

Review

Nutrient Removal and Recovery from Municipal Wastewater

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Abstract: With the ongoing amendment of the EU legislation on the treatment of urban wastewater, stricter requirements for the removal of pollutants are expected, which calls for the need for innovative wastewater treatment technologies. Biological systems are still the first choice. A survey of typical bioreactors applied in wastewater treatment is presented. The wastewater treatment objective, biochemical environment, and microbial growth are selected as the main criteria for the classification of these bioreactors. Hydraulic and kinetic aspects are considered, along with the advantages and drawbacks of these bioreactors regarding the selection of the appropriate type of reactor; as well, details regarding the operation of reactors are mentioned. The aim of this paper is to provide operators and designers with a brief overview of the selected traditional and advanced processes, reactors, and technologies for nutrient removal from municipal wastewater. The possibilities and limitations in complying with more strict effluent standards are also discussed. Methods of nutrient recovery are added value. From the evaluation of the published papers, we determine that the currently applied traditional methods for nutrient removal have the potential to also convey the expected stricter limits.

Keywords: municipal wastewater; nutrient; removal; recovery; secondary; tertiary; treatment



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1. Introduction

Wastewater (WW) is essentially the water supply of a community from a variety of uses. From the point of origin, wastewater may be characterized as a combination of the liquid and solid waste removed mainly from residences, social and industrial institutions, and similar facilities together with groundwater and stormwater, depending on the type of sewer system. Domestic wastewater means wastewater from residential settlements and services that originates from the human metabolism and from household activities [1]. Municipal wastewater is water delivered to communities after various uses originating from domestic, industrial, commercial, and institutional sources within a given human settlement or community [2]. Urban wastewater includes both municipal wastewater and urban runoff. The accumulation of untreated wastewater can lead to the production of malodorous gases due to the decomposition of organic impurities. In addition, untreated wastewater usually contains numerous pathogenic or disease-causing microorganisms. It usually contains nutrients, which stimulate the growth of algae and other aquatic plants and consequently accelerate eutrophication. A high content of organic and ammonium impurities can lead to the excessive consumption of dissolved oxygen and undesirable changes in the aquatic life of the receiving water. Wastewater can also contain toxic compounds. It is therefore a necessity to treat wastewater before discharging it into the receiving water. Nitrogen and phosphorous are inevitable for the growth and vitality of living beings. However, the discharge of nutrient-rich wastewater into aquatic ecosystems leads to eutrophication. Thus, the effective removal of nutrients N and P from WW is a

Principles And Practice Of Nutrient Removal From Municipal Wastewater

**C. P. Leslie Grady Jr., Glen T.
Daigger, Nancy G. Love, Carlos D. M.
Filipe**

Principles And Practice Of Nutrient Removal From Municipal Wastewater:

Principles and Practice of Nutrient Removal from Municipal Wastewater Soap and Detergent Association, 1988

Phosphorus and Nitrogen Removal from Municipal Wastewater Richard I. Sedlak, 2018-04-27 This valuable new book offers practical guidance regarding the design and operation of systems for reducing effluent nitrogen and phosphorus. The principles of nitrogen and phosphorus removal are discussed including sources of nitrogen and phosphorus in wastewater, removal options, nitrogen and phosphorus transformations in treatment process, selection and treatment. The book also covers the design and operation of nitrogen and phosphorus removal systems including system options, system design, facility design, facility costs, and operation. Practical case studies are provided as examples of successful system implementations that may be able to help you decide what will work best in your plant.

Upgrading Wastewater Treatment Plants, Second Edition

Glen T. Daigger, 1998-06-09 FROM THE PREFACE In this time of dwindling budgets, increasing service needs, and increasing regulatory requirements, wastewater treatment professionals are continually called upon to upgrade their wastewater treatment plants. To do so efficiently and effectively, one must develop a clear approach to use in upgrading a plant and have the proper tools available to implement that approach. This book is meant to assist readers in developing and implementing their upgrading projects. First Chapter 1 details the upgrading approach. The tools to be used are presented in Chapters 2 through 6. Finally, in Chapter 7, six case histories are presented to illustrate the plant upgrading techniques presented in the previous chapters. Through this book, the authors hope to assist readers in meeting their upgrade requirements while making the most efficient use of the resources at hand.

Biological Wastewater Treatment, Revised and Expanded Carlos D.M. Filipe, C.P. Leslie Grady, Jr., 1998-10-15 Written by noted experts in the field sharing extensive academic and industrial experience, this thoroughly updated Second Edition covers commonly used and new suspended and attached growth reactors. The authors discuss combined carbon and ammonia oxidation, activated sludge, biological nutrient removal, aerobic digestion, anaerobic processes, lagoons, trickling filters, rotating biological contactors, fluidized beds, and biologically aerated filters. They integrate the principles of biochemical processes with applications in the real world, communicating approaches to the conception, design, operation, and optimization of biochemical unit operations in a comprehensive yet lucid manner.

