

# Guidelines for Using Activated Sludge Models

IWA Task Group on Good Modelling Practice

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Takayuki Ohtsuki, Andrew Shaw, Imre Takács and Stefan Winkler

# Guidelines For Using Activated Sludge Models Scientific Technical Report

**Guang-Hao Chen, Mark C.M. van  
Loosdrecht, G.A. Ekama, Damir  
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## **Guidelines For Using Activated Sludge Models Scientific Technical Report:**

Guidelines for Using Activated Sludge Models Leiv Rieger, Sylvie Gillot, Guenter Langergraber, Takayuki Ohtsuki, Andrew Shaw, Imre Takacs, Stefan Winkler, 2012-09-14 Mathematical modelling of activated sludge systems is used widely for plant design optimisation training controller design and research The quality of simulation studies varies depending on the project objectives finances and expertise available Consideration has to be given to the model accuracy and the amount of time required carrying out a simulation study to produce the desired accuracy Inconsistent approaches and insufficient documentation make quality assessment and comparison of simulation results difficult or almost impossible A general framework for the application of activated sludge models is needed in order to overcome these obstacles The genesis of the Good Modelling Practice GMP Task Group lies in a workshop held at the 4th IWA World Water Congress in Marrakech Morocco where members of research groups active in wastewater treatment modelling came together to develop plans to synthesize the best practices of modellers from all over the world The most cited protocols were included in the work amongst others from HSG Hochschulgruppe STOWA BIOMATH and WERF The goal of the group is to set up an internationally accepted framework to deal with the ASM type models in practice This framework shall make modelling more straightforward and systematic to use especially for practitioners and consultants Additionally it shall help to define quality levels for simulation results a procedure to assess this quality and to assist in the proper use of the models The framework will describe a methodology for goal oriented application of activated sludge models demonstrated by means of a concise guideline about the procedure of a simulation study and some illustrative case studies The case studies shall give examples for the required data quality and quantity and the effort for calibration validation with respect to a defined goal The final report will include an extended appendix with additional information and details of methodologies Additional features in Guidelines for Using Activated Sludge Models include a chapter on modelling industrial wastewater an overview on the history current practice and future of activated sludge modelling and several explanatory case studies It can be used as an introductory book to learn about Good Modelling Practice GMP in activated sludge modelling and will be of special interest for process engineers who have no prior knowledge of modelling or for lecturers who need a textbook for their students The STR can also be used as a modelling reference book and includes an extended appendix with additional information and details of methodologies Scientific and Technical Report No 22

**Applications of Activated Sludge Models** Damir Brdjanovic, S. C. F. Meijer, C. M. Lopez-Vazquez, C. M. Hooijmans, Mark C. M. van Loosdrecht, 2015-02-15 In 1982 the International Association on Water Pollution Research and Control IAWPRC as it was then called established a Task Group on Mathematical Modelling for Design and Operation of Activated Sludge Processes The aim of the Task Group was to create a common platform that could be used for the future development of models for COD and N removal with a minimum of complexity As the collaborative result of the work of several modelling groups the Activated Sludge Model No 1 ASM1 was

published in 1987 exactly 25 years ago The ASM1 can be considered as the reference model since this model triggered the general acceptance of wastewater treatment modelling first in the research community and later on also in practice ASM1 has become a reference for many scientific and practical projects and has been implemented in some cases with modifications in most of the commercial software available for modelling and simulation of plants for N removal The models have grown more complex over the years from ASM1 including N removal processes to ASM2 and its variations including P removal processes and ASM3 that corrects the deficiencies of ASM1 and is based on a metabolic approach to modelling So far ASM1 is the most widely applied Applications of Activated Sludge Models has been prepared in celebration of 25 years of ASM1 and in tribute to the activated sludge modelling pioneer the late Professor G v R Marraais It consists of a dozen of practical applications for ASM models to model development plant optimization extension upgrade retrofit and troubleshooting carried out by the members of the Delft modelling group over the last two decades

