



Performance assessment of wastewater treatment plants with special reference to phenol removal

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Abstract

This study investigated the performance of five different wastewater treatment plants (WWTPs) in some rural areas in the Eastern Cape, South Africa, through an assessment of the physicochemical qualities of the effluents and their removal capacity for selected phenolic compounds. Water samples were collected on a monthly basis (February–July 2016), and temperature, pH, turbidity, total dissolved solids (TDS), total suspended solids (TSS), electrical conductivity (EC) and dissolved oxygen (DO) were measured *on-site* using standard methods. Phenolic compounds were determined using the solid-phase extraction technique followed by derivatization and gas chromatography–mass spectrometry analysis. Recorded temperatures for all the WWTPs effluents were 29–30 °C in summer, 20–27 °C in autumn and 12–17 °C in winter, and the pH was between 6.8 and 9.1. The treatment processes increased only the DO of the final effluents, while TDS, EC, turbidity and TSS were considerably reduced. Out of the nine phenolic compounds investigated, 2,4-dimethylphenol (2,4-DMP), 4-chloro-3-methylphenol (4-C-3MP), 2-nitrophenol (2-NP) and pentachlorophenol (PCP) were prominent in the influent (17.3–42.1 µg/L) and concentrations of phenolic compounds in the effluents and receiving water bodies were mostly below the tolerable limits allowed internationally for a safe aquatic environment. Generally, the WWTPs removal capacities range between 33 and 96%, however, South Africa standard limits for discharged effluents were occasionally exceeded especially with some WWTPs. This poses health challenges to rural communities that rely heavily on surface water for domestic use.

Keywords Final effluent · Phenolic compounds · Physicochemical parameters · Receiving water · Wastewater treatment plants

Introduction

Efficient wastewater treatment plants (WWTPs) are those that produce effluents that meet the desired standard criteria in chemical and biological quality at the minimum operational cost and maintenance (Sukumaran et al. 2015). The relative ease of removal of contaminants of health concern

such as pathogens, chemical waste including heavy metals in the WWTPs remained a strong yardstick for measuring the efficiency of WWTPs (Coskuner and Ozdemir 2006). In line with this, developing an integrated approach for assessing the efficiency of WWTPs is, therefore, a welcome idea in this direction (Sukumaran et al. 2015).

In South Africa for instance, many water quality studies conducted identified poor operation and maintenance of wastewater and sewage treatment facilities as contributors to pollution of surface water on which many rural communities depend for their domestic, agricultural and other purposes (Mema 2010). Consequently, this has impacted negatively on human health and the environment. Williams (2008) stated that the water quality of a combined sewer is dependent on the different lifestyles of the inhabitants of the area and the temporal flow pattern. Different disease outbreaks: diarrhea, typhoid fever, cholera, reported in some parts of the country (Delmas, Mpumalanga Province, KwaZulu-Natal, Limpopo Transkei and Eastern Cape), have led to the death of children

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Wastewater Treatment Technologies Mritunjay Chaubey, 2021-02-15 WASTEWATER TREATMENT TECHNOLOGIES Globally the practice of wastewater treatment before discharge is inconsistent The United Nations World Water Development Report 2017 estimated that globally over 80% of all wastewater is discharged without treatment The discharge of untreated or inadequately treated wastewater into the environment results in the pollution of surface water soil and groundwater According to the WHO water related diseases kill around 2.2 million people globally each year mostly children in developing countries We need to understand that wastewater is not merely a water management issue it affects the environment all living beings and can have direct impacts on economies The establishment of UN Sustainable Development Goal 6 Clean Water and Sanitation which aims to ensure availability and sustainable management of water and sanitation for all reflects the increased attention on water and wastewater treatment issues in the global political agenda Water reuse is one of the most efficient cost effective and eco friendly ways to ensure water resilience Embedding sustainability into wastewater treatment is the best opportunity for industries to drive smarter innovation and efficient wastewater treatment The modern concept of industrial wastewater treatment is moving away from conventional design Wastewater treatment technology is moving towards extreme modular design using smart and sustainable technology This book is intended as a reference book for all wastewater treatment professionals and operational personnel It may also be used as a textbook on graduate and postgraduate courses in the field of wastewater treatment and management The book takes a holistic view of the practical problems faced by industry and provides multiple needs based solutions to tackle wastewater treatment and management issues It elaborates on selection of technology and their design criteria for different types of wastewater This will enable engineering students and professionals to expand their horizons in the fields of wastewater treatment and management

