and catalytic reduction are the two most common techniques applied for this purpose. In this regard, nanoparticle-mediated technology has contributed significantly. In the current review article, a systematic investigation has been carried out to find the latest developments that took place in the domain of Cr(VI) removal by nanotechnology. The major portion deals with the advancement and application of the new-age materials, such as carbon nanotubes (CNTs), g-C_3N_4, MXenes, zero-valent iron (ZVI), and their composites, for the Cr(VI) remediation purpose. Various interesting mechanisms, as proposed by different research groups, have been covered. Applications of the nanocomposites in the real wastewater scenario have also been highlighted. Different characterization techniques often conducted in order to get insight into Cr(VI) removal process have been mentioned. Some patents related to this field have been discussed. Lastly, the future scope of the nanomaterials, current challenges, feasibility of using these nanomaterials in large-scale treatment plants, etc., have been addressed before concluding the article.

Keywords: Cr(VI); MXenes; g-C3N4; nanocomposites; water bodies; zero-valent iron

Document Type: Review Article

Publication date: December 1, 2023

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A Brief Review on the Latest Developments on Pharmaceutical Compound Degradation Using g-C_3N_4-Based Composite Catalysts

by Subhadeep Biswas [1] and Anjali Pal [2,*]

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(This article belongs to the Special Issue Development of G-C_3N_4-Based Photocatalysts: Environmental Purification and Energy Conversion)

Abstract

Pharmaceutical compounds (PCs) are one of the most notable water pollutants of the current age with severe impacts on the ecosystem. Hence, scientists and engineers are continuously working on developing different materials and technologies to eradicate PCs from aqueous media. Among various new-age materials, graphitic carbon nitride (g-C_3N_4) is one of the wonder substances with excellent catalytic property. The current review article describes the latest trend in the application of g-C_3N_4-based catalyst materials towards the degradation of various kinds of drugs and pharmaceutical products present in wastewater. The synthesis procedure of different g-C_3N_4-based catalysts is covered in brief, and this is followed by different PCs degraded as described by different workers. The applicability of these novel catalysts in the real field has been highlighted along with different optimization techniques in practice. Different techniques often explored to characterize the g-C_3N_4-based materials are also

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Materials Chemistry and Physics

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Eggshell powder as an efficient recyclable catalyst generates H_2O_2 prompted radicals for selective oxidative mineralization of crystal violet dye at room temperature

Ankurita Nath [a], Subhadeep Biswas [b], Anjali Pal [b]

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Abstract

Eggshell powder (ESP) was explored as a selective heterogeneous catalyst for oxidative degradation of crystal violet (CV) dye in aqueous media in presence of H_2O_2 at room temperature. Natural but throw-away material ESP as a carbonate (CO_3^{2-}) source ics/vol/303/suppl/C rmation of carbonate anion radicals in presence of H_2O_2. Carbonate

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Effective Fatality Alert System using Predictive Learning

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Abstract:

With the advent of technological advancement, lots of data are created everywhere, every moment. Each of those data carries some information regarding some purpose. In recent days most of the challenging task is to predict more relevant information using available data through statistical or mathematical analysis. One of the most useful tool for this effort is Machine learning. Since March, 2020 the pandemic of COVID-19 started. So the data about covid infection, fatality and vaccination are collected from the website of Health and Family Welfare Department, West Bengal Government, India and arranged accordingly for further processing to develop an effective fatality alert system with the help of popular predictive learning methods. The proposed model is being trained and tested by using Decision tree, Random Forest, AdaBoost algorithms. Using all those, the optimum accuracy rate of the models are calculated and the best one is chosen to develop a system for the fatality rate alert by predicting number of death cases which is very much similar with reality.

Keywords: *Machine Learning, Decision tree, Random Forest, AdaBoost Algorithm*

1. Introduction

The fatality alert model is being developed with the help of fatality cases on a region of interest. For each gove[redacted]ecessary to stay alert

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An Investigation on Machinability during Turning Al-Mg_2Si-Si Composite in Dry Condition

Dipanwita Biswas[1], Amit Banerjee[2], Santanu Das[3] and Prosenjit Das[4]

Abstract

In this work, machinability study during turning of Al-Mg_2Si-Si is taken into consideration with varying cutting tools. Latin square method is applied to find out the effect of cutting velocity, feed as well as insert type onto force requirement. Results show that in relatively high cutting velocity range, feed has significant effect on forces. Under 60 –75 m/min cutting velocity with 0.06-0.08 mm/rev feed, good machinability is obtained, and hence, these cutting conditions may be recommended for application in the industry.

Key Words: Machining, turning, Al-Mg_2Si-Si, cutting force, machinability, cutting tool.

Nomenclature

Main cutting force	P_z
Horizontal cutting force	P_{xy}
Chip-reduction coefficient	ζ
Depth of cut	t
Yield shear strength of workpiece	τ_s
Orthogonal rake	γ_o
Longitudinal feed	s_o

Introduction

Nowadays, advanced manufacturing industries face the challenge regarding manufacturing of high quality product through machining operation. To meet this challenge, exploring the way to achieve high machinability is quite important. In general, good machinability implies low force and power requirement, low cutting zone temperature, desired finish as well as integrity of work piece, long tool life and formation of favourable chip. The main purpose of machining is to meet the requirements, increase the performance and longer service life of the product at low cost. Metal matrix composites with particle reinforcement are being used commercially at present [1-2]. Aluminium based metal matrix composites are having huge applicability for having low density, processing flexibility, heat treatment capability, high wear resistance, relatively high Young's modulus of elasticity and strength [3-5]. Mg_2Si being an intermetallic, has enough hardness, and has a melting point of 1085°. Particle size was found to change abruptly with increase

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CNN-BiLSTM Hybrid Deep Network Aided Infra-Red Image Classification Framework for Non-contact Monitoring of Overhead Insulators

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[2] Department of Electrical Engineering, Birla Institute of Technology Mesra, Ranchi, India
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Abstract: In this paper, a novel vision-based automated framework for estimation of pollution severity of outdoor insulators is proposed. Correct estimation of pollution severity is important to prevent the premature flashover of insulators. Existing methods to determine the degree of contamination of insulator surface requires direct contact with the insulator which is practically problematic. Considering the afore-said fact, in this article, a novel infrared thermal (IRT) image-based automated framework is proposed for non-contact monitoring the surface condition of outdoor insulators. A large number of IRT images corresponding to different contamination levels were captured from several porcelain disc insulators using a thermal camera. The captured IRT images were initially segmented using mask region-based convolutional neural network (mask-RCNN) to remove the effect of background. Then, a hybrid deep learning network consisting of CNN and BiLSTM (CNN-BiLSTM) is designed for automated classification of IRT images. It has been observed that the proposed network has achieved an accuracy of 98.86%, specificity of 99.72%, precision of 98.86% and F-1 score of 98.86% respectively. Comparative study with other deep learning models indicated that the proposed CNN-BiLSTM network delivered better performance. Hence, the proposed framework can be used in real-life for non-contact condition monitoring of insulators.

1. Introduction

Overhead line insulators are one of the pivotal components of power transmission and distribution system [1]. It has been reported that 70% the power outages occur due to the failure of the insulators [2]. Power outages incur huge financial losses to an electrical utility. One of the main reasons behind the insulator failure is frequent flashover triggered by surface contamination [3]. Due to long-term exposure to environmental pollutants (especially in heavily polluted areas and coastal regions), the surface of overhead insulator gets gradually contaminated. Under moist condition, the soluble component (salt, alkali) in the contamination layer is partially dissolved, which leads to formation of conductive layer [1]. Formation of conductive layers leads to an increase in leakage current flow along the surface of the insulator. With the increase in contamination level, magnitude of leakage current increases which results

Considering the aforesaid fact, researchers all over the world are trying to develop vision based non-contact monitoring system for condition assessment of transmission line insulators. In this context, infrared thermal (IRT) imaging technique has been proven to be a viable approach for contactless monitoring of insulator surface condition. In infrared thermography, infrared thermal camera detects the infrared radiation emitted by an object and form a thermogram of the object [7]. The thermogram formed by the infrared thermal camera is also known as infrared thermal (IRT) image of the object. It should be noted here that the pixel value of IRT image is directly proportional with surface temperature of the object [7]. According to [3], increment in contamination degree leads to the temperature rise at different points of an insulator surface. Therefore, thermogram of insulators for different contamination levels will be different from each other which can be used to quantify the contamination severity of the insulator surface.

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Multisynchrosqueezing transform based improved time-frequency representation for automated contamination severity estimation of overhead line insulator

AK Das, S Deb, D Dey, B Chatterjee, S Dalai

IEEE Sensors Journal, 2022 ieeexplore.ieee.org

Contamination flashover of overhead line insulator is a serious problem which interrupts the power flow and affect reliability of transmission and distribution system. Therefore, timely and accurately estimation of contamination severity is a key to prevent contamination flashover henceforth enhancement of the reliability of transmission and distribution system. This paper presents an innovative and automated framework to estimate contamination level of overhead line insulator in service accurately employing surface leakage current (SLC) signal. In this framework, SLC signal procured at different contamination level has been analyzed in a joint time-frequency plane through Multisynchrosqueezing Transform. Thereafter, time-frequency spectrogram image obtained through Multisynchrosqueezing Transform has been fed to a configured CNN model for automated feature extraction and classification of SLC signals. Experimental results revealed that proposed framework is highly accurate and delivered better performance compared to other time-frequency spectrogram-based approach.

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Fabrication of a novel composite gel bead to reclaim methyl orange from a binary dye mixture: An active role of adsolubilization phenomenon

Subhadeep Biswas, Anjali Pal

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Abstract

The present work demonstrates a novel protocol in accordance with the reduce, reuse, and recycle principle of waste management rules for dye wastewater treatment as well as selective extraction of desired dye. Here two model dyes viz., methyl orange (MO) (an

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Materials Chemistry and Physics

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Use of surfactant bilayer modified silica for evolution and application of size variable solid Ag nanoparticle catalyst

Iman Kalyan [a], Subhadeep Biswas [b], Tarasankar Pal [c], Anjali Pal [b]

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Abstract

Zero valent arsenic nanoparticles (As(0)) in two different size ranges such as 55±8 and 61±9nm were prepared by reducing As(III) using $NaBH_4$, and designated as As1 and As2. Galvanic replacement reaction (GRR) of As(0) was employed for the synthesis of Ag nanoparticles (AgNPs) in two different size ranges. The as-prepared AgNPs i.e. AgNP1 and AgNP2 were then converted to heterogeneous catalyst by adsolubilizing them onto surfactant-modified silica (SMS) surface, and the immobilized AgNPs were designated as Ag1-

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A comprehensive review on BPA degradation by heterogeneous Fenton-like processes

Ankunta Nath; Subhadeep Biswas; Anjali Pal

Water Sci Technol (2022) 86 (4): 714–745.

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Abstract

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Reduction of 4-nitrophenol using copper loaded surfactant-modified chitosan beads: An approach towards sludge management

Ankurita Nath [a], Subhadeep Biswas [b], Preeti Pal [a], Anjali Pal [b]

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Abstract

Chitosan hydrogel (CS) beads and surfactant-modified chitosan hydrogel (SMCS) beads

European Journal of Chemistry 13 (2) (2022) 234-240

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Synthesis, crystal structure, and antidiabetic property of hydrazine functionalized Schiff base: 1,2-Di(benzylidene)hydrazine

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RESEARCH ARTICLE

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KEYWORDS

Synthesis
Hydrazine
Schiff base
Antidiabetic activity
X-ray crystal structure
Structural characterization

ABSTRACT

Hydrazine functionalized Schiff base, 1,2-di(benzylidene)hydrazine has been synthesized through a condensation between hydrazine and benzaldehyde under reflux, and structurally characterized. The crystal structure analysis reveals that the Schiff base crystallizes in an orthorhombic crystal system with the *Pbca* space group. Crystal data for $C_{14}H_{12}N_2$: a = 13.130(2) Å, b = 11.801(2) Å, c = 7.5643(16) Å, V = 1172.1(4) Å^3, Z = 4, T = 298.0(2) K, μ(MoKα) = 0.071 mm^{-1}, D_{calc} = 1.100 g/cm^3, 10272 reflections measured (6.206° ≤ 2Θ ≤ 65.552°), 2027 unique (R_{int} = 0.0282, R_{sigma} = 0.0283) which were used in all calculations. The final R_1 was 0.0627 [I > 2σ(I)] and wR_2 was 0.2162 (all data). It is evident that the imine protons are intramolecularly locked with the imine N bond, and the phenyl rings exist in *anti* orientation with respect to the –N-N– bond adopting a nearly planar conformation. The Schiff base grows a one-dimensional framework in the crystalline phase through long-distant C–H···π interaction. Hirshfeld surface and energy framework analyses have also been performed to understand the supramolecular forces and their contributions meticulously. The hydrazine functionalized Schiff base showed an excellent antidiabetic activity through α-amylase inhibitory assay relative to a standard compound, acarbose, under an identical condition.

