

Practical consideration for design and optimization of the step feed process

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Abstract Based on the anoxic/oxic (A/O) step feed process, a modified University of Cape Town (UCT) step feed process was developed by adding an anaerobic zone and adjusting sludge return pipeline. Performance evaluation of these two types of processes was investigated by optimizing operational parameters, such as the anaerobic/anoxic/oxic volumes, internal recycle ratios, and sludge retention times, for removal of chemical oxygen demanding (COD), nitrogen, and phosphorus. Results showed high removal efficiencies of COD of $(85.0 \pm 1.7)\%$, ammonium of $(99.7 \pm 0.2)\%$, total nitrogen (TN) of $(85.5 \pm 1.7)\%$, phosphorus of $(95.1 \pm 3.3)\%$, as well as excellent sludge settleability with average sludge volume index of $(83.7 \pm 9.5) \text{ L} \cdot \text{mg}^{-1}$ in the modified UCT process. Moreover, $(61.5 \pm 6.0)\%$ of influent COD was efficiently involved in denitrification or phosphorus release process. As much as 35.3% of TN was eliminated through simultaneous nitrification and denitrification process in aerobic zones. In addition, the presence of denitrifying phosphorus accumulating organisms (DNPAOs), accounting for approximately 39.2% of PAOs, was also greatly beneficial to the nitrogen and phosphorus removal. Consequently, the modified UCT step feed process was more attractive for the wastewater treatment plant, because it had extremely competitive advantages such as higher nutrient removal efficiencies, lower energy and dosages consumption, excellent settling sludge and operational assurance.

Keywords step feed, anoxic/oxic (A/O), University of Cape Town (UCT), simultaneous nitrification and denitrification (SND), denitrifying phosphorus removal, biological nutrient removal (BNR)

1 Introduction

Increasingly stringent effluent pollutants (particularly nitrogen and phosphorus) in wastewater treatment plants (WWTPs) are controlled all around the world owing to the eutrophication of receiving waters. In China, the maximum nutrient concentrations in effluent of the first-A level discharge standard (GB 18918-2002) are definitely permitted as follows: ammonium (NH_4^+-N) $\leq 5 \text{ mg} \cdot \text{L}^{-1}$, total nitrogen (TN) $\leq 15 \text{ mg} \cdot \text{L}^{-1}$, total phosphorus (TP) $\leq 0.5 \text{ mg} \cdot \text{L}^{-1}$, and chemical oxygen demand (COD) $\leq 50 \text{ mg} \cdot \text{L}^{-1}$. Therefore, enhanced nitrogen and phosphorus removal should be specially considered for new WWTPs and a considerable number of existing WWTPs have to be retrofitted.

At present, biological treatment processes are relatively dominant over all other physical-chemical methods for municipal wastewater. The biological anaerobic/anoxic/oxic (A/A/O) process has been modified to improve the nutrients removal through sequencing the bioreactors of anaerobic, anoxic, and aerobic units in last decade. The nitrified liquor in the last anoxic unit must be introduced to anoxic units for denitrification, however, and external carbon sources are necessary to achieve higher TN removal [1,2]. All improvements seem to be at the expense of operational cost and accordingly the applications are limited. Consequently, an anoxic/oxic (A/O) step feed is developed without any extra dosages in terms of the conventional A/O process [3]. It consisted of several A/O stages in sequence and the influent was divided into several streams into each anoxic zones. In our preliminary study, the performance and optimization of A/O step feed process was investigated with the synthetic wastewater and municipal wastewater, respectively [4,5]. Chang et al. reported the substrates/nutrients were successfully consumed without recycling either nitrified effluent or external carbon source in A/O/A/O step feed process [6]. Larrea et al. studied the optimal efficient design and operational

