

Full Length Research Paper

## Production and characterization of activated carbon from a bituminous coal by chemical activation

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In this study, the use of a bituminous coal for the production of activated carbons with chemical activation was investigated. The effects of process variables such as chemical reagents, activation temperature, impregnation ratio and carbonization temperature were investigated to optimize these parameters. The resultant activated carbons were characterized in terms of iodine number, BET surface area, and total and micropore volumes. Acidic surface groups were established by Fourier Transmittance Infrared Spectroscopy (FTIR) technique.

**Key words:** Activated carbons, activation, BET surface area, Fourier Transmittance Infrared Spectroscopy (FTIR).

### INTRODUCTION

Activated carbon can be defined as carbonaceous material having high porosity and internal surface area and cannot be characterized by any distinctive chemical formula. Commercial production of activated carbon is performed by pyrolysis and activation of wood, petroleum coke, anthracite and bituminous coals which have high carbon contents. In addition, agricultural wastes and by-products, hulls of almonds, hazelnuts, and coconuts, and stones of olives, apricots and peaches are also used in activated carbon production (Arol and Yalcin, 1993; Bansal et al., 1988; Ottawa et al., 1997; Stavropoulos and Zabanlotu, 2005; Amaya et al., 2007; Solano et al., 2000; Robau-Sanchez et al., 2005; Evans et al., 1999; Zondio and Vetez, 2007; Dongel et al., 1998).

The problems of the ecosystem are increasing with developing technology. Heavy metal pollution is one of the main problems due to their toxicity to human life

(Badmus et al., 2007). Organic pollutants and phenol and its derivatives found in industrial waste waters and as a main components in plastics are considered to have toxic effects on human health even when present in small concentrations (Yener and Aksu, 1999; Qadeer and Akhtar, 2005; Qadeer and Rehan, 2002). Toxic metal compounds coming to the earth's surface not only reach the earth's waters (seas, ponds, lakes, and reservoirs), but can also contaminate underground water in trace amounts by leaking from the soil after rain and snow (Qadeer and Rehan, 2002; Uzun and Guzel, 2000). Therefore, the elimination of toxic metal compounds from water and waste water is important. Activated carbons, with their high porosity, are extensively used in industrial purification and chemical recovery operations (Tekel and Imamoglu, 1999; Lillo-Rodenas et al., 2005; Lozano-Castello et al., 2001). Currently, natural gas storage has been attracting interest among researchers in the materials and adsorption field. Microporous activated carbons were found to be suitable materials for natural gas storage (Azevedo et al., 2007). High surface area, high surface reactivity, suitable pore distribution and mechanical strength are the desired properties for an activated carbon. Depending on the usage, activated carbons are available as powder, granulated and pressed (laminated) sticks in various sizes and shapes (Arol and Yalcin, 1993).

Basically, there are two different processes for the preparation of activated carbon, the so-called physical

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**Abbreviations:** BET, Brunauer, Emmett and Teller (1938) method to measure specific surface area of solids according to physical adsorption of gas molecules on a solid surface,  $m^2/g$ ;  $V_{tot}$ , total pore volume,  $cm^3/g$ ;  $V_{mic}$ , micropore volume,  $cm^3/g$ ;  $V_{mes}$ , mesopore volume,  $cm^3/g$ ; TGA, thermal gravimetric analysis; TG, thermal gravimetry; DTG, derivative thermal gravimetry; and FTIR, Fourier Transform Infrared Spectrum Analysis.

# Production Of Activated Carbon And Characterization From

**Sebastian Brünink**



## **Production Of Activated Carbon And Characterization From:**

*Production, Characterization, and Applications of Activated Carbon* Eric Paul Leimkuehler, 2010 This thesis investigates the production of activated carbon an environmentally friendly adsorbent which is used in many industries Activated carbon can be derived from many different sources and produced in varying production processes The raw materials used activation process and process parameters determine the physical properties and performance characteristics of the resulting carbon Modifying these activation properties determines the porosity and pore volume distribution in the carbon In preparation for commercial production detailed mass balances are needed to quantify yield quantify the masses of waste streams understand the propensity to recycle the KOH and to provide a benchmark for further optimization A mass balance on the reaction of phosphoric acid and KOH with carbon is provided Additionally analyzing carbons can be expensive and time consuming making it important to identify physical properties which indicate that a carbon may have favorable performance characteristics The following paper proposes three ways of screening carbons observing the mass loss in the chemical activation process measuring the density of the carbon and testing the methane uptake of the carbon in a rapid uptake fixture Carbons made from different precursors reacted with different activating agents and heated at different process temperatures for different process hold times were analyzed