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1. Introduction

Hydrazine-containing compounds have gained the utmost importance as they serve as a fundamental unit in the areas of pharmaceuticals [1], agrochemicals [2], a precursor to polymerization catalysts [3,4], fuel [5,6], chemosensors [7], etc. The expanding research on the hydrazine-based molecule is evident from the world hydrazine market value which is US$424 million in 2020 as per the report by Future Market Insight (FMI) and in 2021 the value surpassed US$426 million [8]. On the verge of the development of efficient hydrazine based materials, many functionalizations have been achieved [9-17]. The functionalization of hydrazine improves the efficiency of the materials and may create new properties in it. Among various functionalizations, one with Schiff base is trending due to the diverse properties of Schiff base including antibacterial [13,14], antifungal [15-17], antioxidant [18-20], antiviral [21], antitumor [22], anti-inflammatory [23,24], biominics [25], luminescence [26] and catalytic activity [27-29]. A brief literature survey shows that Diswas *et al.* has successfully designed a Schiff base functionalized with hydrazine and employed it for the synthesis of nanoaggregates that showed blue emission properties [30]. Additionally, Roy *et al.* developed an analogue of hydrazine-functionalized Schiff base and used it for cascade sensing for fluoride and bisulphate [7]. On the other hand, the tremendous rise in the field of pharmaceutical and medicinal chemistry has drawn the attention of researchers toward the formulation of efficient drugs even for the treatment of diseases as complex as diabetes mellitus. Diabetes mellitus, one of the global health issues, is due to irregular insulin production that can lead to a series of other diseases. Recently, functionalized Schiff bases are found to be a promising candidate in this field [31]. In various studies conducted to investigate insulin-mimetic properties, hydrazine derivatives of Schiff base have some interesting results, for example, Sakharwade's group showed the antidiabetic potentiality of a Schiff base [32]. In this context, we report the synthesis, crystal structure, Hirshfeld surface, and energy framework analysis of novel hydrazine functionalized Schiff base. We have also evaluated the antidiabetic activity of the prepared Schiff base by α-amylase inhibitory assay.

2. Experimental

2.1. Instrumentations

The percentage contribution of the elements of the Schiff base was determined on a Perkin Elmer 2400 CHN Elemental Analyzer.

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materialstoday COMMUNICATIONS

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Iron oxide-loaded alginate-bentonite hydrogel beads as a green and sustainable catalyst for 4-nitrophenol reduction

Subhadeep Biswas, Anjali Pal

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Abstract

The development of sustainable green catalysts is always a challenging task. Besides this, the catalyst should be recyclable and hence cost-effective. In the present work, alginate hydrogel beads were used as a support of iron oxide to form iron oxide-loaded alginate beads (Io-alg). Alginate is a biopolymer, cheap, and nontoxic. Iron is abundant in nature and a non-toxic element. To improve the mechanical stability of the beads, bentonite was

Carbohydrate Polymer Technologies and Applications

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Application of biopolymers as a new age sustainable material for surfactant adsorption: A brief review

Subhadeep Biswas, Anjali Pal

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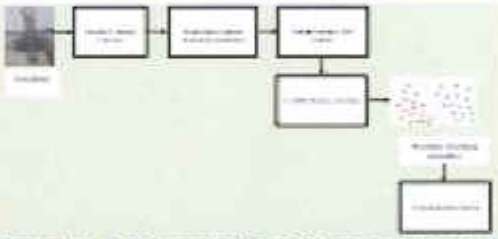
Highlights

IEEE Sensors Council IEEE SENSORS JOURNAL, VOL. 21, NO. 9, MAY 1, 2021 10967

Condition Monitoring of Overhead Polymeric Insulators Employing Hyperbolic Window Stockwell Transform of Surface Leakage Current Signals

Kaushik Sit, Arup Kumar Das, *Graduate Student Member, IEEE*, Debojyoti Mukherjee, Nasirul Haque, *Member, IEEE*, Suhas Deb, Arpan Kumar Pradhan, *Senior Member, IEEE*, Sovan Dalai, *Senior Member, IEEE*, and Biswendu Chatterjee, *Senior Member, IEEE*

***Abstract*—In this article, an efficient technique has been proposed to estimate the contamination level of overhead polymeric insulators. Deposition of contamination on polymeric insulator surface, is a serious issue as it often results in the flashover and even insulator failure. For estimating the severity of contamination level, surface leakage current (SLC) signals of a 11kV polymeric insulator with contaminated surface has been analyzed in time-frequency domain through hyperbolic window stockwell transform (HST). HST is more flexible than classical stockwell transform. Also, HST can able to handle both the low and high frequencies adequately. Considering the advantage, HST has been used here to estimate contamination degree from SLC signature. HST analysis of SLC signal returned a 2d complex time-frequency HS matrix. The complex time-frequency HS matrix has been separated into magnitude and phase spectrum. Based on the phase and magnitude spectrum, 15 statistical features, namely HST features has been extracted. Thereafter, 5 relevant HST features have been selected through least absolute shrinkage and selection operator (LASSO) feature selection technique. Finally, these relevant HST features are fed to four machine learning classifiers for estimation of contamination degree. It has also been observed that, the proposed framework method offered better classification accuracy compared to other standard time-frequency analysis and existing methods available in literature.**



***Index Terms*— Polymeric insulator, condition monitoring, surface leakage current, time-frequency analysis, stockwell transform, classification.**

I. Introduction

In RECENT times, reliable and uninterrupted power supply is the outmost requirement to the consumers end. A significant portion of this power is transmitted through high voltage overhead transmission lines. It has to be mentioned here that, one of the major reasons behind power outage is the failure of overhead transmission line insulators [1], [2]. In recent times, non-ceramic insulators are becoming increasingly popular compared conventional ceramic insulators due to many advantages such as, light weight, better pollution performance and hydrophobic property [3], [4]. Likewise, ceramic insulators, the condition of polymeric insulators is also significantly affected by the level of pollution layer [5], [6]. Under polluted environment, the surface of polymeric insulator may get contaminated due to accumulation of salt, dust and sand. Soluble pollutants like salt may form a conductive layer in the presence of water. Formation of these conductive layer increases the surface leakage current density, which may further result in formation of dry band and partial arcing. These arcs get elongated which finally bridges the whole insulator leading to pollution flashover of the insulator. As a result, the ageing process of insulator is accelerated, making it prone to failure [5]–[7] and deterioration of the insulator material which can result

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RESEARCH ARTICLE

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Optimization of alongwind and crosswind force coefficients on a tall building with horizontal limbs using surrogate modeling

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Summary

For tall buildings, values of wind force coefficients can be obtained from wind tunnel tests or Computational Fluid Dynamics (CFD). This paper is concentrated to analyze a set of CFD data and propose parametric equations for determining force coefficients in the alongwind and crosswind direction (C_{fx} and C_{fy}) of tall buildings with horizontal limbs. Initially, a parametric study is performed with CFD analysis considering *RANS* $k-\varepsilon$ turbulence models keeping a constant plan area 22,500 mm^2. The length and velocity scales are taken as 1:300 and 1:5, respectively. The required design parameters are obtained and used for fitting parametric equations. The CFD data are further utilized for training artificial neural networks of C_{fx} and C_{fy}. The results of CFD, ANN, and parametric equations are compared. The parametric equations are validated by employing a wind tunnel study. Finally, three optimization studies are carried out using a genetic algorithm (GA), of which the first two aim to present the maximum and minimum force coefficients considering single objectives. The third optimization is a multi-objective optimization problem, carried out to simultaneously minimize and maximize the two orthogonal force coefficients. Pareto-optimal design results are presented.

KEYWORDS

artificial neural network (ANN), force coefficient, optimization, parametric equations, tall building, wind tunnel

1 | INTRODUCTION

The wind is one of the significant lateral load on buildings and essential to consider in structural load analysis. For the design of structural frames such as columns and beams, determination of wind pressure is required. Again, for the design of finishing and cladding as well as their joints, wind force should be known. As the guidelines of building codes are unable to guess the wind loads with the desired degree of accuracy in case of tall buildings, specialized literature is needed for the design. So there had been extensive investigations carried out by the researchers to determine the wind loads on different plan shapes of tall buildings with different aspect ratios. Experimental or numerical techniques of model analysis were adopted, and in some cases, analytical expressions were proposed to facilitate the determination of wind loads with lesser cost, time and labor. Mostly the estimations of the wind pressure coefficients on the façade of the buildings had received attention. There is ample opportunity to work towards assessments of alongwind and crosswind forces. Hence, this particular study is focused on the determination of wind force coefficients.

Wind-induced responses depend significantly upon the shape of the building also. In modern days, tall buildings with horizontal limbs (Z-shape, E-shape, and + shape) are becoming popular.[1–6] For limbed buildings, numerous phenomena are contributing to dynamic responses under wind like buffeting, vortex shedding, galloping, and flutter. As wind-induced forces and motions usually govern the properties and

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Aerodynamic shape optimization of a high-rise rectangular building with wings

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Abstract. The present paper is focused on analyzing a set of Computational Fluid Dynamics (CFD) simulation data on reducing orthogonal peak base moment coefficients on a high-rise rectangular building with wings. The study adopts an aerodynamic optimization procedure (AOP) composed of CFD, artificial neural network (ANN), and genetic algorithm (G.A.). A parametric study is primarily accomplished by altering the wing positions with 3D transient CFD analysis using k − ε turbulence models. The CFD technique is validated by taking up a wind tunnel test. The required design parameters are obtained at each design point and used for training ANN. The trained ANN models are used as surrogates to conduct optimization studies using G.A. Two single-objective optimizations are performed to minimize the peak base moment coefficients in the individual directions. An additional multiobjective optimization is implemented with the motivation of diminishing the two orthogonal peak base moments concurrently. Pareto-optimal solutions specifying the preferred building shapes are offered.

Keywords: Artificial Neural Network (ANN); computational fluid dynamics; genetic algorithm; high-rise building; multiobjective optimization; wind tunnel

1. Introduction

The wind being the predominant lateral load in skyscrapers, is to be considered accurate in the critical load analysis. Determination of the wind pressure is needed to design structural frames like beams and columns. Additionally, wind force should be considered when designing the finishing and covering and their joints. As the building code guidelines cannot measure the wind loads in high-rise buildings with the desired level of precision, specialized literature must design them. The researchers have extensively researched the wind load in various plan types of large buildings with various aspect ratios. Model analysis methods (either experimental or numerical, or both) are implemented, and analytical expressions are proposed in some instances to enable the detection of lower-cost, time-efficient determination of wind loads. Reactions caused by wind depend substantially on the geometrical shape of the building too. A rectangular building with wings, like + shape, E-shape, Z-shape type, is becoming common in modern times (Chakraborty *et al.* 2014a, 2014b, Bhattacharyya and Dalui 2018, Paul and Dalui 2016). Many physically significant factors, including flutter, galloping, vortex shedding, and buffeting, contribute to complex wind responses for building with wings. Hence, the building geometry and corners shall be modified to optimize high-rise buildings' aerodynamic shape. As the wind loading requirements do not include provisions for any irregular-shaped buildings, there is enough space and motivation to research dynamic effects on high-rise buildings' asymmetrical geometry under the wind's influence. Kareem (1986) conducted wind tunnel experiments to research aerodynamic interference's effect on prismatic structures' dynamic response. Melbourne (1993) studied the behavior of shear layers separating the leading edge of the bluff body. The author also attributed the critical position of turbulence, particularly the impact on the pressures under the shear layer's reattachment. Surry and Djakovich (1995) studied high peak suctions built on building models, their relationship to building form, and oncoming simulated atmospheric shear flow characteristics. Kijewski and Kareem (2001) analyzed and contrasted seven of the world's principal building codes and standards with a detailed discussion of their estimates of the torsional response for a given building, including wind and wind, where applicable. Lin *et al.* (2004) conferred that the crosswind and torsional responses exceed the along-wind response for super high-rise buildings. Liang *et al.* (2004) used different rectangular buildings of various side-ratios to propose parametric equations to obtain wind-induced dynamic torsional responses. Balendra *et al.* (2005) discussed the details and test results of the laser positioning measurement techniques of wind-induced displacements in a high-rise building. Also, a comparison has been made with the outcomes obtained from the conventional strain gauge method. Irwin (2007) pointed out that strong ground-level winds should be considered, created by high-rise buildings due to their affinity to repel strong upper-level winds downwards. Kim *et al.* (2008) conferred the taper

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STAGING RE(ACTION) TO MIDDLE-CLASS ETHOS IN BADAL SIRCAR'S SELECT PLAYS

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Abstract

Badal Sircar's theatre invariably advocates equality and justice challenging the restrictive middle-class conventions of being self-centred and indifferent to others. Sircar all through his theatrical journey had endorsed equity among different sections of society. Plays like Bhoma, Stale News & That Other History among many others depict the lack of equity and also point out those who are responsible for the exploitation. This research paper attempts to identify the role of the urban middle-class society in triggering the exploitative process. The paper also figures out the Sircarian technique of blistering the conscience of the audience and prepare them for inviting a social change.

Keywords: Sircarian technique, conscience, audience, society, middle-class

Badal Sircar (1925-2011), as a playwright, an actor, a director, and, above all, a crusader, had a clear and definite contribution that is almost unparalleled in the theatrical history of India. Successive events like the partition of India, migration across the border, devastating famine, food movement in 1959, consecutive Communist Party split in 1964 and 1967, Bangladesh Liberation War, the radical Naxalbari Movement and various other national and international events in the 1960s &70s prepared a fertile ground for Sircar to grow as a people's artist. His life as well as his oeuvre is meaningful and purposeful in the sense that both of them were dedicated to the cause of the masses. As we trace the trajectory of Badal Sircar's theatre, we can discern a pattern of steadily growing politicization of his plays and a deepening concern with questions that can be seen as moral, ethical, or political. It is indeed difficult to find a common style running through all the plays of Badal Sircar but a milieu of educated middle-class life in Calcutta might define the common basis in most of his plays. Sircar started rigorous questioning of the *status quo* of the middle-class bourgeois with his highly acclaimed play *Ebong Indrajit* (1963). Thereafter, we notice his works issue out a wholesale repudiation of middle-class complacency, self-interest, guilt and responsibility.

