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Academic Year 2021-2022

INDEX

Published by :
http://www.ijert.org

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 04, April-2022

Identification of Appropriate Locations for Various Water Supply and Sanitation Infrastructure in Chiplun using Q-GIS

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***Abstract*: QGIS is one of the best software for site selection. With the help of QGIS software we can select sites without doing the physical survey of the region for which we are going to do site selection.**

There should be the proper or appropriate sites for water treatment plant, sewage treatment plant and Landfill. The proper or appropriate site means the site should be at proper distance from different areas like agricultural area, residential area, forest area, road, railway line, etc. according to the government norms, For this we can QGIS software. If we do the site selection by actually going on site, then it will be time consuming but this disadvantage can be overcome with the help of QGIS. In this study we have done site selection for landfill, WTP, STP by using QGIS software. First, we have identified the study area for which we are going to select the WTP, STP and landfill sites. Then we have prepared LULC map. We have identified different regions of land like agricultural, forest, river, etc. and prepared LULC map also we have located road network and railway line.

After preparing LULC we have found the buffer distances to locate buffer zones for WTP, STP, Landfill. Buffer zone means the area which separates the two lands from each other. In our case buffer zone separates WTP, STP, Landfill from agricultural, residential, forest, etc. After that we have applied buffer distances for each area. After application of buffer the which remained in which we have located the sites for WTP, STP and landfill.

INTRODUCTION:

The proper disposal and management of wastes (Liquid waste and solid waste) generated in the city is one of the critical issues. The management of waste has major impact on ecology and environmental health. Due to rapid urbanization and increasing growth of population solid waste management has become acute in India. There are different water supply and sanitary infrastructures for the management and disposal of waste. Landfilling is one of the best solutions for solid waste disposal. If the region contains the different industries, then liquid waste is one of the greatest issues along with the solid waste and hence there should be facilities for the disposal of these generated wastes. Sewage generated from industries should undergoes proper treatment in the sewage treatment plant. With the help of these infrastructures, we can control waste management efficiently, but for this these infrastructures should be located on proper site.

Population growth, rapid urbanization and booming economy and also the increase in living standards of each community the rate of municipal solid waste generation is increasing nowdays in every country. Usually, the municipality has the responsibility for the management of the waste generated within the cities, municipality facing the challenges associated with the economy, space and providing effective system for the inhabitants. The elementary goal for the solid waste management system is to handle the land use, economic consideration, health and environmental aspects connected with inappropriate disposal of waste. In many countries due to the poor management of waste disposal creates severe environmental issues that have an effect on the welfare of humans and animals and produce cocering serious economic and welfare losses.

Site selection is becoming very challenging task involving socio-economical, environmental and technical dimension. Because while selecting the site we have to take care all the environmental, ecological and social factors. The treatment of sewage is large scale process so it should be done at proper site. While treating sewage so many harmful substances or gases are generated. If the site is very close to the residential, agricultural, water bodies or near to any environmentally sensitive area then there will be enormous harmful impact. So, to avoid this we have to select the appropriate sites for the sewage treatment plant which satisfying all the site selection criteria. With the help of Quantum Geographic Information System (Q-GIS) we can achieve this goal very easily.

STUDY AREA:

CHIPLUN is a city and a tehsil in Ratnagiri district in the state of Maharashtra, India. It is the head-quarter of Chiplun taluka and located on the Mumbai–Goa highway (NH-66) (it was earlier numbered as NH-17) in western India. The city is about 320 km south of Mumbai in the Konkan region of Maharashtra. It is a fast-developing city in Konkan with a strong cultural background. The name Chiplun means "The abode of Lord Parshuram".

Chiplun city is the economical and commercial Centre of the Ratnagiri District. It is connected to the National Highway 66 and the State Highway 78. It is well connected to Mumbai, Pune, Panaji, etc.

Chiplun municipal council is the head quarter of taluka Chiplun in Ratnagiri district of Maharashtra state situated on a west coast of India. This is hilly region and it also lies in between the valley which is covered by Western

International Journal of Engineering Research & Technology (IJERT)
ISSN: 2278-0181
Vol. 11 Issue 04, April-2022

Ghats on one side and the Arabian Sea on the other side. The work area of Chiplun region is 24.73 Sq. Kms. The industries are growing on large scale. There are 3 MIDC developed Sat a distance of 12 to 15 Kms from Chiplun.

Fig.01: Study Area (Chiplun)

Material: A geographic information system (GIS) is a computer system for capturing, storing, checking, and displaying data related to positions on Earth's surface. GIS can show many different kinds of data on one map. This enables people to more easily see, analyse, and understand patterns and relationships. With GIS technology; people can compare the locations of different things in order to discover how they relate to each other. It can include information about the land, such as the location of streams, different kinds of vegetation, and different kinds of soil. It can include information about the sites of factories, farms, and schools, or storm drains, roads and electric power lines.

In this study we have used version 3.16 of Q GIS software. We have used this version because this version is user friendly. It is very easy to use.

METHODOLOGY:

1) Identification of different planning parameter: Based on literature study, considering Geophysical conditions, and available data on the study area, following criteria were adopted to select suitable site for landfill, WTP & STP.The importance of those criteria and the basis of their selection are outlined below:

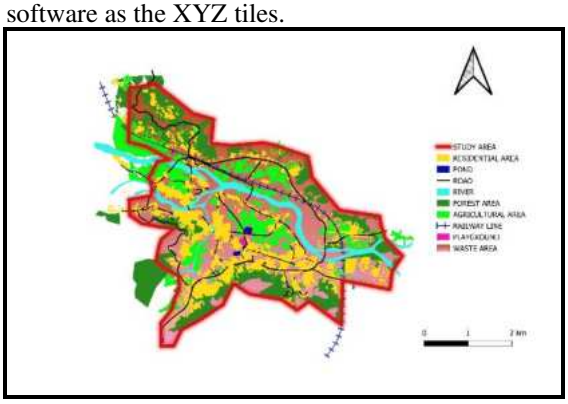
Sr N	Landfill	WTP	STP
1	Elevation	Elevation	Elevation
2	Availability of waste land	Source of water bodies	Away from Residential area
3	Distance from Road, Residential area, water bodies, Agricultural area	Distance from Road, Residential area, water bodies, Agricultural area	Distance from Road, water bodies, Agricultural area
4	Existing dumping ground	Present & Future land use	Present & Future land use
5	Ground water depth	Topography of the area	Ground water depth