**Lignocellulosic Precursors Used in the Synthesis of Activated Carbon** Virginia Hernández Montoya, Adrian Bonilla-Petriciolet, 2012-02-29 The present book discusses the principal lignocellulosic precursors used in the elaboration of activated carbons in different countries such as Asia America Europe and Africa the different methods and experimental conditions employed in the synthesis of activated carbons including one analysis of the principal stages of the preparation such as carbonization and activation i e chemical or physical activation Also the recent and more specialized techniques used in the characterization of activated carbons are discussed in this book For example the techniques employed to determine textural parameters mercury porosimetry and gas adsorption isotherms at 77 K and different spectroscopies to determine chemical functionality Raman FT IR etc and other X Ray techniques Additionally an overview of the application of activated carbons obtained from lignocellulosic precursors for wastewater treatment Specifically the analysis and discussion are focused on the advantages and capabilities of activated carbons for the removal of relevant toxic compounds and pollutants from water such as heavy metals dyes phenol etc Finally the use of pyrolysis method for the valorization of two Mexican typical agricultural wastes orange peel and pecan nut shell for energy and carbon production is considered in this book

**Synthesis, Technology and Applications of Carbon Nanomaterials** Suraya Abdul Rashid, Raja Nor Izawati Raja Othman, Mohd Zobir Hussein, 2018-10-10 Synthesis Technology and Applications of Carbon Nanomaterials explores the chemical properties of different classes of carbon nanomaterials and their major applications As carbon nanomaterials are used for a variety of applications due to their versatile properties and characteristics this book discusses recent advances in synthesis methods characterization and applications of 0D 3D

dimensional carbon nanomaterials It is an essential resource for readers focusing on carbon nanomaterials research Explores the chemical properties of different classes of carbon nanomaterials and their major applications Discusses recent advances in synthesis methods characterization and applications of 0D 3D dimensional carbon nanomaterials The Production, Characterization, and Upgrading of Biochars Into Activated Carbon Kasey Johnston,2018 Raw Material Characterization and Production of Activated Carbon Quamie Nkrumah Kenyata Mortley,1988 **Environanotechnology** Maohong Fan,C.P. Huang,Alan E. Bland,Zhonglin Wang,Rachid Slimane,Ian G. Wright,2010-04-22 Understanding and utilizing the interactions between environment and nanoscale materials is a new way to resolve the increasingly challenging environmental issues we are facing and will continue to face Environanotechnology is the nanoscale technology developed for monitoring the quality of the environment treating water and wastewater as well as controlling air pollutants Therefore the applications of nanotechnology in environmental engineering have been of great interest to many fields and consequently a fair amount of research on the use of nanoscale materials for dealing with environmental issues has been conducted The aim of this book is to report on the results recently achieved in different countries It provides useful technological information for environmental scientists and will assist them in creating cost effective nanotechnologies to solve critical environmental problems including those associated with energy production Presents research results from a number of countries with various nanotechnologies in multidisciplinary environmental engineering fields Gives a solid introduction to the basic theories needed for understanding how environanotechnologies can be developed cost effectively and when they should be applied in a responsible manner Includes worked examples that put environmental problems in context to show the actual connections between nanotechnology and environmental engineering **Biomass and Bioenergy** Khalid Rehman Hakeem,Mohammad Jawaid,Umer Rashid,2014-08-25 Biomass obtained from agricultural residues or forest can be used to produce different materials and bioenergy required in a modern society As compared to other resources available biomass is one of the most common and widespread resources in the world Thus biomass has the potential to provide a renewable energy source both locally and across large areas of the world It is estimated that the total investment in the biomass sector between 2008 and 2021 will reach the large sum of 104 billion Presently bioenergy is the most important renewable energy option and will remain so the near and medium term future Previously several countries try to explore the utilization of biomass in bioenergy and composite sector Biomass has the potential to become the world s largest and most sustainable energy source and will be very much in demand Bioenergy is based on resources that can be utilized on a sustainable basis all around the world and can thus serve as an effective option for the provision of energy services In addition the benefits accrued go beyond energy provision creating unique opportunities for regional development The present book will provide an up to date account of non wood forest residues agricultural biomass natural fibers and energy crops together with processing properties and its applications to ensure biomass utilization and reuse All aspects of biomass and bioenergy and their

properties and applications will be critically re examined The book consists of three sections presenting Non wood and forest products from forestry arboriculture activities or from wood processing agricultural biomass natural fibers from agricultural harvesting or processing and finally energy crops high yield crops and grasses grown especially for energy production