In three among many of Sircar's plays, *Bhoma, That Other History* and *Stale News*, the focus is centred upon the hypocrisy of the urban middle class that exploits resources and underprivileged sections of the society. Instead of exaggerating the threats of the exploiters and the callousness of the political leaders, Badal Sircar focuses on the callousness of the middle class and their capacity to watch the sufferings of the people without doing any efforts at alleviation of their misery. Repelled by the pedantic philosophical approach of Marxism that seems to explode the tea table discourse or get applauded in the cloister of a seminar hall, he radically separates his ideals; within the ambit of his plays the narratives displace the jargons and empty utopic discourses of radicalism. Sircar challenged the clichéd forms of protest and found a unique idiom of expression that does justice to the continuous bothering of conscience. The intriguing interplay of discrete and fragmented dialogues in the plays as mentioned earlier trace the narrative of the urban middle class that undermines the severe concerns and voice of a marginal, poverty-stricken country. In all these three plays we see an extreme insensitivity and indifference of the urban community while responding to the concerns of the 'other'.

In *Bhoma* (1975) Sircar depicts the ever-widening gap of the urban-rural populace The dramatization of the oppression of the rural poor in the hands of the local rich, bureaucrats and apathetic

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TECHNICAL PAPER

A shaft finite element for analysis of viscoelastic tapered Timoshenko rotors

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Abstract

Finite element modeling of thick rotor (deep rotor) requires the use of the Timoshenko element, which takes care of shear deformation. Modeling a rotor whose cross section varies can be done using uniform stepped cylindrical elements, but the number of elements required for the converged results is enormous. Further modeling of doubly tapered rotors and rotors with sharp changes in taper angle using such methods become difficult and does not appear feasible that is why the formulation of conical rotor elements is necessary. The complexity in formulations arises due to the presence of the shear parameter in the denominator. Till now, in the literature of the Timoshenko rotor, geometric properties are taken to be linearly varying; the shear parameter is the approximation of average values of two end nodes. On the other hand, the modeling of damping in rotors becomes essential as it controls the stability limit. The present paper develops three different viscoelastic tapered rotor elements using the Maxwell–Wiechert model. While the first element (VTRE 1) uses the average shear parameter, the second element (VTRE 2) uses a higher degree polynomial to approximate the shear parameter. While the first two-rotor elements are solid, the third element (VTRE 3) is hollow. Results show that viscoelastic tapered elements provide better results with the lesser number of elements. For the rotor with a large taper angle, VTRE 2 performs better than VTRE 1. Further modeling of the hollow tapered rotor with a linear variation of taper angle and discontinuities at definite points is not possible by the use of uniform elements. Modeling such a rotor using VTRE 3 is rendered simple. Practical usage of such rotors further enhances the importance of the present work.

Keywords Maxwell–Wiechert model · Viscoelastic tapered rotor element · Timoshenko beam theory

1 Introduction

Damping is inherent in all mechanical systems. In a vibrating system, it usually helps to decay the transient response or reduce the amplitude of the steady-state response. In contrast, in a rotating system, it may become the cause of instability. So the development of a mathematical model for damping is of importance. There are several methods to quantify damping, depending upon the reason for damping like viscous damping, Coulomb damping, hysteresis damping, etc. Instability in rotor dynamics creeps in after a certain speed. In the following paragraph, several damping models available in the literature have been discussed.

During stress analysis of structures considering linear viscoelastic material, Williams [1] transformed the problem in the Laplace domain considering the Laplace transformation of stress–strain relation. Then, the inverse Laplace transformation is carried out on the solution obtained in the Laplace domain to achieve a time-domain solution of the actual time-domain problem. Analysis performed in the frequency domain is found to be suitable for viscoelastic component subjected to harmonic loading, where storage modulus and loss coefficient are readily available. But for loading other than harmonic, a viscoelastic material model is required in the time domain. Many researchers prefer the Maxwell–Wiechert model for this purpose. The GHM material model [2] is frequently used in finite element analysis.

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Estimation of Contamination Level of Overhead Insulators Based on Surface Leakage Current Employing Detrended Fluctuation Analysis

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Abstract—**This article proposes an advanced technique for condition assessment of outdoor insulators based on its surface leakage current through employing detrended fluctuation analysis (DFA). Analysis of surface leakage current of in-service insulator can be useful for assessing its surface condition. In the proposed technique, a tracker signal has been developed based on the fundamental component of surface leakage current to extract the distortions from it which carries significant information about contamination level. DFA has then been applied on the extracted distortions of leakage current to estimate its contamination level. In order to investigate experimentally, surface leakage current of 11-kV disc insulator (contaminated at different level) has been captured at different applied voltage level. The proposed technique has been applied on the captured leakage current to estimate contamination level. Results show that employment of the proposed technique provides satisfactory outcomes regarding assessment of insulator condition, which in turn improves the reliability of power system.**

Index Terms—**Condition monitoring, detrended fluctuation analysis (DFA), harmonics, outdoor insulator, surface leakage current.**

I. Introduction

RELIABLE operation of power system network primarily depends on the performance of overhead transmission line insulators. However, flashover through insulator surface can bring severe impact to the reliability on entire power system network. During operation, insulators get contaminated easily by salt, dust, industrial pollutants, agricultural pollutants, etc. Contaminants in presence of moisture, drizzle, fog and rain, etc., cause leakage current to flow over the surface of insulator, which subsequently leads toward flashover [1]–[5]. Therefore, regular assessment of insulator surface is essential for uninterrupted power supply to the consumers end.

Available literatures show that estimation of equivalent salt deposit density (ESDD), nonsoluble material deposit density (NSDD) can be the effective parameter for condition assessment of porcelain insulators [6]–[16]. However, estimation of ESDD, NSDD is time-consuming process and hence difficult to automate [9]. Considering limitations of ESDD, NSDD measurement techniques, researchers have focused on analyzing surface leakage current for condition assessment of insulators. Investigation of leakage current pattern can be a suitable indicator of insulator surface condition [11]. In this regards, analysis of lower order harmonic contents within leakage current can be useful to retrieve significant information about the surface condition of insulators [4], [12]–[16]. It is reported in [4] that ratio of fifth to third harmonic can be an indicating parameter of contamination level deposited on insulators surface. Besides, phase angle measurement [9], phase difference cosine (%PD) [13] can also be employed as a diagnostic parameter for outdoor insulators. Although employment of various parameters (ratio of fifth to third harmonic, phase angle, %PD) evaluated based on applied voltage and corresponding surface leakage current can be effective indicator of contamination level of insulator surface, however, these parameters value can be varied with the applied voltage level. Hence, proper information about applied voltage is necessary during usage of these parameters. Besides, operating voltage of an in-service insulator can be different from the voltage level applied during testing, which can result somewhat inappropriate estimation of contamination level.

Considering the abovementioned limitations, a technique has been proposed in this article that can estimate the contamination level of insulators surface by analyzing surface leakage current through employing detrended fluctuation analysis (DFA) [18]. The advantage of the proposed method is that only leakage current information is sufficient to estimate contamination severity of insulator. The proposed technique is applied on 11-kV contaminated porcelain disc insulator to investigate its effectiveness.

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SPECIAL ISSUE PAPER

Even big data is not enough: need for a novel reference modelling for forensic document authentication

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Abstract

With the emergence of big data, deep learning (DL) approaches are becoming quite popular in many branches of science. Forensic science is no longer an exception. However, there are certain problems in forensic science where the solutions would hardly benefit from the recent advances in DL algorithms. Document authentication is one such problem where we can have many reference samples, and with the big data scenario probably we would have even more number of reference samples but number of defective or forged samples will remain an issue. Experts often encounter situations where there is no or hardly a scanty number of forged samples available. In such situation, employment of data-hungry algorithms would be inefficient as they will not be able to learn the forged samples properly. This paper addresses this problem and proposes a novel reference modelling framework for forensic document authentication. The approach is based on Mahalanobis space. Two questioned document examination problems have been studied to show the effectiveness of our reference modelling algorithm which has also been compared to a commonly used learning approach, namely neural network-based classification.

1 Introduction

In forensic science, many experts often deal with authentication or verification of a given entity. It could be authentication (or verification) of signature, handwriting, legal paper, bank currency, art, audio, video, etc. Based on this problem, a separate discipline of forensic science has emerged which is known as questioned document examination (QDE) [20,30]. The primary goal of this branch is to provide opinion about a suspicious or questionable document based on a variety of scientific processes and methods [21].

In order to authenticate (or verify) a document in question, experts surely need genuine samples of the corresponding documents. This is needed in every authentication or verification task as to develop idea about what the reference is against which something will be authenticated or verified. Reference sample(s) helps experts to develop an idea about the distinctive aspects which are to be checked in the sample in question. Reference handwriting helps in characterizing the handwriting, and reference security document helps in finding out the security features in the document. Human experts check whether the reference characteristics are naturally retained in the sample in question or they are forged or they are absent.

As human judgement can be subjective, efforts have been made to present the human analysis in a scientific way so that court of law keeps confidence in such analysis. The approach is a semi-automatic one as human expert not machine takes a decision, and in taking the decision expert takes help of machines. Emergence of digital forensics, computational forensics, etc., is the result of this trend. Machine help can be of different types; it could be image from digital microscope or UV scanner, and some machine computed measurements like image hue, intensity or histogram, etc. Sometimes machine help could be of high end in nature where suitable algorithms are to be designed. For instance, given a suitable algorithm machine can produce frequency analysis of a voice signal, stroke pattern analysis of a handwriting, etc. However, using all such helps if decision is finally taken by an expert, the decision making process remains semi-automatic.

In the recent times, researchers have attempted to develop fully automated decision making systems for certain areas

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ATIPC – 2020 Special Issue

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The effect of current density and charge loading for total organic carbon (TOC) removal by electrocoagulation

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In this research the effect of current density and charge loading was investigated on the removal of total organic carbon (TOC) from a synthetic water sample. It was noted that during Electrocoagulation (EC) at a constant current density, TOC removal was increased when charge loading was increased. However, for a constant charge loading, the TOC removal was decreased when the current density was increased. Therefore, the investigation pointed out anomalously, that the indiscriminate growth of current density does not only decrease the TOC removal but also cause economic loss.

Keywords: Total organic carbon (TOC), electrocoagulation (EC), current density, charge loading.

Introduction

The extent and unprejudiced of water treatment are to remove objectionable constituents from water to make it potable. The conventional water treatment process uses alum coagulation, especially for the separation of suspended solids. In subsequent operations like filtration and disinfection water is make pathogen free. However, the trace amounts of dissolved organic substances which interfere with the disinfection process and produces carcinogenic disinfection byproducts (DBPs) are the major concern which remain unattended during treatment. Though electrocoagulation is widely used for wastewater treatment, the systematic study on different EC process variables is still not rigorously studied for potable water. Natural waters are drawn from different surface water sources contain a wide variety of water quality parameters among those suspended and colloidal particles are the commonest which is responsible for turbidity in surface water. These contaminants may be generated from organic and inorganic sources. The negatively charge of colloids on the surface exhibited repulsion forces and the aggregation between the colloids get hampered[1,2]. The process of EC is easily operated by simple equipment for the dosing of coagulant in experiment and the sludge generation is quite less than another conventional counterpart[3]. The associated anions are not produced in EC like chemical coagulation and easy to maintain the environmentally friendly compatibility[4,5]. The electrocoagulation process exhibits lower operational costs for low and intermediary doses of coagulant compared with conventional coagulation with aluminum polychloride (PACl)[6]. Thus, the cost of the electrocoagulation process relates favorably with that of conventional coagulation for less coagulant demands[7] and the effective workability may partially replacement of the chemical coagulation[8].

TOC impart unfavorable taste and visual effect in water samples. This organic compound coordinates with different metallic ligand and transmit metal complexes to the natural water sources[9,10]. During the disinfection procedure this compound mixed with disinfectant in water and produce disinfection by-products (DBPs). Human population faced carcinogenic, mutagenic toxic effects due to different DBP's like, trihalomethanes, halo acetic acids etc. Due to the health consideration this fulvic acid compound must be removed from the water for drinking water treatment process[11].

ATIPC – 2020 Special Issue

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Total organic carbon (TOC) removal from textile wastewater by electro-coagulation: Prediction by response surface modeling (RSM)

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Water pollution control is presently one of the most important areas for scientific research. Strict regulatory measures are asking industries to treat their waste effluents up to the standards set by the governing body. Color removal, in particular, has recently become an area of major scientific interest as indicated by many related research reports. The textile industries use huge amount of water in their various processes of dyeing and are thus one of the largest producers of industrial liquid waste (ILW). In this study TOC removal was evaluated by electro-coagulation using iron electrode from real textile dye waste and mathematical model was developed to predict TOC removal performance. The parameters that were taken into considerations were the effect of pH, time, current and initial TOC concentration. At optimum condition the removal was achieved as 95.7%.

Keywords: Textile dye, electrocoagulation, TOC, modeling, Doehlert design.

Introduction

Worldwide production of dye-containing wastewaters is still an important ecological issue due to the persistent nature of the compound, their low biodegradation rate and carcinogenic nature. Textile industries are one of the most polluting industries in terms of the volume of water being used and complexity of its effluents discharged. A huge amount of effluent is generated in the various processes such as sizing, scouring, bleaching, mercerizing, dyeing, printing, and finishing[1]. In many cases effluents are discharged directly to the mainstream especially for small scale industries. Therefore, treatment of textile wastewater is a must do step before releasing it into the water bodies.

There are various treatment methods available that have been widely applied to remove the color and organic pollutants from textile wastewater namely: adsorption, precipitation, chemical degradation, photochemical degradation, biodegradation, coagulation-flocculation, advanced oxidation etc. However, most of these treatment methods have been proved insufficient in terms of removal efficiency and economic burden[2,4,5]. On the other hand, the electrocoagulation process has attracted great attention of many researchers due to its unique advantages, such as its lack of chemical additives, simple operation and high efficiency. Furthermore, dye effluent may contain chemicals, which are toxic and carcinogenic in nature.