*Activated Sludge: Developments And Sustainable Solutions* Nicholas F Gray, 2023-02-27 Activated sludge is the most widely used biological wastewater treatment process globally to date although its high energy demand makes it a major contributor of greenhouse gas emissions Over recent decades it has been constantly modified and retrofitted to treat ever higher loads or improve effluent standards which have often resulted in even greater carbon emissions Conventional activated sludge treatment is at a crossroads where new sustainable solutions are required if we are to protect the quality of our rivers and meet net zero carbon targets The book details current operation and design with special emphasis on the biological aspects of the process From the microbial kinetics to the fascinating process of floc formation and development the book explores the development of our understanding of the process looking at new sustainable designs including biological nutrient removal and new aeration systems Sludge separation problems and control options are explained with a trouble shooting guide to non bulking problems Environmental issues including noise odor aerosols micro plastics and nanoparticles are all reviewed as is pathogen removal and the problem of antibiotic resistant genes and bacteria The development of membrane bioreactors has increased process reliability and effluent quality while integrated fixed film activated sludge processes are more efficient and compact The book concludes by exploring how activated sludge can become more sustainable for example by carbon harvesting and byproduct recovery This interdisciplinary book is essential reading for both engineers and scientists whether training at university or practitioners and consultants in the wastewater industry Related Link s

*Biological Wastewater Treatment: Principles, Modeling and Design* Guang-Hao Chen, Mark C.M. van Loosdrecht, G.A. Ekama, Damir Brdjanovic, 2020-07-15 The first edition of this book was published in 2008 and it went on to become IWA Publishing s bestseller Clearly there was a need for it because over the twenty years prior to 2008 the knowledge and understanding of wastewater treatment had advanced extensively and moved away from empirically based approaches to a fundamental first principles approach based on chemistry microbiology physical and bioprocess engineering mathematics and modelling However the quantity complexity

and diversity of these new developments was overwhelming for young water professionals particularly in developing countries without readily available access to advanced level tertiary education courses in wastewater treatment For a whole new generation of young scientists and engineers entering the wastewater treatment profession this book assembled and integrated the postgraduate course material of a dozen or so professors from research groups around the world who have made significant contributions to the advances in wastewater treatment This material had matured to the degree that it had been codified into mathematical models for simulation with computers The first edition of the book offered that upon completion of an in depth study of its contents the modern approach of modelling and simulation in wastewater treatment plant design and operation could be embraced with deeper insight advanced knowledge and greater confidence be it activated sludge biological nitrogen and phosphorus removal secondary settling tanks or biofilm systems However the advances and developments in wastewater treatment have accelerated over the past 12 years since publication of the first edition While all the chapters of the first edition have been updated to accommodate these advances and developments some such as granular sludge membrane bioreactors sulphur conversion based bioprocesses and biofilm reactors which were new in 2008 have matured into new industry approaches and are also now included in this second edition The target readership of this second edition remains the young water professionals who will still be active in the field of protecting our precious water resources long after the aging professors who are leading some of these advances have retired The authors all still active in the field are aware that cleaning dirty water has become more complex but that it is even more urgent now than 12 years ago and offer this second edition to help the young water professionals engage with the scientific and bioprocess engineering principles of wastewater treatment science and technology with deeper insight advanced knowledge and greater confidence built on stronger competence

**International Conference on Advanced Intelligent Systems for Sustainable Development** Janusz Kacprzyk, Mostafa Ezziyyani, Valentina Emilia Balas, 2023-06-11 This book describes the potential contributions of emerging technologies in different fields as well as the opportunities and challenges related to the integration of these technologies in the socio economic sector In this book many latest technologies are addressed particularly in the fields of computer science and engineering The expected scientific papers covered state of the art technologies theoretical concepts standards product implementation ongoing research projects and innovative applications of Sustainable Development This new technology highlights the guiding principle of innovation for harnessing frontier technologies and taking full profit from the current technological revolution to reduce gaps that hold back truly inclusive and sustainable development The fundamental and specific topics are Big Data Analytics Wireless sensors IoT Geospatial technology Engineering and Mechanization Modeling Tools Risk analytics and preventive systems