Table no 01: Different planning parameter for Landfill, WTP, STP

2) Analysis of different routes: Transportation is one of the major factors which affect the economy of the solid waste management. Transportation of the sludge generated in the STP, WTP required cost and this cost can be reduced by optimizing the best route. It is possible that there may be the multiple routes for transportation of waste. From these routes to identify the best appropriate route we will required to do the analysis of the road network in the study area.

3) Preparation of different types of maps (LULC, Contour map):

Land use-Land cover is all about differentiating a given land into various entities such as residential area, agricultural land, water bodies, waste area etc. For the particular area, a land use land cover analysis has to be done to analyse land use and land coverage areas so that we can identify the vacant sites in the given study area. Vacant sites mean the the area of the land which not comes under the any category like agricultural, residential or forest area etc. Basically, identification is very important because in the vacant sites we are going to locate the sites for the landfill, WTP and STP. In this paper the major classification used for the land is residential area, agricultural land, water bodies, forest area. To do so, the google map is opened in the QGIS software as the XYZ tiles.



Map 01: Land use Land cover map

4) Buffering & Analysis: Buffering usually creates two areas: one area that is within a specified distance to selected real world features and the other area that is beyond. The area that is within the specified distance is called the buffer zone.

According to the Schedule-I of (Solid Waste Management Rules, Ministry of Environment, India 2016) , **(T. Subramani, et al. (2014)), (Kerala Water Authority, (2021)** following are the buffer distances for Landfill, WTP, STP with respect to different areas mentioned in table 02.

AREA	BUFFER DISTANCES IN METERS		
	LANDFILL	WTP	STP
Residential	500	200	400
Road	100	60	200
River	100	100	200
Pond	200	200	200
Agricultural	200	300	200
Playground	200	200	400
Forest	200	100	100
Railway	200	100	200

Table 02: Buffer Distances for LANDFILL, STP, WTP

Hierarchical Control of a Low Voltage DC Microgrid with Coordinated Power Management Strategies

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Abstract-A microgrid consists of a cluster of renewable energy sources, energy storage elements, and loads. One of the main objectives of a microgrid is to provide reliable and high-quality power to the loads. Under normal operating conditions, this is achieved through suitable Power Management Strategy (PMS). However, under emergency conditions, such as the failure of any source, overloads, or faults, the PMS may not be able to retain the microgrid in operating conditions. Any emergency condition may demand a significant change in control and coordination between various subsystems of the microgrid to survive and continue the operation. This feature makes a microgrid "a fault resilient" system as visualized in its objectives. This paper proposes a novel Coordinated Power Management (CPM) strategy based on three-layer hierarchical control for an autonomous Low Voltage DC (LVDC) microgrid. The proposed CPM strategy ensures the continuation of the microgrid operation under normal and emergency conditions. An emergency control layer is established to extend the microgrid operation during an emergency condition. The performance of the proposed control scheme is validated through simulation and experimental results.

Keywords-coordinated power management; DC microgrid; hierarchical control; fault resilient system

I. INTRODUCTION

Some of the challenges the conventional power generation faces are the environmental pollution, the reduction in the fossil fuels reservoirs, and the continuous increase in the power demand, which lead to increased penetration of the RES based Distributed Generation (DG). The resultant large penetration of RESs like Solar Photovoltaic (SPV) panels and wind turbines in existing grid is subsequently challenging its stability due to their intermittent nature. Small capacity sources with diverse nature integrated with Energy Storage Systems (ESSs) feeding aggregated loads are controlled and coordinated as a single entity, referred to as a Microgrid (MG). It facilitates the integration of free and locally available micro energy sources with suitable energy storage elements to meet the local load demand. In MGs, micro-sources are controlled through suitable power electronic converters. Based on voltage type, an MG can be classified as an AC MG, a DC MG or DCMG, and a Hybrid MG [1]. A DCMG possesses more advantages such as higher efficiency and natural interface with RES, ESS, and the loads. Figure 1 shows a typical schematic of an LVDC MG configuration.

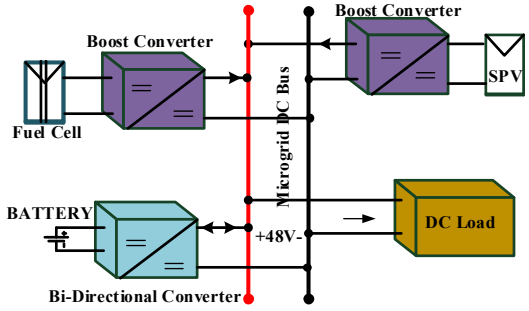

Fig. 1. A typical LVDC MG configuration.

The intermittent behavior of RES along with the unpredictable load fluctuations generally results in imbalance between the power generation and the load demand which significantly affects the overall operation of the system. Various power sharing control strategies have been presented in the past and are classified as decentralized, centralized and multilevel (hierarchical) control. In decentralized control, generally power management with droop control is adopted based on the capacity of individual sources. This method is simple and easy to implement with locally measured variables, but possesses some operational challenges like optimal Load Sharing (LS), voltage regulation, power regulation, real time source optimization etc. These challenges mainly persist due to the lack of information about source parameters. To address these issues, some improved droop control strategies have been proposed to enhance the load sharing accuracy, source optimization and voltage regulation achieved with low bandwidth communication [2, 3].