Depending on the process being used, the textile wastewater is known to have varying pH, high temperature, high chemical oxygen demand (COD) and high concentrations of suspended solids (SS)[3]. Thus, the removal of contaminants and color from these effluents poses challenge for the textile industry before being discharged to the inland surface. The disposal of sludge often involves huge expenditure as it must be safely disposed[6,7]. So, there is an urgent need to develop more efficient and inexpensive method which require minimum chemical and energy consumptions, as well as minimum installation space. In recent years, investigations have been focused on the treatment of wastewaters using electrocoagulation[8]. Electrocoagulation is a process where metallic hydroxide flocs are generated *in situ* via electro-dissolution of a soluble sacrificial anode immersed in wastewater to be treated[9,10]. The rate of floc generation is generally

Special Issue on "Innovative Technologies for Industrial Waste Management"

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Removal of dissolved organic carbon by functional reduced graphene oxide from organic–rich water pre-treated by electrocoagulation

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Dissolved organic carbon (DOC) is produced from different anthropogenic activities and microbial activities on organic matter. TOC influences the production of carcinogenic disinfection by-product (DBP) at the time of disinfection during water treatment. This TOC is extremely hydrophilic in nature and difficult to separate from water by the conventional treatment procedures. Therefore, an integrated system is introduced to control TOC where a pre-treatment by electrocoagulation (EC) followed by adsorption with a nano-adsorbent made of reduced graphene oxide (rGO) coated sand impregnated by iron was used. The pre-treatment reduced 38.19% of TOC whereas 99.3% of TOC was removed by this integrated process. The process can be introduced successfully for domestic level application with small footprint successfully.

Keywords: Dissolved organic carbon (DOC), disinfection by-product (DBP), electrocoagulation (EC), functionalized reduced graphene oxide (rGO).

Introduction

In water bodies dissolved organic carbon (TOC) can be contributed anthropogenic activities or by decomposition of organic matter naturally. Natural organic matter (NOM) has hydrophobic tail and hydrophilic head which make it difficult to remove from water. The hydrophilic component is dissolved in water and contributes to TOC in the water system[1]. The hydrophilic substances, like fulvic acids (FAs), humic acid (HA) are organic acids of dark coloured and derived from plant residue.

Structurally, they consist of aliphatic chains connected with aromatic rings[2]. It influences the water bodies by changing the physical and chemical characteristics. They also produce different complexes reacting with heavy metals[3–5]. Moreover, they are very much responsive with a large range of disinfectants which are used during water and wastewater treatment and producing carcinogenic disinfection by-products (DBPs). The major constituents of DBP are trihalomethanes and halo acetic acids. These are mutagenic, carcinogenic and affect harmful toxicity on the human cell line[6–9]. The DBPs are difficult to remove by conventional water treatment process[10] and impair the performance of other processes like adsorption[11], photocatalysis[12], ion-exchange[13], granular filtration, membrane filtration[14], advanced oxidation process[15]. The hypothetical molecular structure of FA is given in Fig. 1.

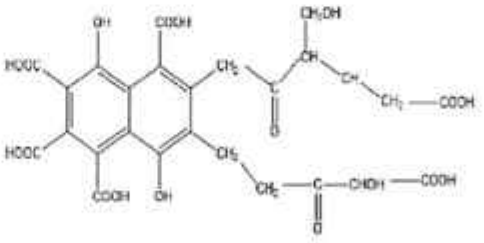

Fig. 1. Hypothetical molecular structure of fulvic acids (FA)[16].

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RESEARCH ARTICLE

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Capacity Estimation of Multilane Highways under Heterogeneous Traffic Conditions using Micro-Simulation Technique

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Abstract

The behavior of a driver of any vehicle is important in estimating heterogeneous traffic conditions with no strict lane discipline. In the present study, a micro-simulation model is used to analyze the mixed traffic condition with different drivers' behavior parameters. The field data collected on traffic flow characteristics of multilane highways are used in the calibration and validation of the simulation model. Out of the ten coefficient of correlation (CC) parameters in the simulation model, five are used in the present study to make a model of simulation for heterogeneous traffic; the other five parameters are not considered for testing their influence on simulated capacity values as they represent very typical behavior of a driver, either in car-following, or in free-flow conditions. Two separate simulation models are made by changing the CC (CC0, CC1, CC2, CC7, and CC8) parameters, each for a four-lane divided and a six-lane divided highway as the geometric conditions of the roads, and the traffic flow is different for both the cases. These models are then applied on two other sections of a four-lane divided and a six-lane divided highway to validate the parameters of the model developed earlier for other sections.

Keywords: Behavior, Calibration, Capacity, Heterogeneous, Parameters, Traffic.

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Introduction

In developing countries, the traffic includes numerous vehicle classes that interact in a disorderly manner with no lane discipline, forming an imprecise mixed traffic condition. The nature of the traffic condition is exceedingly diverse as several vehicle categories with changing features, both statically and dynamically move or operate on a common road width without any physical segregation. The traffic operations are affected as the vehicles with smaller dimensions pierce the gaps formed between larger dimension vehicles. Unrestricted movement of vehicles makes the traffic situation further multifaceted in comparison with standardized traffic situations. Aimed at the persistence of better preparation and organization of highways, the determination of roadway capacity of various highways and expressways is the utmost serious matter under consideration. For the execution of a proper plan, design, and operations of roads, the information of the capacity of a roadway is crucial. Underneath diverse traffic circumstances, the volume of traffic along with the composition is important to estimate roadway capacity concerning the vehicles moving through a particular section in a unit amount of time. The simulation represents a mirror or projection of actual traffic behavior, which is difficult to observe in real-world situations. So, it is very much essential for the usage of a minuscule model of traffic simulation to generate the mixed traffic flow after calibrating its influencing model parameters affecting the longitudinal behavior of a driver or vehicle.

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ORIGINAL CONTRIBUTION

Assessment of Multilane Highway Capacity Through Simulation Process by Considering the Effect of Behavior of Driver of a Vehicle

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Abstract In case of a non-lane based heterogeneous traffic flow, the vehicle driver's behavior becomes one of the major considering aspects for proper traffic maneuverability. In the present study, microscopic simulation model has been used, as it contains abundant autonomous parameters to illustrate the features of traffic flow, behavior of drivers and traffic regulatory processes. The present traffic simulation model follows two modified models based on vehicle following theories and behaviors as modified by Wiedemann. A driver in the micro-simulation model considers the preceding vehicle as well as neighboring lane vehicles in a traffic stream. The methodological description of a vehicle technically, behavior and interdependency of a driver and a vehicle as a unit is attributes of a driver and his or her vehicle in a traffic stream. Thus, hysteresis plots of relative speed against relative distance are made for aggregated leader and follower vehicles of each vehicle type based on follower vehicular category to get the calibrated coefficient of correlation parameters (CC). A new simulation model with calibrated CC parameters is made to get a realistic capacity estimate of different multilane highways in Indian conditions.

Keywords Heterogeneous · Microscopic · Simulation · Hysteresis · Correlation

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Introduction

The multilane highways are high speed roads with high traffic volume that provide unhindered traffic movement and better connectivity to various places of importance in a country. In most of the multilane interurban highways of India, the share of non-motorized traffic has become insignificant. However, the characteristics of motorized traffic on the above class of highways continue to be diverse in nature due to the fact that the motorized two wheelers and three wheelers (possessing varying size and speed characteristics) share the same road space with other vehicle types like cars, buses and varying types of goods vehicles. This situation arises due to the reason that there is no centralized monitoring system over the traffic movement and the drivers of the vehicles are also not educated enough to understand the importance of moving in a particular lane for a better traffic flow. This notable difference in the nature of the traffic flow requires detailed studies of the microscopic behavior of stochastic traffic of Indian multilane highways. The non-lane based vehicular movement increases the importance of leading vehicles as the follower vehicle has to adopt the situation with respect to the leader vehicle, so a thorough vehicle to vehicle interaction becomes important in this scenario. As traffic capacity is a major parameter for planning, analysis and design of a multilane highway by considering the traffic characteristics, so the estimation of capacity of multilane

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Prognosis of Wind-tempted Mean Pressure Coefficients of Cross-shaped Tall Buildings Using Artificial Neural Network

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Abstract

The present paper focuses on the study of wind-induced responses of cross-plan shaped tall buildings. Initially, three parametric building models are studied for the purpose with a constant plan area 22500 mm^2. The length and velocity scales are taken as 1:300 and 1:5, respectively. Wind angle of attack (WAA) is considered from 0° to 330° with an increment of 30°. At first, the external surface pressure coefficients (C_p) at different faces of the models are carried out for different wind occurrence angles employing Computational Fluid Dynamics method of simulated wind flow. Again, Fast Fourier Transform (FFT) fitted expressions as the sine and cosine function of WAA are proposed for attaining mean wind pressure coefficient on the building faces. The accuracy of the Fourier series expansions is justified by presenting histograms of sum square error (SSE), R^2 value and root mean square error (RMSE). The results are also compared by training Artificial Neural Networks (ANN). Training is continued till Regression (R) values are more than 0.99 and Mean Squared Error (MSE) tends to 0, ensuring a close relationship among the outputs and targets. The face-wise value of (C_p) obtained using all three methods, are plotted. The error histograms of the ANN models show that the fitting data errors are spread within a reasonably good range. It is observed that the deviation in the result is not more than 5 % in any case. Finally, the ANN predictions are presented for nine parametric models to cover a wide range of possible cross-shaped buildings.

Keywords

cross-plan, tall building, Artificial Neural Network (ANN), Fast Fourier Transform (FFT), pressure coefficient, regression

1 Introduction

With the advent of modern technology and scarcity of available land in the globe, modern buildings are very tall and also non-conventional and irregular in both plan shape and elevation. Thus, tall buildings being susceptible to lateral forces (Part-especially for the response of across direction), may vibrate in all the three directions (x, y, z). As the building height increases, wind becomes the predominant lateral force as the wind intensity intensifies exponentially with the altitude of the building. Not only that, but wind-induced responses depend significantly upon the shape of the building also. Different International Standards are providing guidelines for estimating wind-induced responses for regular (both in plan and elevation) shaped buildings. But non-conventional, irregularly shaped structures demand guidance from specialized literature or wind tunnel study or CFD approach. Over the years, wind tunnel model experiments were conducted by the researchers to study localized wind forces [1], experimental results of U and L shaped building in the plan [2], occupant comfort under dynamic wind [3], the effect of size of recessed and chamfered corners of tall buildings [4], aerodynamic forces and wind pressure on various unconventional configurations [5], pressure coefficients on the walls of the buildings (C_{pe}) and propose surrogate models [6], the deviation of pressure dispersal of tall square plan shaped building for various wind azimuths [7] so on and so forth. In some cases, a combination of wind tunnel study and numerical simulation was also carried out to demonstrate wind-induced responses of '+' shaped in plan tall building model for 0° as well as 45° [8], mean pressure coefficient of 'E' plan shaped tall building [9]. Again numerical simulation techniques were adopted to study wind tempted interference characteristics [10], turbulent scalar flux for near-field scattering around buildings [11], the variation of external pressure coefficients and force coefficients on 'Z' plan

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Shape Optimization to Reduce Wind Pressure on the Surfaces of a Rectangular Building with Horizontal Limbs

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Abstract

The present study consists of shape optimization of a rectangular plan shaped tall building with horizontal limbs under wind attack, which would minimize the wind pressure on all the faces of the building model simultaneously. For the purpose, the external pressure coefficients on different faces of the building (C_{pe}) are selected as the objective functions. The position of the limbs and the wind incidence angle are taken as design variables. The design of experiment (DOE) is done using random sampling. The values of the objective functions are obtained by using Computational Fluid Dynamics method of simulated wind flow at each design point. The building model has a constant plan area 22500 mm^2. The length and velocity scales are taken as 1:300 and 1:5, respectively. The results are used to construct the surrogate models of the objective functions using Response Surface Approximation method. The optimization study is done using the Multi-Objective Genetic Algorithm. The building shapes corresponding to the Pareto optimal decision variables are shown. The function values corresponding to the decision variables are verified by further introducing a CFD study.

Keywords

tall building, wind pressure coefficient, optimization, multi-objective genetic algorithm, pareto-optimal solutions, Response Surface Approximation

1 Introduction

Due to the associated intricacy during wind-structure interaction in case of tall flexible buildings, simple quasi-static method of analysis is insufficient. Physical modelling using a wind tunnel or numerical simulation technique is the recommended means of obtaining precise information on wind effects on tall buildings [1, 2]. Numerical simulation can be carried out using computational fluid dynamics (CFD) under simulated atmospheric boundary layer (ABL). For super tall buildings, the wind is the predominant lateral load. There arises many flow situations and dynamic responses when wind interacts with tall buildings.

Moreover, if the tall building is built with unconventional shapes or in unusual locations, then wind becomes a phenomenon of high complexity concerning the design of tall buildings against the wind. The dynamic characteristics of wind depend on many factors, including the outer shape of a building. Hence wind loads on structural frames are calculated based on the elastic response of the whole building against fluctuating wind forces. Globally the building codes do not incorporate the expected maximum wind speed for the life of the building. Neither the wind standards consider the high local suction, which causes the first damage. So, model analysis of buildings is required to get a more in-depth insight into the wind-structure phenomenon. At present, wind tunnel experiment and numerical simulation using computational fluid dynamics (CFD) are the available research tools to carry out model analysis of tall buildings.