7th International Symposium on High-Temperature Metallurgical Processing Jiann-Yang Hwang, Tao Jiang, P. Chris Pistorius, Gerardo R. F. Alvear F., Onuralp Yucel, Liyuan Cai, Baojun Zhao, Dean Gregurek, Varadarajan Seshadri, 2016-02-08 The technology operation energy environmental analysis and future development of the metallurgical industries utilizing high temperature processes are covered in the book The innovations on the extraction and production of ferrous and nonferrous metals alloys and refractory and ceramic materials the heating approaches and energy management and the treatment and utilizations of the wastes and by products are the topics of special interests This book focuses on the following issues High Efficiency New Metallurgical Process and Technology Fundamental Research of Metallurgical Process Alloys and Materials Preparation Direct Reduction and Smelting Reduction Coking New Energy and Environment Utilization of Solid Slag Wastes and Complex Ores Characterization of High Temperature Metallurgical Process Hybrid Nanomaterials for Sustainable Applications Janardhan Reddy Koduru, Rama Rao Karri, Nabisab Mujawar Mubarak, 2023-04-11 Hybrid Nanomaterials for Sustainable Applications Case Studies and Applications brings together the latest advances in hybrid nanocomposites and their diverse applications for improved sustainability The book begins by introducing hybrid nanomaterials synthesis strategies and approaches to production for engineering applications Subsequent sections provide chapters on key application areas including water purification nanobiotechnologies energy storage and biomedicine presenting approaches for sustainable application for each usage Throughout the book key challenges are addressed with case studies used to support implementation and improve end applications This is a valuable resource for researchers and advanced students in nanotechnology polymer science sustainable materials chemistry chemical engineering environmental science and materials engineering as well as industrial scientists engineers and R D professionals with an interest in hybrid nanomaterials for a range of applications Offers the latest techniques in the synthesis and preparation of hybrid nanomaterials Addresses challenges and uses case studies to support further development and implementation Opens the door to key sustainable applications across water purification nanobiotechnologies energy storage and biomedicine Handbook of Sustainable Development Through Green Engineering and Technology Vikram Bali, Rajni Mohana, Ahmed A. Elngar, Sunil Kumar Chawla, Gurpreet Singh, 2022-09-27 Green engineering involves the designing innovation and commercialization of products and processes which promote sustainability without eliminating both efficiency and economic viability This handbook focuses on sustainable development through green engineering and technology It is intended to address the applications and issues involved in their practical implementation A new range of renewable energy technologies modified to provide green engineering will be described in this handbook It will explore all green technologies required to provide green engineering

for the future These include but are not limited to green smart buildings fuel efficient transportation paperless offices and many more energy efficient measures Handbook of Sustainable Development through Green Engineering and Technology acts as a comprehensive reference book to use when identifying development for programs and sustainable initiatives within the current legislative framework It aims to be of great interest to researchers faculty members and students across the globe

*Preparation and Characterization of Activated Carbon from Raw Red Macroalgae and Bio Char from Macroalgae* Bouaik Hassan,2020 This article discusses the preparation and characterization of activated carbon by the combined method combination of two methods of chemical activation by ZnCl<sub>2</sub> and physical CO<sub>2</sub> leads to essentially microporous coals with specific BET specific surfaces which can exceed 800 m<sup>2</sup> g It is generally obtained by the BET method which is based on the adsorption capacity in vapor phase of nitrogen at 77 K and the steric hindrance of the N<sub>2</sub> molecule Microporous activated carbon prepared from Moroccan red macroalgae can be used as excellent carriers for adsorbing small molecules like heavy metals and other organic molecules like pesticides This work was devoted to the characterization of active carbon prepared from red macroalgae with H<sub>3</sub>PO<sub>4</sub> ZnCl<sub>2</sub> CO<sub>2</sub> H<sub>3</sub>PO<sub>4</sub> CO<sub>2</sub> ZnCl<sub>2</sub> by TFIR BET and SEM

*Encyclopedia of Green Materials* Chinnappan Baskar,Seeram Ramakrishna,Angela Daniela La Rosa,2024-12-26 Encyclopedia of Green Materials covers comprehensive overview recent research and development of Green Materials and Green Nanomaterials and their applications in all areas including electronics sensors textiles biomedical energy and energy storage building constructions and interiors design automotive green plastic manufacturing food packing membrane technology wastewater treatment rubber technology and tire manufacturing The contents focus on sustainable development renewable circular economy