In centralized control, the sources are controlled by a remotely located centralized controller with high-speed communication links. The communication network with sufficiently large bandwidth plays an important role to exchange the information among the micro sources. However, the reliability of this centralized scheme suffers by the high probability of single point failures like the failures of the

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central controller or of the communication networks. The hierarchical control is a better approach which neither suffers a single point failure nor demands the use of a high-speed communication network. However, a low to medium bandwidth communication link is needed, which plays an important role in the overall optimization of the system operation. Most of the difficulties associated with decentralized and centralized control are overcome in this approach. The hierarchical control provides continuous operation at suboptimal level during a failure of the controller or communication network.

In the existing literature, various control schemes for DC MGs have been reported. Authors in [2] presented the drawbacks of conventional droop control and showed the effect of different droop gains on the current sharing accuracy and voltage regulation. The current sharing accuracy changes with the higher value of line impedance while reduction in voltage. Authors in [3] proposed and analyzed 3 nonlinear droop control techniques to obtain the optimal operation for load sharing accuracy and bus voltage restoration. A power distributed control method for proportional load power sharing and bus voltage restoration is reported in [4]. The proportional output power sharing with load voltage restoration is achieved by adjusting only the output source voltage instead of introducing the virtual impedance. However, poor load sharing at light load and voltage deviation in heavy load conditions persist in the system. Frequency droop control method is proposed in [5]. Fuzzy logic is used to define the frequency droop coefficient. Authors in [6] proposed and evaluated a fault detection method which is independent of the MG topology. Authors in [7] proposed a decentralized controller with low bandwidth communication to enhance high reliability, low voltage regulation, and equal load sharing. Eigenvalue analysis and mathematical modal were derived. The conventional droop curve equation is shifted along with x-axis by adding additional voltage. A similar approach has been presented in [8], but the compensating average voltage of the identified critical busses is determined by the proposed modal analysis.

The hierarchical architecture was proposed for DC microgrid with reliable and optimum utilization of resources in [9, 10]. Primary level control is embedded in Local Controllers (LCs) directly acting on power converters according to the references generated by the secondary level controller with faster dynamics. The secondary level control facilitates functions like bus voltage regulation, power management, and overall system optimization. Authors in [11] proposed a power management control strategy to DC MGs under different operating conditions. The developed control algorithm ensures optimal utilization of the available resources and maintains a healthy State of Charge (SoC) of the ESS. A two-level hierarchical control algorithm is proposed in [12] that can operate the main source at constant power and reduce the fluctuations on the voltage-controlled source in system while maintaining the SoC of the storage unit. Authors in [13] addressed the Adaptive Dynamic Power Management Strategy (ADPMS) for a self-reliant DC MG. Authors in [14] presented the design and implementation of a low voltage autonomous MG integrating different RES combination with suitable energy storage units to meet the electrical energy needs in remote locations. It consists of a single voltage source converter and a Bidirectional DC Converter (BDDC) to manage the power flow in self-sustain low voltage MGs.

Emergency power and energy management system are essential in ensuring the optimal restoration process and continue the healthy operational amongst available RESs, energy storage system. Authors in [15] proposed a multi-level novel reconfigurable hierarchical architecture for an AC MG to transfer its functionalities from a source-level control to system level control to supports long-term optimization of MG operation under normal conditions and front-line switching roles in emergency conditions. Authors in [16] proposed the design and control of integrated RESs for energy management. The peak load demand problem was resolved with a combination of demand side energy management and ESSs. Authors in [17] proposed a methodology of making a schedule of list of actions such that the distribution system operator is able to provide continuous electricity supply for classified customers. This is achieved by considering some power management options such as intentional load shedding, dispatch of expensive fossil fuel sources, system reconfiguration, and so on. Authors in [18] presented a mathematical formulation based on mixed integer linear programming under normal and emergency operating conditions for an AC MG to improve the system resilience.

As discussed above, the focus of the research in DC MGs is more on power management under steady-state operation. Not much research is reported in operational management under emergency operating conditions. Therefore, it is essential to make more investigations in emergency cases to extend the MG operation in such emergency. This paper describes the novel Coordinated Power Management Strategy (CPMS) implemented on a typical LVDC MG architecture shown in Figure 2. The proposed CPMS facilitates LVDC MG operation under both steady-state and emergency conditions. The proposed strategy incorporates 3 levels of hierarchical control. The details of the proposed strategy are provided along with the simulation and the experimental results. The proposed strategy makes a LVDC MG a fault-resilient system able survive and perform under all operating conditions.

II. THE COORDINATED POWER MANAGEMENT STRATEGY FOR THE LVDC MICROGRID

An MG's main objective is to provide reliable power under all operating scenarios and this demands the use of a failsafe power management strategy. It is also essential to use the locally available resources optimally. The main focus is to maximize the power extraction from RES and to relieve the ESS from its major share in supplying power to the loads. With the abovementioned objectives, a 3 layered hierarchical control strategy is proposed for an autonomous LVDC MG. The power topology of the proposed LVDC MG considered for this study integrates 2 solar PV power plants and a fuel cell-based source as RES components while the ESS consists of battery-based and ultra-capacitor based sources.