Researchers in the area of wind engineering have carried out studies on wind characteristics on tall structures using both experimental and numerical methods over the years. Kareem [3] illustrated the facts of the interference and proximity effects on the dynamic response of prismatic bluff bodies. Liang et al. [4] suggested empirical formulae for different wind tempted dynamic torsional responses through an analytical model. Lin et al. [5] conferred the results of an extensive wind-tunnel study on local wind forces on isolated tall buildings based on the experimental outcome of nine square and rectangular models [1:500]. Gomes et al. [6] enumerated experimental outcomes of

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Renewable Solar Insolation as a Function of Distributed Energy Generation in Microgrids at Indian Sub-continent : An Economic Overview

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Abstract - *The goal of green engineering is to design products that will minimize pollution and improve the environment. Using solar energy is one way to provide clean energy using photovoltaic generators converting sunlight to electricity directly. However, the output of photovoltaic generators is variable and depends on the available solar insolation, temperature, attached loads, etc. In a microgrid with renewable energy sources, unit commitment is one of the challenging issues, due to the uncertainties in forecasting, the realization of renewable energy generation may significantly deviate from the forecasted value.*

For predictive generation planning and installation capacity of photovoltaic generators, a study based on its generation characteristic and trajectory, to determine the influence of the insolation parameters variation on the transient stability of the output of photovoltaic generators in distributed generation as a component of microgrid is indispensable. Computation and characteristics of the monthly variation of averaged solar insolation of India (20.5937° N, 78.9629° E) with respect to annual averaged insolation and Minimum and Maximum Difference from Monthly Averaged Insolation (%) incident on a horizontal surface (kWh/m²/day) is used to assess their impact on the energy demand factor of distributed energy resource, with its market economics.

Key Words: **Solar insolation, SPV energy generation, Transient stability, Indian Sub-continent, Demand Factor, Energy market.**

1. INTRODUCTION

Renewable energy technologies are having increasing presence in electric power systems around the world. According to the International Energy Agency forecast, electric power generation from renewable energy sources will nearly triple from 2010 to 2035, reaching 31% of the world's total power generation, with hydro, wind and solar renewable power providing 50%, 25% and 7.5%, respectively, of the total renewable energy generation by 2035. [1]

The impact of renewable energy generation sources planning is two-fold, as installed sources constraint and renewable energies nature. The intermittent nature of renewable energy generation can lead to insufficient generation and, hence, reliability issues, especially during the islanded operation.

Furthermore, microgrid planning is subject to other external uncertainties, such as long-term fluctuations in renewable energy reaching. The reduction in load predictability introduces higher uncertainties in the power generation scheduling. Similarly, the predictability of renewable energy sources is lower due to their smaller capacity in comparison with utility-scale of solar farms.

In this context, solar photovoltaic energy generation is experienced the fastest growing among all types of renewable technologies currently being investigated. Such that, the integration of large solar energy parks in power systems will affect considerably the dynamic behavior of the system, since solar photovoltaic energy based generation systems and conventional systems with synchronous generators present inherently different dynamic characteristics.

This is important to outline that in all these research works, the transient stability was assessed by observing the demand response to a contingency of the system, i.e., there was not used any advanced tool to obtain extra information beyond a visual observing criterion of the transient behaviour of the state variables. [2]

The study of transient stability in power systems is a significant part of assessing transmission system consistency. The traditional methodology to assess the transient stability of a system after the occurrence of a disturbance consists of simulating the nonlinear dynamic behavior and analyzing the transient behavior of the system state variables (angles and speed of generators, controllers, etc.). Thus, the transient stability analysis consists of observing if the state variables of the disturbed system will remain stable following a particular contingency [3]. Although this approach determines if the system is stable or not following a contingency, it does not have the capability of identifying or sensing the effect of the parameters into the transient stability of the system [4].

In order to get more information about the system and its transient behavior following a solar insolation variation, including how the system parameters influence in the solar

Analyzing Tagore's Emotion With the Passage of Time in Song-Offerings: A Philosophical Study Based on Computational Intelligence

Sirshendu Hore, Tanmay Bhattacharya

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Abstract

The emotions of humans can be observed through tears, smiles, etc. The emotion of poets is reflected through poetry/songs. The works of a poet give philosophical insights about the beauty and mystery of nature, socio-economic conditions of that era, besides his personal state of mind. In the proposed work 'Song- Offerings' A collection of poems and songs composed by Rabindranath Tagore, for which Tagore received the Nobel Prize for literature in 1913, has been analyzed. Earlier, most of the research work on Song-Offerings was based on Zipf's law or bibliometric laws. This article analyzes the changes in Tagore's emotion in Song-Offerings with the passage of time (1895-1912). Emotions are analyzed based on the Arousal-Valence Model. To analyze the arousal state, Plutchik's emotion model has been employed and to find the valence, a Fuzzy-based model has been engaged. The work reveals that the emotions of the poet gradually mellows with the passage of time barring some transitional time, nevertheless, poet submission towards almighty remains unchanged during this period.

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A comparative study on Cr(VI) removal by graphene oxide (GO) and functionalized reduced graphene oxide (fRGO)

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Effluent mainly from metal processing industry contains toxic hexavalent chromium is a major concern. In this study Cr^{6+} removal was done by graphene oxide (GO) and iron functionalized reduced graphene oxide (fRGO) and a comparative study was carried out. At equilibrium pH 2, fRGO gives more removal than GO. For both the materials, Langmuir adsorption isotherm fit better than Freundlich isotherm. The adsorption capacities of GO and fRGO are found to be (9.90 mg g^{-1}) and (17.54 mg g^{-1}) respectively. The Langmuir adsorption isotherm constants for GO and fRGO (K_L) are found to be (32.90) and (24.08) respectively. Both the materials follow pseudo-second order removal kinetics and fRGO (0.07 g mg^{-1} min^{-1}) shows faster removal rate than GO (0.03 g mg^{-1} min^{-1}). It was found that (fRGO) can remove 1.77 times more Cr^{6+} than graphene oxide (GO). The material can remove 97.22% Cr^{6+} at optimum pH of 2 and at fRGO dose of 100 mg/100 mL. The method can be used for treating acidic chrome bath effluent effectively.

Keywords: Chromium, comparative study, adsorption, GO, fRGO.

Introduction

Chromium occurs mostly in the form of trivalent chromium [Cr(III)] and hexavalent chromium [Cr^{6+}] in the aqueous medium. These two oxidation conditions of chromium have dissimilar biological, chemical and environmental properties[1]. Cr^{6+} is 500 times more noxious than Cr(III)[2]. Trivalent chromium [Cr^{3+}] is insoluble and this is also an essential micro nutrient[3], whereas hexavalent chromium is highly toxic and portable in the environment which act as mutagens, carcinogens, teratogens[4].

Chromium(III) is discharged mostly from industries such as leather tanning, lubricant, pesticides, textile dyeing, mining, and electroplating[5,6]. In third world countries the industrial discharges are directed towards different water bodies with different level of contamination. Mostly the discharge from tanning industries contained chromium enhanced tanning process for its processing speed, greater stability of resulting leather and low cost. In leather tanning process leather only takes up 60–80% of chromium and the rest is discharged into water which causes a serious environmental problem[7]. USEPA has recommended the value of chromium is 0.1 ppm in drinking water[8]. Permissible limit for Cr^{3+} and Cr^{6+} in wastewater are 5 mg L^{-1} and 0.5 mg L^{-1} respectively[6,9]. Several methods have been built up for the removal of Cr^{6+} such as electro-chemical precipitation[10], cyanide treatment[11], reverse osmosis[12], ion exchange[13,14], adsorption[15,16]. Among these methods, adsorption is mostly used because of its low cost due to regeneration of adsorbents which solves sludge disposal problems[17–20]. The lubricant manufacture industry produced highly hydrophobic solution of waste that reduced dissolve oxygen rapidly. Pesticide industry discharged recalcitrant outcome that is not biodegradable very easily. Textile and electroplating industry produced heavy metal contaminants those are mutate aqua life[6].

Since the innovation of buckyballs by curl korto and smalley, a rapidly increasing new field, nanotechnology, was developed[21]. Firstly, nanotechnology was used for medicine, electronics and biotechnology. But recently it is seen that it is also beneficial in the case of water treatment[22]. Nanoparticles can show an array of novel properties, because of its small size, which is responsible for development of new technology and improvement of existing one[23].

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Research article

Interlining Cr(VI) remediation mechanism by a novel bacterium *Pseudomonas brenneri* isolated from coalmine wastewater

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ABSTRACT

A bioremedial approach was investigated on the removal of Cr(VI) from aqueous solution using a novel chromium reducing bacteria isolated from coalmine wastewater. Cr(VI) removal efficacy of the bacterium was determined in a series of batch studies under the influence of various parameters viz., pH (1–7), temperature (20–40 °C), initial metal concentration (1–150 mg/L), agitation speed (80–150 rpm) and substrate concentration (1–5 mg/L). Oxygen involvement in the removal process was determined by different incubation conditions. Substrate consumption and its resultant biomass generation were considered for determining the viability of the microbe under varied metal concentration. The microbial isolate survived in Cr(VI) tainted solution with initial concentration of 1–140 mg/L, among which maximum remediation was found in 60 mg/L Cr(VI) loaded solution. The bacterial species also survived in other metal solution viz., Fe(II), As(V), Cu(II), Pb(II), Zn(II), Mg(II), Mn(II) apart from Cr(VI). Multiple approaches were tested to facilitate understanding of the bacterial Cr(VI) removal mechanism. The bacteria accumulated metal ions in the exponential growth phase both on and within the cell. Underlying latent factors which governed the bacterial growth and its removal activity was determined with the classical Monod equation. The isolated bacterium also survived in the bimetallic solutions with significant removal of Cr(VI). The microbial species isolated from mining area was identified as *Pseudomonas brenneri* by 16s rRNA molecular characterization. Hence, the isolated novel bacterium illustrated promising involvement towards bio-treatment of Cr(VI) laden wastewater.

1. Introduction

Mining activity is considered as one of the important source of mineral contamination in nature which is indirectly affecting the quality of life found in its vicinity. (Salem et al., 2000; Johnson and Hallberg, 2005). Among the mining industries, coal mining has been reported to cause comparatively severe after-effects due to its rich elemental effluents which upon discharged into the surrounding topography changes its natural mineralogy (Rudisa et al., 2011; Singh, 1987). These effluents are in general acidic in nature commonly termed as acid mine drainage or AMD. Heavy metals like cadmium (Cd), zinc (Zn), copper (Cu), nickel (Ni), lead (Pb), mercury (Hg), chromium (Cr) are mostly present in the effluent (Pu and Qi, 2011). These are non-biodegradable in nature and tend to circulate within the food chain due to their bio-accumulation in living cells (Bansal, 2011). Therefore, removal of heavy metal ions from mining effluents has received a lot of attention and accordingly, the regulations for environmental protection have become firmer.

Among these metal ions, chromium is frequently found in coalmine waste water and it has been enlisted as one of the toxic metal ions for the past couple of decades. Chromium has been reported to be present in some 10s–100s mg/L in industrial waste water which exists in several forms viz., Cr(0) to Cr(VI). Among these Cr(III) and Cr(VI) are more persistent in nature but their chemical properties contradict, thus imparts different impact on living cells. Among these, Cr(III) which is needed in trace amount for fat and carbohydrate metabolism, is less soluble in nature (Focardi et al., 2012). Cr(VI) on the other hand, is highly soluble and detrimental in nature and its adversity in living body and its permissible limits made by various agencies has been summarized in Table 1 (Abbreviations, 2011; Cervantes et al., 2001).

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ORIGINAL ARTICLE

Elucidation of preferential elimination of Cr(VI) via bioinspired adsorbents: a comparative assessment

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Abstract
The present study investigates uptake of Cr(VI) from synthetic metal solution by superheated steam-activated biochar (SABC) made from roots of *Colocasia esculenta* and synthetic zeolite (ZRHA) prepared from rice husk ash under the influence of pH (1–7), adsorbent dose (1–100 mg/L), initial Cr(VI) concentration (5–190 mg/L), temperature (15–55 °C), agitation speed (100–170 rpm) for a contact time of 30–1440 min. ZRHA and SABC were able to remove metal ions from a stock solution of 90 and 110 mg/L of Cr(VI) with a removal of 85.89% and 94.8%, respectively. Metal ion adsorption onto zeolite ZRHA followed monolayer adsorption, whereas biochar SABC employed multilayer adsorption. Kinetic studies suggested that adsorption of Cr(VI) ions could follow both physisorption and chemisorption depending on the adsorbent used. The two-compartment dynamic model study revealed Cr(VI) adhesion followed a slow phase of adsorption which suggested intraparticle diffusion to be a prominent rate-limiting factor for both cases. The thermodynamic study claimed that Cr(VI) adsorption was a temperature dependent phenomenon. Instrumental studies by TEM, SEM, EDX and FT-IR also advocated their part on Cr(VI) removal. Also, crystallinity of both the adsorbents was determined from their XRD analysis. Thus, the current study promotes both ZRHA and SABC to be a promising adsorbent for Cr(VI) removal from contaminated aqueous solution.

Keywords Cr(VI) contamination · Adsorption · Zeolite · Activated biochar · Intraparticle diffusion · Cost estimation

Introduction

To cope up with the changing economy, there has always been a constant demand for minerals and an urge of continuous supply of raw materials in the international market (Nicolas et al. 2014). This scenario thus has led to exhaustive mining worldwide (Celik and Demirbas 2005). Among various mining industries, coalmines are considered to be a fatal source of contaminants, since the effluents are not only enriched with suspended particles and a higher level of organic carbon, etc., it is also augmented with various heavy metals. Hence, accumulation of heavy metals is a mounting environmental crisis due to the difficulties which encompasses in deionising it from coalmine effluent mixed water bodies (Liang-qi et al. 2010). These are considered to be invincible inhibitors in natural biodegradation processes, since it interferes in the flow of aquatic ecosystems (Ren et al. 2009). Lead, zinc, copper, mercury, chromium etc, are some of the concerning metal ions, whose ionic concentration is gradually concentrating in different spheres of the environment and concurrently imparting detrimental effects on living bodies (Ferdouse et al. 2016). Among these metal ions, chromium is frequently found in effluents discharged from the tannery, wood polishing, metallurgy, mining, textile industries, etc.