**Management and Mitigation of Acid Mine Drainage in South Africa** Munyaradzi Mujuru, S. Mutanga, 2016-12-29 South Africa is facing the increasing challenge of acid mine drainage AMD whose genesis is the country's mining history which paid limited attention

to post mining mine site management In mineral resource rich Africa this has emerged as one of the most daunting challenges of our time South Africa has been bold in its approach to mitigating this problem although the challenge is multi faceted On a positive note substantial research has been conducted to confront the challenge However thus far the research has been largely fragmented This book builds on the work that has been done but also provides a refreshing multi disciplinary approach that is useful in addressing the AMD challenges that South Africa and the continent face Whilst addressing the problem as a scientific and engineering challenge the book also exposes the economic policy and legal challenges involved in addressing the problem The book concludes quite uniquely that AMD is an opportunity that can be used by South Africa and Africa to solve problems such as acute water shortage as well as mineral recovery operations

**Process Modelling and Simulation** César de Prada,Constantinos Pantelides,José Luis Pitarch,2019-09-23 Since process models are nowadays ubiquitous in many applications the challenges and alternatives related to their development validation and efficient use have become more apparent In addition the massive amounts of both offline and online data available today open the door for new applications and solutions However transforming data into useful models and information in the context of the process industry or of bio systems requires specific approaches and considerations such as new modelling methodologies incorporating the complex stochastic hybrid and distributed nature of many processes in particular The same can be said about the tools and software environments used to describe code and solve such models for their further exploitation Going well beyond mere simulation tools these advanced tools offer a software suite built around the models facilitating tasks such as experiment design parameter estimation model initialization validation analysis size reduction discretization optimization distributed computation co simulation etc This Special Issue collects novel developments in these topics in order to address the challenges brought by the use of models in their different facets and to reflect state of the art developments in methods tools and industrial applications *Gas, Water and Solid Waste Treatment Technology* Zhien Zhang,Avelino Núñez-Delgado,Wenxiang Zhang,2021-09-01 This book introduces a variety of treatment technologies such as physical chemical and biological methods for the treatment of gas emissions wastewater and solid waste It provides a useful source of information for engineers and specialists as well as for undergraduate and postgraduate students in the areas of environmental science and engineering **Water Pollution XIV** S. Hernández,S.

Mambretti,2018-08-21 Water pollution problems are of continued importance around the world with an impact on both populated areas and the environment This volume consists of papers presented at the 14th International Conference in the series of Monitoring Modelling and Management of Water Pollution The environmental problems caused by the increase of pollutant loads discharged into natural water bodies requires the formation of a framework for regulation and control This framework needs to be based on scientific results that relate pollutant discharge with changes in water quality The results of these studies allow industry to apply more efficient methods of controlling and treating waste loads and water authorities to

enforce appropriate regulations regarding this matter Environmental problems are essentially interdisciplinary Engineers and scientists working in this field must be familiar with a wide range of issues including the physical processes of mixing and dilution chemical and biological processes mathematical modelling data acquisition and measurement to name but a few In view of the scarcity of available data it is important that experiences are shared on an international basis Thus a continuous exchange of information between scientists from different countries is essential Topics covered include Water contamination Monitoring modelling and forecasting Water management Wastewater management Groundwater and aquifers Flood damage Freshwater quality Coastal and offshore pollution Health risk studies Agricultural contamination Industrial pollution Water reuse Emerging technologies Socio economic political consequences Population and climate change Education and training