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Journal of Environmental Management

Volume 301, 1 January 2022, 113854

Co-pyrolysis of petroleum coke and banana leaves biomass: Kinetics, reaction mechanism, and thermodynamic analysis

Rajnish Kumar Singh [a], Trilok Patil [a], Deeksha Pandey [a], Shyam P. Tekade [b], Ashish N. Sawarkar [a]

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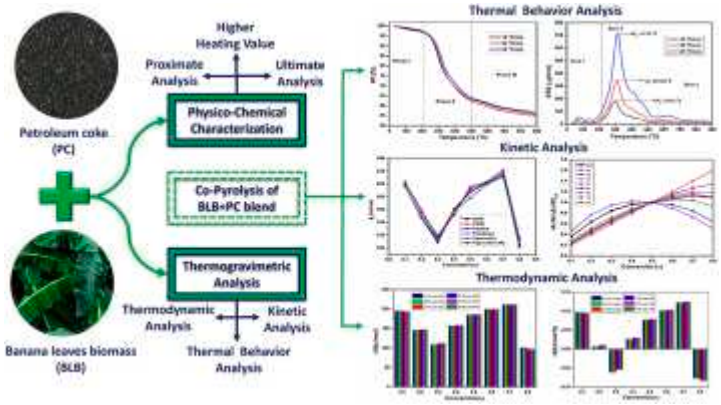
Highlights

- First comprehensive report on co-pyrolysis of PC and BLB through TG experiments.
- ≈32–37% reduction in E_a was observed for co-pyrolysis of PC+BLB vis-a-vis pyrolysis of PC alone.
- $\Delta H \approx 163$ kJ/mol & $\Delta G \approx 151$ kJ/mol proves feasibility and spontaneity of co-pyrolysis.
- Z-Master plots predicted R2 & D3 as plausible reaction models for PC+BLB co-pyrolysis.

Abstract

Insights into thermal degradation behaviour, kinetics, reaction mechanism, possible synergism, and thermodynamic analysis of co-pyrolysis of carbonaceous materials are crucial for efficient design of co-pyrolysis reactor systems. Present study deals with comprehensive kinetics and thermodynamic investigation of co-pyrolysis of petroleum coke (PC) and banana leaves biomass (BLB) for realizing the co-pyrolysis potential. Thermogravimetric non-isothermal studies have been performed at 10, 20, and 30 °C/min heating rates. Synergistic effect between PC and BLB was determined by Devolatilization index (D_i) and mass loss method. Kinetic parameters were estimated using seven model-free methods. Standard activation energy for PC+BLB blend from FWO, KAS, Starink, and Vyazovkin methods was ≈165 kJ/mol and that from Friedman and Vyazovkin advanced isoconversional methods was ≈171 kJ/mol. The frequency factor calculated for the blend from Kissinger method was found to be in the range of 10^6-10^{16} s^{-1}. Devolatilization index (D_i) showed synergistic effect of blending. The data pertaining to co-pyrolysis was found to fit well with R2 (second order) and D3 (three dimensional) from Z(α) master plot. Thermodynamic parameters, viz. ΔH≈163 kJ/mol and ΔG≈151 kJ/mol were calculated to determine the feasibility and reactivity of the co-pyrolysis process. The results are expected to be useful in the design of petcoke and banana leaves biomass co-pyrolysis systems.

Graphical abstract



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Introduction

Petroleum coke, commonly known as petcoke, is a by-product of the delayed coking process in oil refineries (Zhang et al., 2016; Yu et al., 2021) and is getting produced in a significant amount in view of a steady influx of heavy oil in refineries (Sawarkar, 2019a, 2019b). It is estimated that one barrel of synthetic crude oil processing results in the

generation of 20kg of waste petcoke (Pourrezaei et al., 2014). The global production of petcoke is approximately 150 MMTPA (Murthy et al., 2014). These stockpiles of petcoke were proved to be contributing to the generation of particulate matter which has adverse effects on human health (Kozicki et al., 2016; Xing et al., 2017; Wu et al., 2018). Besides, such a large amount of petcoke needs to be stored around the facility area and can occupy significant amount of valuable land resource (Rashidi and Yusup, 2021). Hence, the petcoke is being explored for its thermochemical conversion for producing energy in line with similar another carbonaceous resource, i.e. coal (Verma et al., 2020). It is important to note here that most of the recently commissioned petroleum refineries in India (Paradip refinery, Bina refinery, Panipat refinery) have delayed coker units (DCU) which are producing significant amount of petcoke. Delayed coking process is one of the most sought after processes for processing vacuum residues in petroleum refineries world over (Sawarkar et al., 2007). It may be noted that the low reactivity of petcoke is one of the major limitations of petcoke when it is processed alone for its conversion to value-added products. The advantages of petcoke such as high calorific value, low ash content, easy availability, and lower cost make it an attractive option to be used as an energy resource even though its use results in higher pollution levels (Kumari et al., 2020; Prabhakaran et al., 2021). The consumption of petcoke in India has witnessed an increasing trend from 1997 and it accounted for massive 21.7 million tonnes in 2019-20 (PPAC, 2021). The domestic production of petcoke has also increased from 2.71 million tonnes in 2010-11 to 15.53 million tonnes in 2019-20 (Energy Statistics India, 2021). The petcoke is generally used as fuel in place of coal because of its lower cost as compared to coal. Petcoke also finds applications in other industries such as cement, aluminum, iron and steel, etc. In 2018, owing to the high pollution caused by the use of petcoke as fuel, the Supreme Court of India banned the import of petcoke for using as fuel, however, allowed its import for cement, lime kiln, calcium carbide and gasification industries (The Economic Times, 2018). In 2020, the National Green Tribunal has also directed the Central Pollution Control Board to ensure ban on petcoke being used as a fuel in industries (The Hindu, 2020). On the positive side, petroleum coke has high calorific value (Gajera et al., 2020) and low ash content (Zhong et al., 2018) than coal. Processing of petcoke with biomass in thermochemical conversion routes could be one of the better approaches for utilization of petcoke in line with that of co-processing of biomass and coal. The higher hydrogen content of biomass acts as a hydrogen donor to carbonaceous material such as petcoke during co-pyrolysis process (Quan and Gao, 2016). Biomass, in view of its higher oxygen content, can facilitate the increase in the reactivity of other carbonaceous material during co-pyrolysis process (Konwar et al., 2019).