In nature, chromium exists mainly as trivalent Cr(III) and hexavalent Cr(VI) forms which possess chemically, biologically and environmentally different characteristics (Sivakumar 2016). Cr(III) is an insoluble and lesser toxic form of chromium which has been reported to be used up by various microorganisms as trace element (Owlad et al. 2009; Barnowski et al. 1997). On the other hand, Cr(VI) is a soluble and lethal form of chromium which can easily penetrate the cell membrane and results in detrimental symptoms within the host. Toxic effects of Cr(VI) have been found in animals,

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Thermo-mechanical Analysis of a Crack in an Infinite Functionally Graded Elastic Layer

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Abstract: This paper aims to develop a steady state thermoelastic solution for an infinite functionally graded layer of finite thickness with a crack in it lying in the middle of the layer and parallel to the faces of the layer. The faces of the layer are maintained at constant temperature of different magnitude. The layer surfaces are supposed to be acted on by symmetrically applied concentrated forces of magnitude $\frac{P}{2}$ with respect to the centre of the crack. The applied concentrated force may be compressive or tensile in nature. The problem is solved by using integral transform technique. The solution of the problem has been reduced to the solution of a Cauchy type singular integral equation, which requires numerical treatment. Both normalized thermo-mechanical stress intensity factor (**TMSIF**), thermal stress intensity factor (**TSIF**) and the normalized crack opening displacement are determined. Thermal effect and the effects of non-homogeneity parameters of the graded material on various subjects of physical interest are shown graphically.

Key words and phrases: Fourier integral transform, Singular integral equation, Stress-intensity factor.

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I. INTRODUCTION

Every solid material has its own characteristics in respect of its elastic behavior, density, porosity, thermal and electrical conductivity, magnetic permeability, and so on. In numerous situations, a particular solid does not necessarily fulfill all the criteria for a particular purpose. For example, aerospace industry requires light materials with high strength; the outer part of a space craft body should be a non-conductor of heat such that the heat generated due to friction does not disturb the interior part made of high strength metal. It is difficult to find materials with light weight but high strength or high strength metal with zero heat conductivity. These difficulties are overcome at present using two or more solids at a time to generate a new solid which will fulfill most of our requirements. Composite materials, fibre-reinforced materials and functionally graded materials (FGM) are some of newly manufactured materials which are used at present in various areas of applications. Two solids say A and B with specific properties are used to form a FGM in such a way that the composition gradually vary in space following a definite designed rule. This means that at a particular point in the medium the FGM shows (100 - x) % of A's property and x% of B's property, ($0 \leq x \leq 100$). The idea was originated in Japan in early part of the eighties in the last century and has been found to be very useful in respect of applications in various areas like resisting corrosiveness, controlling thermal activity, increasing strength and toughness in materials etc. FGMs have also several biomedical applications.

Thermal loading on solids has significant effects in their after load behavior and so should be dealt with utmost care. As such, the study of thermoelastic problems has always been an important branch in solid mechanics[1,2]. In the design of a structure in engineering field , considerable attention on thermal stress is a natural task, because many structural components are subjected to severe thermal loading which might cause significant thermal stresses in the components, especially around any defect present in the solid. Thermal stresses along with the stresses due to mechanical loadings can give rise to stress concentration in an around the defects and can lead to considerable damage in the structure.

In literature, problems related to defects such as cracks in solids have been studied in detail for various kinds of solid medium. Cracks in a solid may be generated due to several reasons such as uncertainties in the loading process, compositional defects in materials, inadequacies in the design, deficiencies in construction or maintenance of environmental conditions, and several others. Consequently, almost all structures contain cracks, either due to manufacturing defects or due to inappropriate thermal or mechanical loading. If proper attention to

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Carbinol mediated clusterization of Nickel(II) ions in a Schiff base backbone: Structural & solution properties, phosphoester cleavage activity including theoretical support

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ABSTRACT

In this study, the significant role of carbinol in the construction of a tetranickel(II) cluster, $[Ni^{II}_4(\mu\text{-}OH)(CH_3)_2(L)_2(CH_3OH)_2(2CH_3OH$ (1) with a compartmental Schiff base, [H$_4$L = *N,N'*-bis(3-methoxysalicylidene)-1,3-diamino-2-propanol] is reported and emphasized. The tetranickel cluster crystallizes in a monoclinic system with $P2_1/n$ space group. The tetranickel(II) core exists in a dicubane structure adopting octahedral geometry for each nickel(II) centres. In forming tetrametallic core, carbinol as solvent molecules exhibit its uniqueness through versatile coordination motifs (bridging-, terminal- and solvent of crystallization) in assembling four nickel(II) ion with two Schiff base units. Hirshfeld analysis for 1 defines pivotal role of MeOH in construction of long range crystalline architecture. Examination of its ability towards cleavage of phosphoesterase bonds using 4-nitrophenylphosphate (PNPP) in carbinol authenticates its excellent cleavage efficiency with rate constant 1.61×10^{-4} min^{-1}. Presence of coordinated methanol molecules at Ni(II) centre as well as multiple reaction centres in tetranickel(II) core remain the driving force for the phosphatase activity. Outcomes from extensive density functional theory (DFT) justify well the experimental observations.

1. Introduction

Polymetallic cores containing atomic and/or molecular bridges based on first row transition metal ions (3d ions) with organic backbone have drawn significant interest for their diverse applicability in modern science [1–3]. The investigation to design and construction of metallic clusters are growing on. This is not only for their stimulating structural aspects but for the utility in the advancement of molecular properties for electronic, optical, magnetic and catalytic materials [4–6]. The formation of coordination aggregate is purely a spontaneous self-assembly favoured by thermodynamics in which components of reactions are mixed in solution using simple equipments at room temperature. Large number of self-aggregates based on nickel(II) ion represent as single-molecule magnets (SMMs) for having high ground-state spin (S) in combination with large magnetic anisotropy. Thus, high demand of newly designed synthetic approaches for the production of high-spin polymetallic coordination cluster with promising magnetic properties creates huge appeal to coordination chemists [6,7]. Among transition metal ions, nickel, a bio-essential metal, is conscientious for having its widespread industrial applications in electroplating, Ni-Cd batteries, rods used in arc welding, pigments employed in paints, ceramic materials, surgical products and dental prostheses, magnetic tapes of computers etc. [7–9]. Although this metal has huge application in modern uses but it has also a little negative impact on environment. Further, nickel plays momentous role as an active site in functioning various enzymatic activities such as hydrogenase, superoxide dismutase, carbon monoxide dehydrogenase and other catalytic courses [10–12].

On the other hand, Schiff base (SB), a special class of recognizer,

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Performance and Exhaust Emission Analysis of a Diesel Engine using Neat Diesel Oil and Blends of Pongamia Pinata Methyl Ester (PPME) with Neat Diesel Oil

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ABSTRACT: Compliance with the limited oil reserves on the earth and governmental regulations about the environment to meet emission standards leads to the quest for fuels which are eco-friendly and safe for the human beings. It is now well established that lower blends of biodiesel and diesel works well in the existing engines without any modifications due to the similarity of the bio fuels to the diesel fuel. Experimental investigation was carried out in a single cylinder direct injection diesel engine fuelled with diesel and blends produced with diesel fuel and Pongamia Pinata methyl ester (PPME) in different proportions such as 0, 10, 20, 30, 40% and 100% (B0, B10, B20, B30, B40 and B100). The performance was evaluated in terms of fuel consumption, brake specific fuel consumption, brake thermal efficiency and exhaust gas temperature (EGT) at different load and exhaust emission characteristics were evaluated in terms of hydrocarbon (HC), Carbon monoxide (CO), and oxides of Nitrogen (NOx), at different load and compared with diesel fuel. The investigation revealed that all the properties of PPME blends are higher (except calorific value) than neat diesel. Lower caloric value of PPME blends is responsible for higher fuel consumption leading to reduction of brake thermal and indicated thermal efficiency. Presence of higher cetane number PPME blends shows better combustion than neat diesel. Hence emission of PPME blends shows lower pollutants except NOx emission than neat diesel.

KEYWORDS: Biodiesel, Pongamia pinata methyl ester, Performance, Emissions, Combustion, Blends, cetane number.

I. INTRODUCTION

The most fundamental requirement for human existence into the earth is the energy. The world energy demand has highly increased in few decades and the use of these energy resources has increased major environmental impact. Conventional energy sources, such as coal, oil and natural gas, etc have limited reserves that are expected not to last for long period. Due to limited resources of fossil fuels, rising crude oil prices and the increasing concerns for environment, there has been renewed focus on vegetable oils and animal fats as an alternative to petroleum fuels. The search for alternative fuels which are eco-friendly and can be used as a substitute to conventional hydrocarbon based fuels is in demand due to concerns about depletion of fossil fuel reserves and also growing awareness against global warming [1]. One of the major alternative fuels which have been found to be eco-friendly is biodiesel. Bio-diesel is one

Short Time Modified Hilbert Transform-Aided Sparse Representation for Sensing of Overhead Line Insulator Contamination

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***Abstract*—The service condition of the overhead line insulators is significantly affected by the contamination deposited on the insulator surfaces. The reliability of transmission lines is therefore affected in the case of insulator failures. Leakage current signature has widely been reported to be a good indicator of the contamination level on the insulators. Different characteristics extracted from leakage current can be used to sense and classify insulators based on their contamination levels. In this paper, a method based on short time modified Hilbert transform (STMHT) and sparse representation-based contamination level sensing of overhead line insulator has been proposed. STMHT is capable of enhancing the local characteristic of the leakage current waveform and provides a good technique for differentiating between similar kinds of data. Sparse representation-based classification is used for classification of the extracted features. Results show that the performance is comparable or even better with respect to the results reported in the literature. The present method is generic in nature and can be implemented for any other applications addressing topologically similar problems. All necessary experiments are conducted based on IEC 60507 standard.**

***Index Terms*—Short time modified Hilbert transform (STMHT), sparse representation based classification (SRC), insulator contamination, leakage currents.**

I. Introduction

FOR reliable and uninterrupted power transmission outdoor insulators play a very important role. Insulators give mechanical support to overhead conductors as well as electrical insulation between high voltage conductors and ground. Various studies have revealed that about 70% of line outages occur due to failure of insulator and the cause of such failures are mainly due to contamination flashover or ageing of insulator [1]. Most of the insulators are meant for outdoor type use. Outdoor insulators remain exposed to various kinds of environmental conditions. So, it gets contaminated easily by salt, dust, chemicals, sand, agricultural pollutants etc. As a result leakage current flows over the surface of insulator in presence of moisture. Leakage current increases when level of contamination increases as a result flashover voltage of a particular insulator decreases. Flashover leads to line outages in both transmission and distribution system of a power system network. Therefore, a method should be developed that will be able to predict the level of contamination of insulator properly for averting flashover as far as possible.

Effect of different contaminants on outdoor insulators is investigated by many researchers [2]–[13]. For condition monitoring of insulator equivalent salt deposit density (ESDD), non-soluble salt deposit density (NSDD), leakage current monitoring, surface resistivity are the prime techniques used by many researchers [3], [5], [7], [8]. For condition monitoring of insulator, leakage current is most widely studied parameter [5], [8], and [12]. Leakage current is very much able to provide exact information about the surface condition of a polluted insulator in a much comprehensive way than other methods and in this regard leakage current is mentioned as one of the most dynamic parameters [12]. To find the inherent characteristic of leakage current wavelet transform [7], spectral analysis [10], Fourier transform [8], Artificial Neural Network [8], [9], phase angle approach [7] are being used in recent past. While for prediction of flashover voltages and analysis of other associated characteristics, odd harmonic components (3^{rd}, 5^{th}, 7^{th} etc) of leakage current provides better information than peak value of leakage current [4], [6]. Many researchers have conducted artificial pollution test of insulators at controlled environmental condition where humidity and temperature are adjustable [3], [10], and [12]. According to many researchers change of humidity levels affects the leakage current odd harmonic components [3], [9]. Humidity correction factor is useful solution for flashover voltage calculation or flashover voltage prediction but it is not applicable for calculation of odd harmonics [3], [5], [11], [12], therefore, to determine the surface pollution level of insulator through leakage current method consequenceof humidity is very essential [3]. But different countries have different environmental conditions with variable humidity and temperature. Even in a country or in a particular region environmental condition is not constant. So, leakage current analysis for a same contaminated insulator may vary from country to country owing to

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Removal of turbidity and *E. coli* from surface water by electrocoagulation and study of its economic feasibility

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Abstract : Maximum turbidity removal of 98% is obtained in treatment of raw surface water by electrocoagulation (EC) system. As per World Health Organization (WHO) the permissible limit of turbidity of below 5 NTU can be achieved at a charge loading (CL) of 18 Coulomb/L at a pH value of 7.25. EC followed by plain sedimentation and filtration can remove of 19% of *E. coli* from raw water. Disinfection of filtered water is done by sodium hypochlorite solution (4% available chlorine). The complete (100%) removal of *E. coli* is achieved at a chlorine dose of 2.8 mg/L within 30 min of contact time. The treatment cost per liter of water estimated to be Rs. 0.072 per liter.

Keywords : Turbidity, electrocoagulation, *E. coli*, chlorination, disinfection.