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Practical Considerations for Adaptive Trial Design and Implementation Weili He, José Pinheiro, Olga M. Kuznetsova, 2014-10-15 This edited volume is a definitive text on adaptive clinical trial designs from creation and customization to utilization As this book covers the full spectrum of topics involved in the adaptive designs arena it will serve as a valuable reference for researchers working in industry government and academia The target audience is anyone involved in the planning and execution of clinical trials in particular statisticians clinicians pharmacometricians clinical operation specialists drug supply managers and infrastructure providers In spite of the increased efficiency of adaptive trials in saving costs and time ultimately getting drugs to patients sooner their adoption in clinical development is still relatively low One of the chief reasons is the higher complexity of adaptive design trials as compared to traditional trials Barriers to the use of clinical trials with adaptive features include the concerns about the integrity of study design and conduct the risk of regulatory non acceptance the need for an advanced infrastructure for complex randomization and clinical supply scenarios change management for process and behavior modifications extensive resource requirements for the planning and design of adaptive trials and the potential to relegate key decision makings to outside entities There have been limited publications that address these practical considerations and recommend best practices and solutions This book fills this publication gap providing guidance on practical considerations for adaptive trial design and implementation The book comprises three parts Part I focuses on practical considerations from a design perspective whereas Part II delineates practical considerations related to the implementation of adaptive trials Putting it all together Part III presents four illustrative case studies ranging from description and discussion of specific adaptive trial design considerations to the logistic and regulatory issues faced in trial implementation Bringing together the expertise of leading key opinion leaders from pharmaceutical industry academia and regulatory agencies this book provides a balanced and comprehensive coverage of practical considerations for adaptive trial design and implementation Design and Optimization of Thermal Systems, Third Edition Yogesh Jaluria, 2019-09-06 Design and Optimization of Thermal Systems Third Edition with MATLAB Applications provides systematic and efficient approaches to the design of thermal systems which are of interest in a wide range of applications It presents basic concepts and procedures for conceptual design problem formulation modeling simulation design evaluation achieving feasible design and optimization Emphasizing modeling and simulation with experimentation for physical insight and model validation the third edition covers the areas of material selection manufacturability economic aspects sensitivity genetic and gradient search methods knowledge based design methodology uncertainty and other aspects that arise in practical situations This edition features many new and revised examples and problems from diverse application areas and more extensive coverage of analysis and simulation with MATLAB **IUTAM Symposium Transsonicum IV** H. Sobieczky, 2003-11-30 Proceedings of the IUTAM Symposium held in G ttingen Germany 2 6 September 2002 *Design of Three-phase AC Power Electronics*

Converters Fei "Fred" Wang, Zheyu Zhang, Ruirui Chen, 2023-12-12 DESIGN OF THREE PHASE AC POWER ELECTRONICS CONVERTERS Comprehensive resource on design of power electronics converters for three phase AC applications Design of Three phase AC Power Electronics Converters contains a systematic discussion of the three phase AC converter design considering various electrical thermal and mechanical subsystems and functions Focusing on establishing converter components and subsystems models needed for the design the text demonstrates example designs for these subsystems and for the whole three phase AC converters considering interactions among subsystems The design methods apply to different applications and topologies The text presents the basics of the three phase AC converter its design and the goal and organization of the book focusing on the characteristics and models important to the converter design for components commonly used in three phase AC converters The authors present the design of subsystems including passive rectifiers inverters and active rectifiers electromagnetic interference EMI filters thermal management system control and auxiliaries mechanical system and application considerations and discuss design optimization which presents methodology to achieve optimal design results for three phase AC converters Specific sample topics covered in Design of Three phase AC Power Electronics Converters include Models and characteristics for devices most commonly used in three phase converters including conventional Si devices and emerging SiC and GaN devices Models and selection of various capacitors characteristics and design of magnetics using different types of magnetic cores with a focus on inductors Optimal three phase AC converter design including design and selection of devices AC line inductors DC bus capacitors EMI filters heatsinks and control The design considers both steady state and transient conditions Load and source impact converter design such as motors and grid condition impacts For researchers and graduate students in power electronics along with practicing engineers working in the area of three phase AC converters Design of Three phase AC Power Electronics Converters serves as an essential resource for the subject and may be used as a textbook or industry reference

Computational Fluid Dynamics Review 2010 M. M. Hafez, K?ichi ?shima, Dochan Kwak, 2010 This volume contains 25 review articles by experts which provide up to date information about the recent progress in computational fluid dynamics CFD Due to the multidisciplinary nature of CFD it is difficult to keep up with all the important developments in related areas CFD Review 2010 would therefore be useful to researchers by covering the state of the art in this fast developing field

Scientific and Technical Aerospace Reports ,1989 **Applied Mechanics Reviews** ,1997 **Energy Storage Systems** Birol Kilis, Sadik Kakaç, 2012-12-06 Proceedings of the NATO Advanced Study Institute esme Izmir Turkey 27 June 8 July 1988 *ASIC Design and Synthesis* Vaibbhav Taraate, 2021-01-06 This book describes simple to complex ASIC design practical scenarios using Verilog It builds a story from the basic fundamentals of ASIC designs to advanced RTL design concepts using Verilog Looking at current trends of miniaturization the contents provide practical information on the issues in ASIC design and synthesis using Synopsys DC and their solution The book explains how to write efficient RTL using

Verilog and how to improve design performance It also covers architecture design strategies multiple clock domain designs low power design techniques DFT pre layout STA and the overall ASIC design flow with case studies The contents of this book will be useful to practicing hardware engineers students and hobbyists looking to learn about ASIC design and synthesis

Tunnelling into a Sustainable Future - Methods and Technologies Fredrik Johansson, Anders Ansell, Daniel Johansson, Johan Funehag, Jenny Norrman, 2025-05-12 Tunnelling into a Sustainable Future Methods and Technologies contains the contributions presented at the ITA AITES World Tunnel Congress 2025 Stockholm Sweden 9 15 May 2025 The contributions cover a wide range of topics in the fields of tunnelling and underground engineering including 1 Innovating tunneling 2 Safety Underground 3 Use of underground space 4 Investigations and ground characterisation 5 Planning and design of underground space 6 Conventional tunnelling 7 Mechanised tunnelling 8 Complex geometries including shafts and ramps 9 Grouting and groundwater control 10 Instrumentation and monitoring 11 Operation inspection and maintenance 12 Contractual aspects financing and risk management 13 Impact from climate change Tunnelling into a Sustainable Future Methods and Technologies will serve as a valuable reference to all concerned with tunnelling and underground engineering including students researchers and engineers