Biomass, at present, is the fourth largest source of energy in the world which is led by petroleum which contributes to about 33% of the primary energy supply followed by coal and natural gas. In the recent past, biomass based novel approaches, given the inherent

carbon neutrality of biomass, are making substantial progress not only in the production of biofuels but also in the production of bio-based chemicals (Singh et al., 2020a). However, it may be noted that although biomass has distinct advantages as regards the very idea of sustainable environment, it has some disadvantages like high moisture content, low bulk density, degradation on storage, and low energy efficiency (Chen et al., 2019; Nyoni et al., 2020; Tian et al., 2020). For utilizing the biomass to its fullest potential, of late, thermochemical conversion processes are being increasingly investigated in tandem with other carbonaceous materials (Sakulkit et al., 2020; Uzoejinwa et al., 2018). It is envisaged that the agricultural crop residue based biorefinery concept (Abraham et al., 2016) can really take off massively if biomass can be processed in conjunction with suitable carbonaceous material which could ultimately be advantageous for both the materials. India is one of the largest agrarian economies in the world and in the recent past, greater emphasis has been laid to tap the energy from abundantly available farm residues in India in order to meet the increasing demand for energy (Gokul et al., 2019; Singh et al., 2020b). In tandem with cereal crop residues, the residue of fruit plants which mainly includes leaves and stems could be prominent feedstock for biorefineries for the production of bio-fuel as well as bio-based chemicals (Balogun et al., 2018). Banana is the largest cultivated fruit plant in the world (Bhushan et al., 2019). India is the largest grower of bananas and contributes 29 million tons which accounts for about 25.43% of global banana production (Singh et al., 2020c). A significant amount of waste including leaves, pseudostem, rachis, and peels are generated in banana cultivation. It is important to note that one ton of banana production simultaneously generates about 100kg of waste fruit and four tons of lignocellulosic waste (Fernandes et al., 2013). Unfortunately, most of the banana lignocellulosic wastes are left in the field for decomposition without energy recovery. Therefore, it is imperative to employ various approaches to recover energy and value-added chemicals from banana wastes.

Pyrolysis as a thermo-chemical conversion process has emerged as one of the most sought after processes and is being extensively investigated for converting a variety of carbonaceous materials to gaseous fraction, oil, and char as per the desired product fraction by tuning the process parameters (Jiang et al., 2020; Lu et al., 2020; Singh et al., 2021a). The gaseous products obtained through the pyrolysis of biomass can be utilized in various combustion devices. The micro-combustor may be one of such efficient devices for utilizing renewable energy and efforts are on to improve the efficiency of these systems (Zuo et al., 2021). In addition to the energy dense products such as oil and gas, the solid product of pyrolysis of biomass i.e. biochar has been found advantageous in soil amendment (Turan, 2020) and other host of applications. However, one of the major disadvantages of bio-oil, a liquid product obtained while pyrolyzing biomass as feed, is higher oxygen content (35–60wt%), which is rendered by original biomass (Singh et al., 2021b). Therefore, of late, co-pyrolysis of carbonaceous materials is being investigated

extensively. Evaluation of thermo-chemical conversion kinetics, thermodynamics, and mechanistic models give valuable insight into the co-pyrolysis process and thus help refine the parameters and in turn, facilitate the design of the co-pyrolysis reactors.

After an extensive literature survey, it was revealed that co-pyrolysis of petcoke and biomass is scarcely studied whereas studies pertaining to biomass and another similar carbonaceous material, viz. coal co-pyrolysis are being progressively explored. A summary of some of the significant investigations in the recent past pertaining to co-pyrolysis of biomass with coal to enhance the rate of biomass pyrolysis, improve the energy efficiency, and quality of bio-oil is restated as follows. Li et al. (2015) investigated co-pyrolysis of four biomasses (rice straw, sawdust, microcrystalline cellulose, and lignin) with bituminous coal. The interaction between biomass and coal in co-pyrolysis was found to increase with the biomass ratio as a result of the enhanced generation of free radicals. Wu et al. (2015) studied co-pyrolysis of bituminous coal with major biomass components in the drop tube furnace. The blends of bituminous coal with cellulose and hemicellulose were found to perform at par during pyrolysis and resulted into improved gas yields as compared to that of individual pyrolysis of these components. Thermogravimetric analysis (TGA) of pyrolysis of briquettes prepared from waste chestnut sawdust (SC), high rank coal (K), bituminous coal (P), and coal tar (T) in various proportions (SC:K:P:T, by %wt-15:70:0:15; 15:35:35:15; 0:42.5:42.5:15; 0:85:0:15) has been reported by Montiano et al. (2016). The presence of such a low amount of waste chestnut sawdust biomass was observed to have an insignificant synergistic effect on the co-pyrolysis characteristics of the prepared briquettes. Wu et al. (2017) studied the kinetics of co-pyrolysis of primary model compounds contents of microalgae biomass (glycine, medium chain triglyceride, and starch) with low rank coal using TGA. The synergistic effect was noted in the co-pyrolysis between them in terms of decrease in char yield and increase in devolatilization index with addition of microalgae biomass model compounds to the low rank coal. Li et al. (2020) investigated the fast pyrolysis of Baiyinhua lignite with pine using TGA and subsequently in an infrared heated fixed bed reactor. The maximum synergistic effect between the lignite and pine was observed at the blending ratio of 5:5at 550°C. The effect of addition of cedar biomass to pyrolysis of low rank coal under rapid infrared heating has been reported by Zhu et al. (2020). The maximum synergistic effect in the co-pyrolysis was found for 75% cedar content of the mixture at 600°C. From the foregoing discussion, it can be concluded that the addition of coal has an effect in terms of both product quality and energy efficiency during co-pyrolysis with biomass and vice-versa. As pointed out earlier, since the co-pyrolysis studies involving petcoke and biomass are scanty, it was felt desirable to explore petcoke as a carbonaceous material to the pyrolysis of biomass in line with that of coal. The information on kinetic and thermodynamic parameters as well as determination of controlling mechanism is vital for the design of pyrolysis reactor

systems. The 'International Confederation for Thermal Analysis and Calorimetry' (*ICTAC*) committee underlines the importance of model free isoconversional methods (Vyazovkin et al., 2011) for evaluating kinetic parameters of the pyrolysis process. Therefore, the present work explores the application of the seven various model-free isoconversional methods, using TGA data for determining the kinetics of pyrolysis/co-pyrolysis reaction of PC and BLB and their blend. To the best of authors' knowledge, the present communication is the first attempt to investigate kinetic and thermodynamic analysis along with reaction mechanism of co-pyrolysis of petcoke and banana leaves biomass.