*Assessment of Treatment Plant Performance and Water Quality Data: A Guide for Students, Researchers and Practitioners* Marcos von Sperling ,Matthew E. Verbyla ,Silvia M.A.C Oliveira,2020-01-15 This book presents the basic principles for evaluating water quality and treatment plant performance in a clear innovative and didactic way using a combined approach that involves the interpretation of monitoring data associated with i the basic processes that take place in water bodies and in water and wastewater treatment plants and ii data management and statistical calculations to allow a deep interpretation of the data This book is problem oriented and works from practice to theory covering most of the information you will need such as a obtaining flow data and working with the concept of loading b organizing sampling programmes and measurements c connecting laboratory analysis to data management e using numerical and graphical methods for describing monitoring data descriptive statistics f understanding and reporting removal efficiencies g recognizing symmetry and asymmetry in monitoring data normal and log normal distributions h evaluating compliance with targets and regulatory standards for effluents and water bodies i making comparisons with the monitoring data tests of hypothesis j understanding the relationship between monitoring variables correlation and regression analysis k making water and mass balances l understanding the different loading rates applied to treatment units m learning the principles of reaction kinetics and reactor hydraulics and n performing calibration and verification of models The major concepts are illustrated by 92 fully worked out examples which are supported by 75 freely downloadable Excel spreadsheets Each chapter concludes with a checklist for your report If you are a student researcher or practitioner planning to use or already using treatment plant and water quality monitoring data then this book is for you 75 Excel spreadsheets are available to download

Design of Water Resource Recovery Facilities, Manual of Practice No.8, Sixth Edition Water Environment Federation,2017-09-29 Complete Coverage of the State of the Art in Water Resource Recovery Facility Design Featuring contributions from hundreds of wastewater engineering experts this fully updated guide presents the latest in facility planning configuration and design Design of Water Resource Recovery Facilities WEF Manual of Practice No 8 and ASCE Manuals and Reports on Engineering Practice No 76 Sixth Edition covers key technical advances in wastewater treatment

including Advances with membrane bioreactors applications Advancements within integrated fixed film activated sludge IFAS systems and moving bed biological reactors systems Biotrickling filtration for odor control Increased use of ballasted flocculation Enhanced nutrient control systems Sidestream nutrient removal to reduce the loading on the main nutrient removal process Use and application of wireless instrumentation Use and application of modeling wastewater treatment processes for the basis of design and evaluations of alternatives Process design and disinfection practices to minimize generation of TTHMs and other organics monitored for potable water quality Approaches to minimizing biosolids production and advances in biosolids handling including effective thermal hydrolysis and improvements in sludge thickening and dewatering technologies Increasing goals toward energy neutrality and driving net zero Trend toward resource recovery

*Frontiers in Wastewater Treatment and Modelling* Giorgio Mannina, 2017-05-04 This book describes the latest research advances innovations and applications in the field of water management and environmental engineering as presented by leading researchers engineers life scientists and practitioners from around the world at the Frontiers International Conference on Wastewater Treatment FICWTM held in Palermo Italy in May 2017 The topics covered are highly diverse and include the physical processes of mixing and dispersion biological developments and mathematical modeling such as computational fluid dynamics in wastewater MBBR and hybrid systems membrane bioreactors anaerobic digestion reduction of greenhouse gases from wastewater treatment plants and energy optimization The contributions amply demonstrate that the application of cost effective technologies for waste treatment and control is urgently needed so as to implement appropriate regulatory measures that ensure pollution prevention and remediation safeguard public health and preserve the environment The contributions were selected by means of a rigorous peer review process and highlight many exciting ideas that will spur novel research directions and foster multidisciplinary collaboration among different water specialists

Computational Intelligence Techniques for Bioprocess Modelling, Supervision and Control Maria Carmo Nicoletti, 2009-07-09 Computational Intelligence CI and Bioprocess are well established research areas which have much to offer each other Under the perspective of the CI area Bioprocess can be considered a vast application area with a growing number of complex and challenging tasks to be dealt with whose solutions can contribute to boosting the development of new intelligent techniques as well as to help the refinement and specialization of many of the already existing techniques Under the perspective of the Bioprocess area CI can be considered a useful repertoire of theories methods and techniques that can contribute and offer interesting alternative approaches for solving many of its problems particularly those hard to solve using conventional techniques Although throughout the past years CI and Bioprocess areas have accumulated substantial specific knowledge and progress has been quick and with a high degree of success we believe there is still a long way to go in order to use the potentialities of the available CI techniques and knowledge at their full extent as tools for supporting problem solving in bioprocesses One of the reasons is the fact that both areas have progressed steadily and have been continuously



accumulating and refining specific knowledge another reason is the high level of technical expertise demanded by each of them The acquisition of technical skills experience and good insights in either of the two areas is very demanding and a hard task to be accomplished by any professional