Evolutionary Multi-Criterion Optimization Carlos M. Fonseca, Peter J. Fleming, Eckart Zitzler, Kalyanmoy Deb, Lothar Thiele, 2003-08-03 This book constitutes the refereed proceedings of the Second International Conference on Evolutionary Multi Criterion Optimization EMO 2003 held in Faro Portugal in April 2003 The 56 revised full papers presented were carefully reviewed and selected from a total of 100 submissions The papers are organized in topical sections on objective handling and problem decomposition algorithm improvements online adaptation problem construction performance analysis and comparison alternative methods implementation and applications

The John Zink Combustion Handbook Jr., Charles E. Baukal, 2001-03-27 Despite the length of time it has been around its importance and vast amounts of research combustion is still far from being completely understood Industrial applications of combustion add environmental cost and fuel consumption issues to its fundamental complexity and the process and power generation industries in particular present their o

Transcranial Direct Current Stimulation in Neuropsychiatric Disorders André Brunoni, Michael Nitsche, Colleen Loo, 2016-09-12 The aim of this book is to provide a comprehensive review of the use of Transcranial Direct Current Stimulation tDCS in different psychiatric conditions Here we review tDCS clinical studies employing different types of design from single session tDCS studies to randomized clinical trials as well as studies evaluating the impact of tDCS in neurophysiological behavioral and brain imaging outcomes Although the understanding about physiological foundations and effectiveness of clinical therapies of psychiatric diseases has been considerably increased during the last decades our knowledge is still limited and consequently psychiatric diseases are still a major burden to the individual patient and society Recently interest in pathological alterations of neuroplasticity in psychiatric diseases as a critical condition for development and amelioration of clinical symptoms increased caused by the fact that new

tools such as functional imaging and brain stimulation techniques do allow to monitor and modulate these phenomena in humans Especially non invasive brain stimulation techniques evolved as an attractive potential new therapeutic tool The interest in non invasive brain stimulation has grown exponentially in the past 25 years with the development of non pharmacological neuromodulatory techniques such as tDCS and repetitive transcranial magnetic stimulation rTMS TDCS although even newer than rTMS has attracted considerable attention in both basic and clinical research scenarios In the context of clinical research tDCS is being increasingly investigated as a novel treatment tool for several psychiatric disorders such as major depression schizophrenia and neurocognitive and substance abuse disorders Transcranial Direct Current Stimulation in Neuropsychiatric Disorders Clinical Principles and Management intends to serve as a practical guide on the field attracting the interest of psychiatrists neurologists and neuroscientists with little or no experience with tDCS as well as those with a background on tDCS who want to increase their knowledge in any particular psychiatric condition Advances in VLSI, Signal Processing and Wireless Communication Aniruddha Kanhe,Suresh Balanethiram,Pao-Ann Hsiung,Dushantha Nalin K. Jayakody,2025-08-26 This book presents select proceedings of the International Conference on Communication Systems ICOCs 2023 The book includes cutting edge research papers in the emerging fields of communication signal processing and VLSI The book is a unique collection of chapters from different areas with a common theme It benefits academic researchers and practitioners in the industry who work in this field *Advanced Polymeric Materials* Gabriel O. Shonaike,Suresh G. Advani,2003-04-14 Featuring contributions from experts at some of the world s leading academic and industrial institutions Advanced Polymeric Materials Structure Property Relationships brings into book form a wealth of information previously available primarily only within computer programs In a welcome narrative treatment it provides comprehensive coverage of p Energy Research Abstracts ,1991 Solar Energy Update ,1981 **Design Optimization of Active and Passive Structural Control Systems** Lagaros, Nikos D.,Plevris, Vagelis,Mitropoulou, Chara Ch,2012-08-31 A typical engineering task during the development of any system is among others to improve its performance in terms of cost and response Improvements can be achieved either by simply using design rules based on the experience or in an automated way by using optimization methods that lead to optimum designs Design Optimization of Active and Passive Structural Control Systems includes Earthquake Engineering and Tuned Mass Damper research topics into a volume taking advantage of the connecting link between them which is optimization This is a publication addressing the design optimization of active and passive control systems This title is perfect for engineers professionals professors and students alike providing cutting edge research and applications **Nuclear Science Abstracts** ,1974 **Structures and Architecture** Mario Rinke,Marie Frier Hvejsel,2025-06-23 Structures and Architecture REstructure REmaterialize REthink REuse contains the contributions to the 6th International Conference on Structures and Architecture ICSA 2025 Antwerp Belgium 8 11 July 2025 As a response to the pressing global climate and energy crisis and with new settings and tools the design and construction of

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