Section snippets

Feedstocks, analytical methods, and experiments

Petcoke was obtained from the operating delayed coker unit of an Indian petroleum refinery and banana agro-waste, i.e. banana leaves were collected from MNNIT campus located in Prayagraj. Petcoke was reduced to small size using mortar and pestle and its uniform size (250μm) was obtained from BSS-60 model sieve. Banana leaves were dried in sunlight for a couple of weeks. After drying, this agro-waste was changed into powdered form by grinding and mixing. Uniform size (250μm) of the sample was …

Physico-chemical characterization

The proximate analysis, ultimate analysis, and energy content of PC, BLB, and PC+BLB blend are shown in Table 2. The proximate analysis of PC indicates that it has 0.64% moisture, 10.5% volatile matter, 88.63% fixed carbon, and 0.23% ash whereas BLB has a respective composition as 8.4%, 73.05%, 11.29%, and 7.26%. The blend of PC+BLB was found to content 7.8% moisture, 44.04% volatile matter, 49.89% fixed carbon, and 3.23% ash. The observed proximate analyses of PC and BLB were found …

Conclusions

A detailed report on co-pyrolysis processes of PC and BLB in terms of characterization, kinetics, thermodynamics, possible synergism, and reaction mechanism is presented. Following points can be summarised from the current study:

- From physico-chemical characterization, kinetics, and thermodynamic parameters, it was revealed that PC+BLB co-pyrolysis could be a more sustainable approach than the pyrolysis of individual materials. …
- Activation energy obtained for PC+BLB blend from various …

…

Credit author statement

Rajnish Kumar Singh: Investigation, Writing – original draft, Writing – review & editing. **Trilok Patil:** Methodology, Data curation, Writing – review & editing. **Deeksha Pandey:** Formal analysis **Shyam P. Tekade:** Writing – original draft, Visualization, Writing – review & editing. **Ashish N. Sawarkar:** Conceptualization, Writing – original draft, Writing – review & editing, Supervision, Funding acquisition. …

Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper. …

Acknowledgements

ANS is thankful to Marathi Vidnyan Parishad, Mumbai for the financial assistance to the project (Ref. No. 154/MVP/16-17). …

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Isolation and Characterization of Cellulose Nanocrystals Produced by Acid Hydrolysis from Banana Pseudostem

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Gaurav Zope, Ajaygiri Goswami & Sunil Kulkarni

Abstract

Synthesis of useful products from waste material improves the process economy and sustainability. Cellulose nanocrystals (CNCs) have unique properties like nanoscale dimensions and excellent mechanical strength. CNCs can be synthesized from Banana pseudostem, the renewable agro-waste. In a two-step process for isolation of CNCs, chemically purified cellulose (CPC) was obtained from raw fibers and CNCs were isolated from CPC by acid hydrolysis method. The effect of chemical treatments on properties of prepared CNCs was investigated. The effect of hydrolysis reaction time on the morphology of cellulose nanocrystals was also studied. It was observed that partial lignin and hemicellulose with other extractives were removed during alkali treatment. FTIR analysis indicated that peaks at 1730 cm^{-1} and 1250 cm^{-1} only were present in the spectrum of raw

fibers. It indicated the removal of lignin, hemicellulose, and waxes after pre-treatment. The spectrum for treated cellulose indicated that most of the lignin and hemicelluloses were washed out in alkali treatment. Rod-like nanocrystals with average length 500 nm and diameter 80 nm were observed from FE-SEM images. Increase in crystallinity with successive treatments, from raw fibers (18.2%) to CNCs (64.2%), was observed from XRD analysis. CNCs have lower thermal stability than the raw fibers as observed from thermogravimetric analysis. The percentage crystallinity was found to be 18.2% for raw fibers. The diffractogram of raw fibers also indicated increase in % crystallinity value upon alkali treatment (52.4%) and bleaching treatment (62.6%). The hydrodynamic size (*Z* average) of CNC was 140.3 nm.

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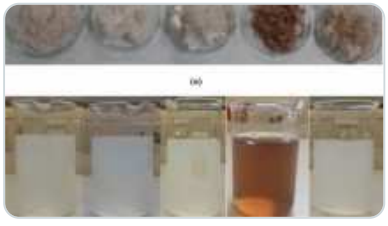

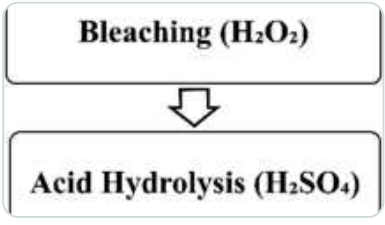

Advances in Environmental Technology 3 (2021) 185-194

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Factors affecting photocatalytic degradation of Reactive Green-19 with CdO-TiO_2 nanocomposite

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ARTICLE INFO

Article history:
Received 1 October 2021
Received in revised form
20 December 2021
Accepted 22 December 2021