I. Introduction

The scarcity of potable water is one of the major issues of the world. Low cost and efficient water treatment technology is inevitable for water industries, specially producing potable water. This technology should be sustainable. A sustainable system is socially acceptable, techonologically feaseable and economically viable. Any water treatment technology involves removal of turbidity, color, odor, heavy metals or metaloids nutrients, pesticides, pathogens etc. Suspended solids and colloids are mainly responsible for turbidity in surface water[1]. Coagulation, flocculation, sedimentation and filtration are the basic common unit operations used to remove colliods effectively. The charge charecteristics of colloid may differ depending on hydrophobic (clay) or hydrophilic colloids (proteins)[2]. Low cost water treatment technology with small footprint has been reported efficient removal of turbidity, oraganic and pathogens[3,4]. High quality water is the essential part of modern life and this resource is becoming scare very fast. fact, the demand for water is still on the rise due to growing population. The centralised water treatment system demand huge funding with requirment of land, power, chemicals and maintainance staffs. Thus drinking water is becoming a costly commodity rapidly[5].

Metal salts (alum, ferric salts etc.) are added as coagulant to netrilize surface charges which subsequently destabilized colloidial particles[6–8]. The process of coagulation is basically combined into surface charge neutralization of particles and floc formation defined as bridging the particles is called as flocculation[9]. Primary floc are formed by charge neutralization of unstabilized particles are also called coagulation floc and floc enlarged by bridging are sometimes termed as secondary flocs[6]. The coagulating agent, the pH of solution, the coagulant dosage, ionic strength, the concentration of solution and the nature of the organic compounds influenced the

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Original Article

Parametric optimization of delignification of rice straw through central composite design approach towards application in grafting

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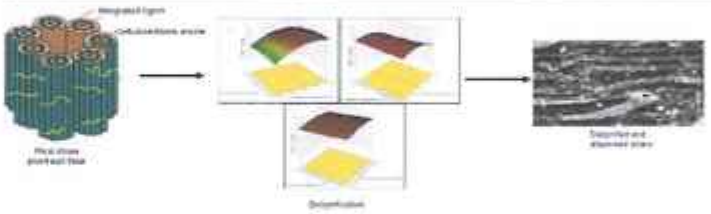
HIGHLIGHTS

- Rice straw was delignified for use in free-radical grafting as a roofing material.
- NaOH concentration, reaction time and temperature on delignification were studied.
- Delignification of rice straw was optimized by central composite design approach.
- Alkali concn.7.59%, time 75.11 min and temperature 40 °C were best optimized conditions.
- Lignin extraction concentration was found to be 70.3 mg/g.

GRAPHICAL ABSTRACT



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ABSTRACT

The present investigation deals with process optimisation of delignification of rice straw towards its micro-porous structural enhancement for its utilization in polymer grafting. The individual effect of influential parameters viz. sodium hydroxide concentration (1–12%, w/v), reaction time (30–126 min), and temperature (20–150 °C) on delignification were studied in a single mode batch process. The process parameters were further optimized with Central composite design (CCD) approach of response surface methodology in Design expert software. Delignification of rice straws was observed to follow quadratic equation. Analysis of variance (ANOVA) study suggested the equation to be significant for the process with major impact of sodium hydroxide concentration on the delignification process than reaction time and temperature. The optimized parametric conditions of delignification are: alkali concentration 7.59%, reaction time 75.11 min, and reaction temperature 40 °C. The software predicted lignin extraction concentration to be 72.4 mg/g, which upon experimentation was found to be 70.03 mg/g. Instrumental analysis of the delignified rice straw demonstrated porous structure and change in surface chemistry due to lignin removal. Therefore, the delignified rice straw obtained under optimized conditions were found to be appropriate for grafting of polymers which improved its resilience for variable usages.

Introduction

In tropical countries, rice straw is a commonly found agricultural by-product which is produced annually in large quantities remains vastly under-utilized [1]. In India and in other countries, rice straws are alternatively used as precursor in paper and pulp industries. Although, rice straws are alternatively used as animal

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RESEARCH ARTICLE

Acid and Heavy Metal Tolerant *Bacillus* sp. from Rat-Hole Coal Mines of Meghalaya, India

Augustine Lamin Ka-ot[1] · Soumya Banerjee[2] · Gopinath Haldar[2] · Santa Ram Joshi[1]

Received: 20 May 2016 / Revised: 12 January 2017 / Accepted: 8 March 2017

Abstract Coal is a major natural resource of Northeast India and the indigenous process of coal mining known as rat-hole mining results in the pumped mine water being released to the nearby land and water bodies contaminating the area and destroying life forms due to acid mine drainage. The present study aimed at isolating acid and metal resistant bacteria from the rat-hole coal mines to assess their acid and metal tolerance isolated two *Bacillus* sp. with good tolerance to iron, cadmium and chromium which grew well at pH 5 and could remain viable up to pH 2 without any apparent growth. Growth experiments at pH 2–4 indicated the failure of the isolates to grow and produce colony though they survived metabolically viable. However the inoculum obtained from broth culture incubated for 72 h at pH 2–4 produced distinct colonies when plated in medium at pH 5. *Bacillus subtilis* subsp. *inaquosorum* SK22 showed comparatively higher maximum tolerable concentration (MTC) for iron in comparison to *Bacillus cereus* SK44. Both had the same MTC for both cadmium and chromium. The minimum inhibitory concentration (MIC) and maximum bactericidal concentration (MBC) was similar for cadmium and chromium for both the *Bacillus* sp. MIC and MBC for iron was higher in case of *Bacillus subtilis* subsp. *inaquosorum* SK22 than that of *Bacillus cereus* SK44. This higher resistance to acidic pH and high metal concentration indicated their potential to be good candidates for bioremediation of contaminated soil and water bodies affected by rat-hole mining and acid mine drainage.

Keywords Rat-hole mining · Acid mine drainage · *Bacillus* sp. · Tolerance

Introduction

The Jaintia hills districts of Meghalaya is one of the major coal producing district of the state with an estimated coal reserves of 40 million tonnes. The mode of mining in the area is unscientific rat-hole mining. It is practiced by the local populations who own the plots of land containing coal. Although coal mining has brought livelihood to people of the region, the activities however, has its disadvantages in the form of extensive environmental degradation and ecological disturbance in the area [1]. Deforestation, soil erosion, surface runoff, caving in the underground and pollution of land, air and water are some of the prominent environmental problems associated with rat-hole coal mining [2]. Since the area receives rainfall throughout the year, the water bodies are badly affected by contamination from acid mine drainage (AMD) originating from the mines and spoils, leading to leaching of heavy metals, organic enrichment and silting by coal and sand particles. Deterioration of water quality is observable in color of the water (brownish to reddish orange), low pH (between 2 and 4), high conductivity, high concentration of sulphate, high content of iron and toxic heavy metals, low dissolved oxygen and high BOD and acidic sulfur-rich wastewaters. Due to heavy metal leaching at low pH, these waters usually pose an additional risk as they contain higher concentrations of metals

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Elucidation of ibuprofen uptake capability of raw and steam activated biochar of *Aegle marmelos* shell: Isotherm, kinetics, thermodynamics and cost estimation

Prasenjit Chakraborty, Soumya Banerjee, Sumit Kumar, Sutanu Sadhukhan, Gopinath Halder

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Abstract

The present study investigates the sorption capabilities of raw and steam activated biochar derived from *Aegle marmelos* (wood apple) shell in the removal of ibuprofen (IBP) from aqueous solution. The influence of various parameters viz. initial ibuprofen concentration (1–45 mg L^{-1}), contact time (0.5–24 h), temperature (15–45 °C), adsorbent dosage (0.033–3.33 g L^{-1}), pH (2–6) and agitation speed (100–180 rpm) were considered for ibuprofen sorption by wood apple biochar (WAB) and wood apple steam activated biochar (WASAB). WAB and WASAB achieved maximum removal of 90% and 95% respectively from aqueous solution

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ORIGINAL ARTICLE

Elucidation of preferential elimination of Cr(VI) via bioinspired adsorbents: a comparative assessment

Soumya Banerjee[1] · Sanghamitra Barman[2] · Gopinath Halder[1]

Received: 9 September 2017 / Accepted: 30 January 2019

Abstract

The present study investigates uptake of Cr(VI) from synthetic metal solution by superheated steam-activated biochar (SABC) made from roots of *Colocasia esculenta* and synthetic zeolite (ZRHA) prepared from rice husk ash under the influence of pH (1–7), adsorbent dose (1–100 mg/L), initial Cr(VI) concentration (5–190 mg/L), temperature (15–55 °C), agitation speed (100–170 rpm) for a contact time of 30–1440 min. ZRHA and SABC were able to remove metal ions from a stock solution of 90 and 110 mg/L of Cr(VI) with a removal of 85.89% and 94.8%, respectively. Metal ion adsorption onto zeolite ZRHA followed monolayer adsorption, whereas biochar SABC employed multilayer adsorption. Kinetic studies suggested that adsorption of Cr(VI) ions could follow both physisorption and chemisorption depending on the adsorbent used. The two-compartment dynamic model study revealed Cr(VI) adhesion followed a slow phase of adsorption which suggested intraparticle diffusion to be a prominent rate-limiting factor for both cases. The thermodynamic study claimed that Cr(VI) adsorption was a temperature dependent phenomenon. Instrumental studies by TEM, SEM, EDX and FT-IR also advocated their part on Cr(VI) removal. Also, crystallinity of both the adsorbents was determined from their XRD analysis. Thus, the current study promotes both ZRHA and SABC to be a promising adsorbent for Cr(VI) removal from contaminated aqueous solution.

Keywords Cr(VI) contamination · Adsorption · Zeolite · Activated biochar · Intraparticle diffusion · Cost estimation

Introduction

To cope up with the changing economy, there has always been a constant demand for minerals and an urge of continuous supply of raw materials in the international market (Nicolas et al. 2014). This scenario thus has led to exhaustive mining worldwide (Celik and Demirbas 2005). Among various mining industries, coalmines are considered to be a fatal source of contaminants, since the effluents are not only enriched with suspended particles and a higher level of organic carbon, etc., it is also augmented with various heavy metals. Hence, accumulation of heavy metals is a mounting environmental crisis due to the difficulties which encompasses in dejonising it from coalmine effluent mixed water bodies (Liang-qi et al. 2010). These are considered to be invincible inhibitors in natural biodegradation processes, since it interferes in the flow of aquatic ecosystems (Ren et al. 2009). Lead, zinc, copper, mercury, chromium etc, are some of the concerning metal ions, whose ionic concentration is gradually concentrating in different spheres of the environment and concurrently imparting detrimental effects on living bodies (Ferdouse et al. 2016). Among these metal ions, chromium is frequently found in effluents discharged from the tannery, wood polishing, metallurgy, mining, textile industries, etc.

In nature, chromium exists mainly as trivalent Cr(III) and hexavalent Cr(VI) forms which possess chemically, biologically and environmentally different characteristics (Sivakumar 2016). Cr(III) is an insoluble and lesser toxic form of chromium which has been reported to be used up by various microorganisms as trace element (Owlad et al. 2009; Barnowski et al. 1997). On the other hand, Cr(VI) is a soluble and lethal form of chromium which can easily penetrate the cell membrane and results in detrimental symptoms within the host. Toxic effects of Cr(VI) have been found in animals,

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Mechanistic insight into sorptive elimination of ibuprofen employing bi-directional activated biochar from sugarcane bagasse: Performance evaluation and cost estimation

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Reusability

ABSTRACT

The present investigation attempts in separating Ibuprofen (IBP) a pharmaceutical compound from aqueous solution tooled with two different activated form of sugarcane biochar as adsorbent. Differences in adsorption capability of the sugarcane biochar were derived after activating its surface both physically and chemically. Operational conditions viz., initial ibuprofen concentration (1–50 mg/L), contact time (0.5–24 h), temperature (15–40 °C), adsorbent dose (0.033–5 g/L), pH (1–7) and agitation speed (100–200 rpm) were considered for both steam activated biochar (SPAB) and chemically activated biochar (SCAB) for sorptive elimination of IBP. Characterisation of the adsorbents were carried out by scanning electron microscopy (SEM), Energy dispersive X-ray spectroscopy (EDX), FT-IR spectroscopy and determination of zero point charge (pH_{PZC}). IBP adsorption isotherm study was found to follow both Langmuir and Freundlich isotherm. Uptake capacity of SCAB and SPAB were 13.51 mg/g and 11.90 mg/g respectively. The sorption process obeyed pseudo second order kinetic model in both the cases. Exothermic, spontaneous and feasible nature of IBP adhesion on to SCAB and SPAB were confirmed from thermodynamic analysis. Estimated costs incurred in production of the adsorbents were found to be cheaper and reusability study was also validated for their usage of multiple cycles. SPAB and SCAB were able to remove 82% and 91% of ibuprofen from aqueous solution for a contact time of 18 and 12 hs respectively. Therefore, *sugarcane* bagasse derived biochar exhibited potential role towards adsorptive removal of ibuprofen from aqueous solution.

1. Introduction

The gloomy impacts of pharmaceutical active compounds (PAC) on to the environment and on human health have subjected to apprehension for the researcher [1,2]. Non-steroidal anti-inflammatory drugs (NSAID) are most commonly used treatment for various diseases occurring in both human and animal [3]. Ibuprofen is one of the most decisive and consumed NSAID drug worldwide which is identified in reasonable amount as effluent in several wastewater treatment plant [4]. Existence of elevated IBP concentrations have been found to be around 0.050–100 μg/Lin accordance to the investigation as reported earlier [5,6]. Carboxy and hydroxyl ibuprofen are metabolites product of IBP degradation in aqueous solutions regarded as contaminated by-products which has an undesirable effect on human central nervous system and also has a cumulative effect to changes of aquatic ecosystem [7–9]. Hence, elimination of such pharmaceutical surplus from natural water reservoir is important in order to minimize its counter-impact on animal health.