WASTEWATER TREATMENT KARIA, G. L., CHRISTIAN, R.A., JARIWALA, NAMRATA D., 2023-11-01 This Third Edition of the book is thoroughly revised to present a detailed understanding of the principles of operation and design of domestic wastewater treatment plants The book opens up with clearly stating the basic concepts of treatment of wastewater and the design considerations required for an efficient treatment plant Thereafter the design criteria for domestic wastewater treatment units are discussed which forms the basis of sizing of the treatment plant units In essence the text is strengthened to give detailed procedures for design computations of all units of a wastewater treatment plant with many solved numericals Most common types of reactors used for physical operations and biological processes in wastewater treatment plants are also discussed in detail The present edition includes a new chapter on Biological Nutrient Removal covering the aspects of nitrification and denitrification This is now essentially legally required The book is intended for the undergraduate and postgraduate students of Civil and Environmental Engineering It will also be useful to the practising and consulting engineers involved in the design of wastewater treatment plant and municipal corporation and pollution control authorities

KEY FEATURES Provides several examples supported by graphs and sketches to highlight the various design concepts of wastewater treatment units Encapsulates significant theoretical and computational information and useful design hints in Note and Tip boxes Includes well graded practice exercises to help students develop the skills in designing treatment plants

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Advanced Design of Wastewater Treatment Plants: Emerging Research and Opportunities Hussain, Athar, Bhattacharya, Ayushman, 2019-05-31 With the advancement of new technologies existing wastewater treatment units need to be reexamined to make them more efficient and to release the load currently placed on them Thus there is an urgent need to develop and adopt the latest design methodology to determine and remove harmful impurities from water sources

Advanced Design of Wastewater Treatment Plants Emerging Research and Opportunities is a critical scholarly resource that explores the design of various units of wastewater treatment plants and treatment technologies that can produce reusable quality water from wastewater The book covers topics that include the basic philosophy of wastewater treatment designing principles of various wastewater treatment units conventional treatment systems and advanced treatment processes It is an integral reference source for engineers environmentalists waste authorities solid waste management companies landfill operators legislators researchers and academicians

Wastewater Engineering Ashok Kumar Gupta, Venkatesh Uddameri, Abhradeep Majumder, Shripad K. Nimbhorkar, 2023-07-24 *Wastewater Engineering Issues Trends and Solutions* explains current treatment scenarios of wastewater in different countries across the globe the characteristics of wastewater and rules and regulations associated with the treatment and disposal reuse of wastewater It covers the design and theory involving laying of sewerage network and different conventional and advanced treatment technologies employed to treat domestic wastewater It overviews different types of emerging contaminants and their properties ecological impacts detection quantification treatment technologies and circular economy

Features Gives an overview of current wastewater treatment scenarios across the world Provides insights into emerging contaminants sources procedure to sample available methods for analyses and possible treatments Reviews existing rules and regulations on wastewater engineering and standards for wastewater disposal or reuse Includes how to use wastewater as a resource in the context of circular economy Describes fundamentals of wastewater conveyance and treatment The book is aimed at graduate students and researchers in wastewater treatment water and environmental engineering

Application of Low Cost Ceramic Membranes in Wastewater Treatment Sibdas Bandyopadhyay, 2025-05-01 This book reviews the status of developing tailor made low cost membranes and membrane based separation processes for applications in wastewater treatment It also presents an overview of industry specific case studies upholding the waste to resource strategy for utilization of low cost ceramic membranes in industrial wastewater treatment This book highlights methods results and examples demonstrating that low cost ceramic membranes possess similar features and advantages comparable to the

commercially available ceramic membranes thereby minimizing the prohibitive cost of their usage in wastewater treatment. Thus the readers who are looking for more economical alternatives for wastewater treatment can be introduced with the cheaper membrane materials. It also discusses the selection and method of application of such membranes in the treatment processes. This book can serve as a valuable reference for researchers and professionals interested in wastewater treatment and allied fields.

Wastewater Treatment Plants Salah Souabi, Abdelkader Anouzla, Shalini Yadav, Vijay P. Singh, Ram Narayan Yadava, 2025-07-20. The book provides technical information on the operation of wastewater treatment plants and strategies to be adopted for the design of plants, assessment processes and technologies for wastewater treatment and reuse for irrigation and industry including protecting the environment. It discusses the crucial parts that science, technology and innovation play in formulating, implementing and administering wastewater treatment policy. It highlights the challenges that must be overcome to successfully adopt the wastewater treatment infrastructure regulations and provides some answers. It investigates how the operation of wastewater treatment plant technology can be used in a wide variety of fields apart from other on the shelf publications on the market. It also delves into the core concepts of the operation of wastewater treatment plants. It explores how these concepts can be modified to fit a variety of contexts and uses. Applications such as managing facilities dealing with pandemics, urban wastewater treatment and reuse, farming and other applications are included in this book. Consequently, this book's content is engaging and it will pique the interest of a diverse audience of readers who come from a wide variety of professional backgrounds. This book will be helpful to industrialists, researchers, entrepreneurs, professionals, planners, policymakers, environmental engineers and others interested in the operation of wastewater treatment system management strategies through the application of breakthroughs in the operation of wastewater treatment plants. The book constitutes a database that can help companies guide the choice of a treatment technique considering operating and investment costs. Similarly, the book presents several solutions to problems encountered during the operation of treatment plants, particularly the challenges encountered at the biological and physicochemical treatment levels. The book also illustrates some design and sizing methods and methods for good practice to organize the extension of a treatment plant if necessary properly. The book also deals with options for resource recovery and wastewater governance, thus establishing a clear link between the performance of a treatment plant and obtaining treated water that could be used for irrigation, which is often the missing link in current debates on the issue of making wastewater an asset. The chapters present experiences from developed and developing countries including case studies on design, eco efficiency and the circular economy applied to wastewater. The book presents advanced methods for evaluating advanced solutions with low investment and operating costs. In addition, the authors and co-authors are key international experts in the field of wastewater treatment.