Keywords:
Precursors
XRD
Peaks
Light intensity
Morphology
Chemical stability

ABSTRACT

Cdo-TiO_2 nanocomposites were synthesized by varying the molar ratio of CdO: TiO_2 as 1:1, 1:2, and 2:1 using the sol-gel method. The pH value for all the CdO-TiO_2 nanocomposites was controlled at two different values, pH-3 and pH-13. The nanocomposites were used for facilitating photolytic degradation of azo dye (Reactive Green-19). The surface morphology, crystallinity, and properties related to interactions with the light of the prepared catalyst were examined by scanning electron microscopy (FE-SEM), X-ray diffraction (XRD), and ultraviolet-visible (UV-Vis) spectrophotometer, respectively. The nanocomposites for all molar ratios synthesized at pH-3 showed rod-like structure and some irregular shapes, while those synthesized at pH-13 were spherical. From XRD patterns, composites at pH-3 and pH-13 were crystalline; however, those at pH-3 were more crystalline. The parameters, namely initial dye concentration, pH of dye solution, and catalyst concentration, affecting photocatalytic activities were examined and optimized at 75 ppm, pH-7.5, and 1g/L, respectively. The progress of the degradation process of Reactive Green-19 was observed by monitoring the change in the concentration of the dye after a certain time interval by measuring the absorbance by UV-Vis spectrophotometer. Catalyst A1:1 (The nanocomposites obtained at pH-3 with 1:1 mol% of CdO:TiO_2) showed maximum degradation (94.53 %) at a catalyst concentration of 1 g/L.

1. Introduction

Sustainable growth is the most important aspect of modern-day research. Rapid industrialization and simultaneous increase in environmental concern have attracted the attention of many researchers towards wastewater treatment. Textile industry effluent is one of the significant sources of water pollution in India. This effluent contains mainly organic dyes and compounds. These compounds can cause diseases such as cancer. Other harmful effects of this effluent include mutagenicity, skin irritation, and ulceration of the skin [1,2].

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DOI: 10.22104/AET.2021.5140.1395

Worldwide, textile industries use azo dyes, a significant class of synthetic dyes, because of their low cost and availability in various color variants [3]. The presence of one or more aromatic parts with azo bonds (-N=N-) is characterized as reactive dyes [4]. The most common colorant widely used in textiles, paint, and garment industries is reactive Green 19(RG-19). RG- 19 molecular structure has twin azo groups as a chromophoric moiety. Also, it has a couple of reactive chlorotriazine groups. The presence of these reactive groups makes Reactive Green 19 the most preferred azo dye in textile industries. [5]. When applied to fabric, it gets washed away with water, generating a huge amount of effluent that needs to be treated. These azo dyes cause health problems for humans and animals if they enter the body through drinking water. The effluent containing azo dyes needs to be treated for degrading the dyes before it is discharged into the environment. Advanced oxidation processes (AOPs) are universally recognized nowadays for the complete destruction of contaminants present in wastewater. Adsorption [6,7], chemical oxidation [8], electro-coagulation [9], microbial action [10,11], and photocatalysis [12,13] are various AOPs that are generally used for wastewater treatment; each process has its own limitations. Nowadays, most studies have focused on photocatalysis using semiconducting nanomaterials as the catalyst for the degradation of reactive azo dyes. Heterogenous photocatalysis has emerged as an important process for removing organic pollutants that are soluble in water [14-16]. For the complete destruction of organic pollutants, various types of semiconductors like titanium dioxide, zinc oxide, cadmium sulfide, tungsten trioxide are widely used in the photocatalytic process [17-19]. As per the literature, TiO_2 is one of the most frequently used photocatalyst due to its photosensitive and stable nature. [17-20]. Semiconductor nanoparticles with different band gaps are coupled to increase the efficiency of the photocatalytic process [21,22]. Recently, CdO (2.2 eV) has been reported as an important semiconductor for the wastewater treatment of organic pollutants [23]. CdO- TiO_2 nanocomposites have been used for the degradation of organic methyl blue and methyl orange dyes with 99 and 97 percent degradation efficiency, respectively [24]. The objective of the present work is to synthesize and characterize CdO/TiO_2 nanoparticles and study their use in the photolytic degradation of Reactive Green 19 (RG-19) dye. The optimum proportion of CdO and TiO_2 is determined by carrying out experiments at different proportions based on earlier reported results. In the present investigation, the synthesis of CdO/TiO_2 nanocomposite is carried out at different CdO/TiO_2 molar ratios (1:1, 1:2 and 2:1) and pH values (3 and 13) using cadmium acetate and titanium isopropoxide (TTIP) as precursors of CdO and TiO_2. The effect of different molar ratios and pH on surface morphology, crystallinity, and band gap of nanocomposite was determined using FE-SEM, XRD, and UV-spectrophotometer, respectively. The prepared CdO/TiO_2 nanocomposites were used for the light-induced decomposition of Reactive Green 19 (RG-19). The influence of parameters like initial dye composition, the concentration of catalyst, and pH of dye solution were examined.

2. Materials and methods

2.1. Materials

TTIP and cadmium acetate were procured from Avra Chemicals (Hyderabad, India). The ethanol was procured from Merck, Germany. The hydrochloric acid and liquid ammonia were purchased from Merck, India. The Reactive Green-19 dye was purchased from Sigma Aldrich.

2.2. Synthesis of CdO/TiO_2 nanoparticles

The nano-sized CdO-TiO_2 was formed by a simple sol-gel technique using cadmium acetate and TTIP as precursors of CdO and TiO2, respectively. The precursors of cadmium acetate and TTIP (1:1 mol %) were separately hydrolyzed at 80 °C in distilled water. The pH (acidic-3, basic-13) of both precursors were adjusted by using 0.1N each of HCl and liquid ammonia. Then, both precursor solutions were mixed and agitated for 10 minutes. Subsequently, 50 ml of distilled water was added to the mixture and stirred. After 30 minutes, the required pH of the overall reaction was again maintained, and vigorous agitation was carried out at 80°C for three hours. The obtained solution was dried in a hot air oven at 100 °C until completely dry. Calcination was performed at 450 °C for 180

Degradation of Tricyclazole fungicide using combined oxidation strategies based on ultrasound, ultraviolet irradiation and microwave