Chemistry 4 0 Chemistry through innovation in transforming the world green chemistry and green engineering upcycling and recycling

Activated Carbon Jude Okolie,Alivia Mukherjee,2025-05-08 Activated Carbon Synthesis Analysis and Industrial Applications explores the fundamentals of activated carbon production and characterization modification techniques and applications of machine learning in the field of activated carbon synthesis and applications The book is divided into three parts to enable readers and researchers of all levels easy access to the information herein Part 1 is on Synthesis methods and characterization techniques The next six chapters on part 2 focus on diverse industrial applications of activated carbon The last section is on machine learning applications as well as research progress in activated carbon synthesis modification and diverse applications Written for researchers graduate and undergraduate students academics and industry professionals in the fields of sustainable environmental science and chemical engineering this book will be a welcomed reference for those who wish to better understand the role of activated carbon in solving sustainability challenges in the world related to energy shortage greenhouse gas emissions and environmental issues Offers useful information for industrial practitioners interested in the development of new biobased technology Opens up new research directions by listing knowledge gaps and future research prospects of activated carbon utilization

**Fossil Energy Update** ,1981 PRODUCTION AND

CHARACTERIZATION OF ACTIVATED CARBON FROM APRICOT STONES. ,2004 In this study characterization of activated carbon produced from apricot stones by chemical activation technique using phosphoric acid  $H_3PO_4$  as activating agent at relatively low temperatures 300 400 and 500oC was investigated To produce activated carbon acid impregnated samples were heated *The Dhaka University Journal of Science* ,1996 Application of Chemical Engineering Zhong Cao,Ying He He,Li Xian Sun,Xue Qiang Cao,2011-05-12 Selected peer reviewed papers from the 2011 International Conference on Chemical Engineering and Advanced Materials CEAM 2011 28 30 May 2011 *Preparation and Characterization of Activated Carbon...* Liza Ramli,1999 *Journal of Scientific & Industrial Research* ,2007 The Industrial Arts Index ,1930

The Top Books of the Year Production Of Activated Carbon And Characterization From The year 2023 has witnessed a remarkable surge in literary brilliance, with numerous captivating novels captivating the hearts of readers worldwide. Lets delve into the realm of popular books, exploring the engaging narratives that have captivated audiences this year. Production Of Activated Carbon And Characterization From : Colleen Hoovers "It Ends with Us" This touching tale of love, loss, and resilience has captivated readers with its raw and emotional exploration of domestic abuse. Hoover masterfully weaves a story of hope and healing, reminding us that even in the darkest of times, the human spirit can succeed. Production Of Activated Carbon And Characterization From : Taylor Jenkins Reids "The Seven Husbands of Evelyn Hugo" This captivating historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reids captivating storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery. Production Of Activated Carbon And Characterization From : Delia Owens "Where the Crawdads Sing" This mesmerizing coming-of-age story follows Kya Clark, a young woman who grows up alone in the marshes of North Carolina. Owens crafts a tale of resilience, survival, and the transformative power of nature, entrancing readers with its evocative prose and mesmerizing setting. These top-selling novels represent just a fraction of the literary treasures that have emerged in 2023. Whether you seek tales of romance, adventure, or personal growth, the world of literature offers an abundance of compelling stories waiting to be discovered. The novel begins with Richard Pape, a bright but troubled young man, arriving at Hampden College. Richard is immediately drawn to the group of students who call themselves the Classics Club. The club is led by Henry Winter, a brilliant and charismatic young man. Henry is obsessed with Greek mythology and philosophy, and he quickly draws Richard into his world. The other members of the Classics Club are equally as fascinating. Bunny Corcoran is a wealthy and spoiled young man who is always looking for a good time. Charles Tavis is a quiet and reserved young man who is deeply in love with Henry. Camilla Macaulay is a beautiful and intelligent young woman who is drawn to the power and danger of the Classics Club. The students are all deeply in love with Morrow, and they are willing to do anything to please him. Morrow is a complex and mysterious figure, and he seems to be manipulating the students for his own purposes. As the students become more involved with Morrow, they begin to commit increasingly dangerous acts. The Secret History is a masterful and thrilling novel that will keep you wondering until the very end. The novel is a cautionary tale about the dangers of obsession and the power of evil.

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