Wastewater to Water Makarand M. Ghangrekar, 2022-11-21. This textbook offers a complete, comprehensive coverage of wastewater engineering from pollutant classification, design of collection systems and treatment systems including operational guidelines.

for the treatment plants Apart from the primary and conventional secondary wastewater treatment this book covers the details and design of advanced biological treatment systems such as sequencing batch reactor SBR up flow anaerobic sludge blanket UASB reactors and hybrid reactor with design examples and photographs of actual working reactors which is useful for students and practicing engineers This textbook is designed to provide complete solution for the wastewater engineering for easy reference to the users This textbook is an ideal reference for courses taught at the university undergraduate and postgraduate level in the field of civil environmental engineering chemical engineering water management and environmental science It should also appeal to practicing engineers in the wastewater engineering and effluent treatment plant designers

Wastewater Treatment and Reuse - Lessons Learned in Technological Developments and Management Issues, 2020-10-22 Wastewater Treatment and Reuse Lessons Learned in Technological Developments and Management Issues Volume 6 explores emerging and state of the art technologies Chapters cover Treatment options for the direct reuse of reclaimed water in developing countries Water reuse in India Current perspectives and future potential Water reuse practices solutions and trends at international Impact of the use of treated wastewater for agricultural need behavior of organic micropollutants in soil transfer to crops and related risks Environmental risks of sewage sludge reuse in agriculture Modeling tools for risk management in reclaimed wastewater reuse systems Focus on contaminants of emerging concern CECs and much more Covers a wide breadth of emerging and state of the art technologies Includes contributions from an international board of authors Provides a comprehensive set of reviews on wastewater treatments and reuse

Waste Management: Concepts, Methodologies, Tools, and Applications Management Association, Information Resources, 2019-12-06 As the world s population continues to grow and economic conditions continue to improve more solid and liquid waste is being generated by society Improper disposal methods can not only lead to harmful environmental impacts but can also negatively affect human health To prevent further harm to the world s ecosystems there is a dire need for sustainable waste management practices that will safeguard the environment for future generations Waste Management Concepts Methodologies Tools and Applications is a vital reference source that examines the management of different types of wastes and provides relevant theoretical frameworks about new waste management technologies for the control of air water and soil pollution Highlighting a range of topics such as contaminant removal landfill treatment and recycling this multi volume book is ideally designed for environmental engineers waste authorities solid waste management companies landfill operators legislators environmentalists policymakers government officials academicians researchers and students

Municipal Water and Waste Water Treatment Rakesh Kumar, R. N. Singh, 2006-01-01 Water is the earth s most ubiquitous and most effective dissolving agent playing a key role in human civilization A variety of natural and human factors affect the quality and use of surface and groundwater This course book simplifies the concepts of water and waste water treatment

Handbook of Water and Used Water Purification Josef Lahnsteiner, 2024-03-25 The book addresses the entire water

cycle The focus is on new technologies processes especially in high performance biological treatment energy recovery water recycling and reuse Recommendations with regard to the right technologies processes for specific situations are provided and a wide range of case studies especially in emerging markets In addition the most modern water terminology with more positive connotations is used This is especially important in the field of direct and indirect potable reuse DPR and IPR respectively

Solar Powered Wastewater Recycling Arun Kumar,Sandhya Prajapati,2023-07-14 The United Nations predicts that by the year 2025 two thirds of the world s population will face water scarcity Further the planet would have well over eight billion people the majority of whom would live in developing countries where more than 80% of those are already experiencing water scarcity Therefore there is an urgent need for wastewater recycling to help solve issues of scarcity and to facilitate better management of generated wastewater Water recycling includes reuse and treatment of municipal wastewater which could be a sustainable approach for environmental sustainability and could also help to offset the increasing water demands for irrigation and industrial and other needs Currently water and wastewater treatment facilities consume large amounts of energy that are mainly generated through the use of fossil fuels Solar Powered Wastewater Recycling examines how solar power can be implemented as an integrated approach whereby all the energy needs of the water and wastewater sector could be supplemented by renewable technologies and in which a synergy can be developed between water and energy

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