Biological Wastewater Treatment C. P. Leslie Grady Jr., Glen T. Daigger, Nancy G. Love, Carlos D. M. Filipe, 2011-05-09 Following in the footsteps of previous highly successful and useful editions, *Biological Wastewater Treatment* Third Edition presents the theoretical principles and design procedures for biochemical operations used in wastewater treatment processes. It reflects important changes and advancements in the field such as a revised treatment of the microbiology and kinetics of nutrient removal and an update of the simulation of biological phosphorus removal with a more contemporary model. See what's new in the Third Edition: A chapter devoted to the description and simulation of anaerobic bioreactors. Coverage of applications of submerged attached growth bioreactors. Expanded discussion of modeling attached growth.

systems Increased information on the fate and effects of trace contaminants as they relate to xenobiotic organic chemicals A chapter on applying biochemical unit operations to design systems for greater sustainability The book describes named biochemical operations in terms of treatment objectives biochemical environment and reactor configuration introduces the format and notation used throughout the text and presents the basic stoichiometry and kinetics of microbial reactions that are key to quantitative descriptions of biochemical operations It then examines the stoichiometry and kinetics used to investigate the theoretical performance of biological reactors containing microorganisms suspended in the wastewater The authors apply this theory to the operations introduced taking care to highlight the practical constraints that ensure system functionality in the real world The authors focus on further biochemical operations in which microorganisms grow attached to solid surfaces adding complexity to the analysis even though the operations are often simpler in application They conclude with a look to the future introducing the fate and effects of xenobiotic and trace contaminants in wastewater treatment systems and examining how the application of biochemical operations can lead to a more sustainable world

Design and Retrofit of Wastewater Treatment Plants for Biological Nutrient Removal Clifford W. Randall, James Lang Barnard, H. David Stensel, 1998-05-06 This book presents information that can be used for the design and operation of wastewater treatment plants that utilize biological nutrient removal processes i e processes that utilize biological mechanisms instead of chemical mechanisms to remove phosphorus and nitrogen from wastewaters The book provides basic fundamentals concepts and theories design of prefermentation units various types of BNR systems and secondary clarifiers retrofitting conventional activated sludge plants modeling considerations and special considerations for BNR systems It includes full scale and pilot plant case histories design examples and retrofit of existing plants

Manual Nitrogen Control, 1993 Item no 0431 K

Environmental Engineering Richard O. Mines, Jr., 2014-03-04 Environmental Engineering Principles and Practice is written for advanced undergraduate and first semester graduate courses in the subject The text provides a clear and concise understanding of the major topic areas facing environmental professionals For each topic the theoretical principles are introduced followed by numerous examples illustrating the process design approach Practical methodical and functional this exciting new text provides knowledge and background as well as opportunities for application through problems and examples that facilitate understanding Students pursuing the civil and environmental engineering curriculum will find this book accessible and will benefit from the emphasis on practical application The text will also be of interest to students of chemical and mechanical engineering where several environmental concepts are of interest especially those on water and wastewater treatment air pollution and sustainability Practicing engineers will find this book a valuable resource since it covers the major environmental topics and provides numerous step by step examples to facilitate learning and problem solving Environmental Engineering Principles and Practice offers all the major topics with a focus upon a robust problem solving scheme introducing statistical analysis example problems with both US and SI units water and wastewater

design sustainability public health There is also a companion website with illustrations problems and solutions **Advanced Composite Materials for Wastewater Treatment** Norzita Ngadi, R.A. Ilyas, Nur Hafizah Ab Hamid, S.M.

Sapuan, 2025-05-08 Advanced Composite Materials for Wastewater Treatment presents the latest technological advancements in this important research field. This book explores recent advances in manufacturing fabrication and the introduction of functional groups such as tailored layered double hydroxide (LDH) based nanocomposites and three dimensional hierarchical nanostructures. Among several discussed composites, those that show maximum efficiency including graphene composites, bio based composites, alginate natural fiber rubber etc, biochar metal organic frameworks, geopolymers, nanocomposites and LDH are all discussed. This book is an essential reference resource for researchers, scientists and industrial professionals as well as postgraduate students, providing them with an in depth understanding of cutting edge developments in this field. It provides readers with an overview of the evolution of composites in water and wastewater treatment applications. Covers wastewater treatment processes using composite materials. Introduces different types of composite materials with an emphasis on performance related to wastewater treatment. Showcases valuable techniques in producing composite materials for wastewater treatment. **Sustainable Development of Water and Environment** Han-Yong Jeon, 2021-08-10 This book addresses the improvement and dissemination of knowledge on methods, policies and technologies for increasing the sustainability of development by decoupling growth from natural resources and replacing them with knowledge based economy, taking into account its economic, environmental and social pillars as well as methods for assessing and measuring sustainability of development regarding water and environment. This book gathers scholars and experts in related fields. All attendees from a vast range of companies, universities and government institutions acquire advanced technical knowledge and are introduced to new fields through discussions that focus on their own specialties as well as a variety of interdisciplinary areas. The authors hope most of scholars can find what they really need in this book.

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