Several conventional method like sedimentation, flocculation, coagulation are not established as convenient and effective technology to eliminate IBP due to its reasonable water solubility (21 mg/L) and high mobility [10]. Accordingly, abolition of such pharmaceutical compound from waste water have compelled for innovation in remedial technologies. Upgraded techniques like electrochemical degradation [11], ultrasonicirradiation [12], combined advanced oxidation processes [13], photodegradation [14,15], ultrafiltration membrane [60], ozonation [61], microcosm constructed wetlands [62], nanofiltration [16], photo fenton [64] and adsorption process has been explored for removal of IBP. Some degradation studies of IBP have also recognized as treatment methodology to eliminate pharmaceuticals from water bodies [17,18]. Although, the aforementioned techniques have been established to be efficient but process characteristics like simplicity, inexpensive, lower selectivity and consistency have enlisted adsorption to be more acceptable than other sophisticated technologies [19–22].

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Title: Application of zirconium caged activated biochar alginate beads towards deionization of Cr(VI) laden water in a fixed bed column reactor

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FRICTIONLESS CONTACT BETWEEN A RIGID INDENTOR AND A TRANSVERSELY ISOTROPIC FUNCTIONALLY GRADED LAYER

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This article is concerned with the study of frictionless contact between a rigid punch and a transversely isotropic functionally graded layer. The rigid punch is assumed to be axially symmetric and is supposed to be pressing the layer by an applied concentrated load. The layer is resting on a rigid base and is assumed to be sufficiently thick in comparison with the amount of indentation by the rigid punch. The graded layer is modeled as a non-homogeneous medium. The relationship between the applied load P and the contact area is obtained by solving the mathematically formulated problem through using the Hankel transform of different order. Numerical results have been presented to assess the effects of functional grading of the medium and the applied load on the stress distribution in the layer as well as on the relationship between the applied load and the area of contact.

Key words: functionally graded material, transversely isotropic medium, Hankel transform, contact problem, Fredholm integral equation.

1. Introduction

When a deformable solid is pressed onto another solid, then depending upon the nature and shapes of the solids as well as on the intensity of the applied load, the area of contact between the solids changes and there occurs a significantly different distribution of stress within and outside of the contact area. The determination of the stresses within and outside of the contact area as well as the relationship between the applied load and contact area dimension has been the subject of study in solid mechanics for a long time which started through the initial investigation of Hertz [1] in 1882. A change in the area of contact due to compressive loading on two bodies in contact depends largely on the shapes of the bodies. Contact areas may increase, decrease and sometimes may even remain stationary. Accordingly, contact problems have been classified as advancing (increase of contact area), receding (decrease of contact area) and stationary (contact area remaining the same). A second kind of classification of contact problems, namely, frictional or frictionless contact problems, may also be made based on the consideration of frictional force at the contact

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REGULAR ARTICLE

Gentisate-1,2-dioxygenase activity by an iron(II)-phenanthroline complex

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Abstract. In this work, we have synthesised and crystallographically characterized a mononuclear iron(II) complex, $[Fe(phen)_3](NO_3)_2 \cdot 2H_2O$ (**1**) (phen = 1,10-phenanthroline). Single crystal X-ray diffraction (SXRD) analysis revealed that **1** crystallizes in monoclinic system with $P\,1^-$ space group. The lattice water molecules in **1** form a water-nitrate cluster, $(H_2O)_2(NO_3)_2$ through strong H-bonding interaction mediated *via* iron(II) complex in a unique binding motif and provide additional stability to the compound in the solid state. This iron(II) complex is able to catalyze the cleavage of aromatic C-C linkage of 2,5-dihydroxybenzoic acid (Gentisic acid, GA) in oxygen environment. The iron(II) complex in the presence of two equivalent of triethylamine (Et_3N) binds with GA stoichiometrically in acetonitrile medium at 25 °C. Observation of GA-to-iron LMCT optical bands at 521 and 609 nm supports *in situ* generated iron-GA adduct in solution. This *in situ* generated iron-GA adduct reacts with molecular oxygen at the rate, $k_{obs} = 6.58 \times 10^{-3}$ min^{-1} in acetonitrile and affords exclusively 2-oxo-4-hydroxy-hepta-3,5-dienedioic acid. The incorporation of both the oxygen atoms of molecular oxygen in the bio-mimicking activity of gentisate-1,2-dioxygenase by this iron(II)-phenanthroline complex remain a rare example in scientific literature.

Keywords. Iron(II); phenanthroline; X-ray structure; gentisate-1,2-dioxygenase activity; bio-mimicking chemistry.

1. Introduction

Iron(II) complexes containing N-donor ligands not only help to enrich molecular library but also bring a new source of light to unveil different mechanistic fate related to organic transformations in chemical and biological sciences.[1–3] Investigation of physicochemical properties of these iron(II) complexes leads to important information to develop the science of living world. Among the different organic transformations in chemical and biological sciences, aerobic degradation of aromatic compounds by iron complexes remains a very difficult challenge to the chemists.[4–6] Especially, iron-based bio-models relevant to important microorganisms in biochemistry provide significant insights towards aromatic ring-fission of substrates like catechol, protocatechuate, homoprotocatechuate, hydroquinone, gentisate or homogentisate (or their substituted derivatives).[7–9] 2,5-dihydroxybenzoic acid, which is commonly known as Gentisic acid is a key intermediate in aerobic bacterial pathways for the metabolism of a large number of aromatic compounds, including anthranilate, β-naphthol, 4-hydroxy benzoates, flavonones, salicylate, *etc.*[10] Among these aromatic ring cleavage enzymes, gentisate 1,2-dioxygenase from *Pseudaminobacter salicylatoxidans BN12* (*P. salicylatoxidans*) appears to be most versatile since it is able to convert a wide range of substituted salicylates with the highest order of enzymatic activities.[11,12] The cell using gentisate derives carbon and energy from direct or indirect conversion of maleylpyruvate to metabolites.[13] During the investigation of oxygen activation

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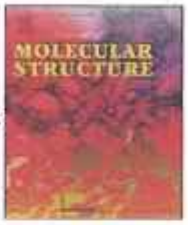

Structural and luminescent properties of a new 1D Cadmium(II) coordination polymer: A combined effort with experiment & theory

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Almost pseudo product structure

P. Debnath

Abstract. The main objective of the paper is to study a new type of structure named as almost pseudo product structure in an n-dimensional Riemannian manifold. Some results involving this structure have been established. The existence of this type of structure is shown with examples. It has also been shown that, every Einstein manifold is an almost product manifold and if the sum of the associated scalars of a quasi Einstein manifold is zero, the manifold is an almost paracontact manifold.

M.S.C. 2010: 53C25.

Key words: Einstein manifold; quasi Einstein manifold; almost product structure; almost paracontact structure.

1 Introduction

Almost product structure on a differentiable manifold were investigated by A.G. Walker [8], Willmore [9], Yano [10], [11] and others [6]. An almost paracontact structure on a differentiable manifold was introduced by Sato [7]. The structure is closely related to almost contact structure [1] and almost product structure. Einstein manifolds have an important role in Riemannian and semi-Riemannian Geometry. Many of the authors have investigated on Einstein manifold equipped with almost product and almost complex structure.

The notion of Quasi Einstein manifolds arose during the study of exact solutions of the Einstein field equations as well as during considerations of quasi-umbilical hypersurfaces. For instance, the Robertson-Walker spacetimes are quasi-Einstein manifolds. Many authors investigated different properties of Quasi Einstein manifold [2], [3], [5]. In [4], U. C. De and G. C. Ghosh introduced generalized quasi-Einstein manifold and showed that a 2-quasi umbilical hypersurface of an Euclidean space is a generalized quasi-Einstein manifold. At the time of investigation on structures on manifolds, the author found that every Einstein manifold admits an almost product structure and similarly every quasi Einstein manifold admits an almost paracontact structure provided the sum of the associated scalars is zero. Inspired by these results, at the time of investigation on generalized quasi Einstein manifold, the author felt the importance to introduce the new structure, named as almost pseudo product structure. This paper is divided in four sections. After introduction in section one and definitions in section two, in section three, it has been shown that every Einstein manifold always

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Parametric optimization of delignification of rice straw through central composite design approach towards application in grafting

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Modelling and analysis of roughness characteristics of aluminium alloy under CNC face milling operation

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Abstract: In the last few decades the use of aluminium and its alloys have increased to a high level due to its light weight, corrosion resistance and excellent castability. It is well known that most of the metal parts are manufactured by machining. In the era of modern manufacturing CNC milling has become one of the most competent, productive and flexible manufacturing methods. Thus different controlling parameters like, spindle speed, feed rate, depth of cut, tool geometry, tool material, coolant have high influence on the surface texture of the machined product. Hence in this study, the effect of three important machining parameters viz., cutting speed, feed rate and depth of cut on the surface roughness (centre line average and ten point height roughness) has been investigated. The optimum combination of these parameters has also been determined for single and multi objective function by two evolutionary optimisation methods (ABC and GA) and compared.

Keywords: CLA; ten point height; CNC machining; stylus profilometer; artificial bee colony algorithm; genetic algorithm; multi-objective optimisation.

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Dibyendu Laya obtained his BTech in Mechanical Engineering from the Hooghly Engineering and Technology College, affiliated to Maulana Abul Kalam Azad University of Technology India in 2017. He has analysed the experimental data and obtained the outcome of analysis.

Sandip Basu obtained his Master of Technology degree from the NITTTR, Kolkata. Currently he is working as an Assistant Professor in Mechanical Engineering Department of Hooghly Engineering and Technology College, Hooghly India.

De-screening low resolution halftone printed portrait images

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***Abstract*—In this paper, one effective descreening method has been proposed for reconstructing continuous tone images from the low screen resolution half-toned (HT) printed document images. This descreening method is much more useful for portraits, engraved, and old historic HT images where screen resolution and dot-shape are important issues. Restructured image quality for descreening or inverse half-tone technique (IHT) greatly depends on these parameters. Conventional IHT generally use high-resolution dispersed-dot HT images, but screen, tonal frequency, shape of halftone dots, and also removal of noise are not seen in broad observation. If even limited halftone patches are present in the HT image or a limited number of HT images are available, then these processes become very difficult or impossible to achieve a good accurate outcome. In this study, we have introduced an improved descreening method or IHT, considering those facts and applied it to various low-resolution half-tone printed images that are usually seen from offset, screen, or lithographic printing. Using two sequential processes, our proposed method converts a low line-tone screen to a continuous tone. A one-inverse half-toning algorithm has been proposed for the first stage, and bilateral filtering and low-pass filtering techniques are used for morphological image decomposition in the second stage to focus on extra smoothing and noise removal. Finally, the reconstructed images have been compared with the original images in terms of standard image quality metrics such as PSNR and SSIM. This study also points to the comparative analysis of IHT for different low-level screen resolution HT images. Our proposed method achieved 0.84 SSIM on 50 lpi HT portrait images.**

***Index Terms*—Half-tone dot, Half-tone Screen resolutions, bilateral filtering, image quality metrices**

I. Introduction

The modern technology has completely revolutionized the electronic publishing industry. For digital publication, the conversion of print document to electronic format is very essential. The lay out of print document mainly consists of two regions: one is text and another is graph (image). Digitization of the image is comparatively difficult task than text portion transformation because HT images are used for printing purpose [1], [2].

In literature, various types of inverse half toning or descreening processes like Look-Up Table (LUT) Method for Inverse Half toning, [8], Edge-Based Lookup Table approach for Inverse Half toning [7], Wavelet based Inverse Half toning [9], Fast Inverse Half toning [14], [15] and so on are available for reconstruction of halftone images. The Efficiency of these above mentioned inverse half toning algorithms greatly depends on execution time and memory requirement. Moreover, during transformation of the scan document image to the continuous tone image, the quality of image degrades and textural aliasing like moirÃ© pattern may appear. most of these work, low frequency level HT images are not yet considered. In our previous research-works, significant amount of quality improvement has been achieved on specified low frequency HT images but if limited HT patches present in samples then, that module difficult to formed or can not achieved significant accuracy-level [4].

The HT-dot shape is dependent on the printing method or the printing plate. The dot (order dithering technique) can be classified into two types: dispersed-dot order and cluster-dot ordered [13]. In the first type, the less relevant dots for representation (e.g., white pixels in a dark area) are spread out in an apparently random order, but the density is varied in order to match the gray-level intensity of the original image. In the second type, geometric shapes of different sizes are used to create a pattern which is proportional to the gray-level intensity of the original image. That is, the pixels of the binary image are clustered to create a visual sensation of different tones. There are very less research work on inverse half toning technique on cluster dot document images. In industrial or commercial printing, various types of half tone techniques are used on print documents and it varies in shape, size and resolution or screen frequency according to picture, print-techniques, substrate, manufacturing requirement or cost. In printing techniques, different shapes of HT-dots like round dots, elliptic dots, square dot etc. are used. Each dot type has its own characteristics. For example, round dots are suitable for light images, especially for skin tones, elliptical dots are appropriate for images with many objects and square dots are best for detailed images, not recommended for skin tones.

One of the most fundamental decisions to be made when preparing a photographic image for printed reproduction is the choice of the proper HT screen frequency or lines per inch (lpi). The appropriate HT frequency depends on the paper stock and type of press used for printing. Like, newspapers commonly use 85 lpi screens. Silk Screen printing uses around 40 lpi. Textile printing uses 50 lpi, Xerox or lithographic uses 50-85 lpi, whereas Magazines use higher resolution screens, such as 133 lpi to 150 lpi [12]. Different dot shapes and screen resolutions provide variations in HT images [10], [11]. It is

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