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The present study investigates the effect of using ultrasound (US), ultraviolet irradiation (UV), and microwave (MW) in different approaches also including the use of intensifying additives as H_2O_2 on the degradation of tricyclazole (TC). The performance of US (20 kHz) and MW have been maximized by the optimization of operating parameters. The maximum degradation of tricyclazole was observed at initial tricyclazole concentration as 10 mg/L, pH of 3, and optimum power dissipation for US as 100 W and that for MW as 490 W. The study into the effect of loading of H_2O_2 on the degradation of tricyclazole in US/H_2O_2 and UV/H_2O_2 confirmed the existence of optimal loading of H_2O_2 (TC:H_2O_2 as 1:5) yielding degradation of 83.93% and 40.27% respectively after 120 min whereas the optimum ratio for the approach of MW was TC:H_2O_2 as 1:7.5 yielding 90.23% degradation only after 60 min of operation. The approaches of US/UV/H_2O_2 and MW/UV/H_2O_2 resulted in the extent of degradation as 99.09% and 99.90% with the COD reduction as 89.06% and 92.7% respectively. The combined processes US/UV/ccc and MW/UV/H_2O_2 lead to the synergistic index of 3.27, and 4.88 respectively. The degradation of TC using different types of oxidation processes followed first-order rate kinetics. In summary, the combination of MW/UV/H_2O_2 is established as the best approach for the degradation of tricyclazole with significant benefits.

Publication:	Environmental Technology & Innovation, Volume 26, article id. 102533.
Pub Date:	May 2022
Bibcode:	2022EnvTI..2602533A
Keywords:	Tricyclazole; Ultrasound; Microwave; Photooxidation; Hydrogen peroxide; Combined treatment methods

Some Studies on Verifying the Applicability of Free Vibration-based Modes Shapes Method to Rectangular Shaped Cracks in a Cantilever Beam

U.Porto Journal of Engineering, 8:2 (2022) 82-94
ISSN 2183-6493
DOI: 10.24840/2183-6493_008.002_0007

Received: 31 October, 2021
Accepted: 3 January, 2022
Published: 28 April, 2022

Some Studies on Verifying the Applicability of Free Vibration-based Modes Shapes Method to Rectangular Shaped Cracks in a Cantilever Beam

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Abstract

Cracks weaken structures. When the crack size increases in service, the structure becomes weaker than its earlier condition. Lastly, the structure may break down due to a small crack. Therefore, crack detection and classification is a fundamental issue. Many aspects of defects have already been addressed, but the application of non-destructive testing methods to structural materials has become more widespread. For a long time, vibration methods based on Natural Frequency and Mode Shapes have been used for possible cracks detection in the beams. The impact of arbitrary and random defect geometry on applying these methods has been overlooked. This study focuses on a mode shapes-based vibration analysis of a cracked cantilever beam to investigate this issue. The effects of crack geometries on mode shapes are examined theoretically and numerically using a new crack model (Rectangular shaped crack), which differs from the well-known V-shaped crack. A MATLAB code is written to obtain the natural frequencies and mode shapes for all cracked instances of beams. The mode shapes result of both the new (Rectangular), and V-shaped models are compared, and it is found that the results are less sensitive to the geometry change.

Author Keywords. Natural Frequency, V-shaped Crack, Mode Shapes, MATLAB, ANSYS, Rectangular Shaped Crack.

Type: Research Article
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1. Introduction

Steel materials are employed in several structural applications in the civil, automotive, and aerospace industries. Steel beams are a typical use of steel in construction. The structures are designed to work safely for the remainder of their useful life. On the other hand, damage begins at the point where the structure breaks down. The crack affects the modal and physical properties of the beam, such as mode shapes, natural frequency, damping, and stiffness. As a result, the beam's dynamic reaction changes dramatically. It is necessary to regularly monitor the condition of beams or structures to avoid catastrophic collapse in applications. Free

Experimental and Numerical Investigation of a Cracked Cantilever Beam for Damping Factor to Access its Applicability in the Crack Detection

U.Porto Journal of Engineering, 8:2 (2022) 169-186
ISSN 2183-6493
DOI: 10.24840/2183-6493_008.002_0013

Received: 11 November, 2021
Accepted: 14 December, 2021
Published: 28 April, 2022

Experimental and Numerical Investigation of a Cracked Cantilever Beam for Damping Factor to Access its Applicability in the Crack Detection

V. Khalkar[1], S. G. Kumbhar[2], K. Logesh[3], P. Hariharasakhtisudhan[4], S. D. Jadhav[5], B. A. Danawade[6], S. H. Gharat[7], L. M. Jugulkar[8], J. G. Borade[9]

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Abstract

The cracks alter the physical and modal properties of the beam, i.e., stiffness, damping, natural frequency, and mode shapes, and, in turn, the dynamic response of the beam changes to a considerable extent. The condition monitoring of the beams is essential to avoid its catastrophic failure in applications. A basic criterion has been followed for modal parameters like natural frequencies, mode shapes, and stiffness for the possible crack detection. In contrast, damping as a dynamic property to represent structural damage has been limited due to the difficulties in measuring damping and analysis. Therefore, in this study, the effect of various possible crack profiles, i.e., V-shaped and U-shaped, on the applicability of using the damping criterion for determining the presence of damage in the cantilever structure was investigated. The damping loss factor for all the cracked cases of a cantilever beam was computed using ANSYS and experimental analysis. The numerical results of the damping loss factor were compared with experimental results. It was understood that the results were susceptible to the crack geometries changes.

Author Keywords. Effective Mass, Dewesoft FRF, Impact Hammer, V-shaped Crack, U-shaped Crack, Structural Health Monitoring, ANSYS, Torsional Stiffness, Resonant Amplitude.

Type: Research Article
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1. Introduction

A structural health monitoring system is generally designed to monitor, inspect and test the health and performance of structures such as beams, buildings, bridges, and dams, to ensure their safety. It mainly consists of two major components: the smart sensing technologies and the damage detection algorithms. The smart sensing technologies use fiber optic sensors, piezoelectric sensors, laser Doppler vibrometers, and accelerometers to monitor various