**CARE-S** Sveinung Saegrov,2006-03-31 CARE S presents the result of an extensive EU project Computer Aided Rehabilitation of Sewer and Storm Water Networks The projects developed a complete management system for sewer and storm water assets including methods and software It comprises methods and models for the three levels necessary of management namely the long term planning the project ranking and the technology selection The results of a comprehensive testing of CARE S in representative European cities are also included in the book Long term planning relies on state of the art description judgement of future service life and available measurements including CCTV This information is handled in tools for Performance Indicators network condition prediction and investment needs Project ranking is conducted by an elimination system and includes analysis by tools for structural condition hydraulic performance and customer requirements The system identifies projects that can be included within actual budget limits Selection of appropriate technologies relies on a comprehensive database for renovation and repair techniques and their properties applied into the conditions of the single projects The purpose of this book is to present a new generation management system of sewer and storm water assets Due to ageing systems and increasing demands to these networks and the complexity of systems and problems advanced management systems are necessary to secure an optimal use of limited resources for repair maintenance and renewal In the future management should be based on solid objective information given by computer programs and databases and judged by professional management engineers The market for modern urban water network management including software and consulting services is expected to increase substantially during the coming years This is the first book to consider a complete management system for sewer and storm water assets The book presents a system that will improve the cost effectiveness of sewer and storm water assets by at least 10% The book presents the methodology and software for modern maintenance and renewal of wastewater networks *Scientific and Technical Aerospace Reports* ,1983 Lists citations with abstracts for aerospace related reports obtained from world wide sources and announces documents that have recently been entered into the NASA Scientific and Technical Information Database Food Industry Wastes Maria R. Kosseva,C.A. Kent,2013-01-31 **Environmental Systems Analysis with MATLAB®** Stefano Marsili-Libelli,2018-09-03 Explore the inner workings of environmental processes using a mathematical approach Environmental Systems Analysis with MATLAB combines environmental science concepts and system theory with numerical techniques to provide a better understanding of how our environment works The book focuses on building mathematical models of environmental systems and using these models to analyze their behaviors Designed with the environmental professional in mind it offers a practical introduction to developing the skills required for managing environmental modeling and data handling The book follows a logical sequence from the basic steps of model building and data analysis to implementing these concepts into working

computer codes and then on to assessing their results It describes data processing rarely considered in environmental analysis outlines the tools needed to successfully analyze data and develop models and moves on to real world problems The author illustrates in the first four chapters the methodological aspects of environmental systems analysis and in subsequent chapters applies them to specific environmental concerns The accompanying software bundle is freely downloadable from the book web site It follows the chapters sequence and provides a hands on experience allowing the reader to reproduce the figures in the text and experiment by varying the problem setting A basic MATLAB literacy is required to get the most out of the software Ideal for coursework and self study this offering Deals with the basic concepts of environmental modeling and identification both from the mechanistic and the data driven viewpoint Provides a unifying methodological approach to deal with specific aspects of environmental modeling population dynamics flow systems and environmental microbiology Assesses the similarities and the differences of microbial processes in natural and man made environments Analyzes several aquatic ecosystems case studies Presents an application of an extended Streeter Phelps S P model Describes an ecological method to estimate the bioavailable nutrients in natural waters Considers a lagoon ecosystem from several viewpoints including modeling and management and more

**Wastewater Treatment Process Modeling, Second Edition (MOP31)** Water Environment Federation. Wastewater Treatment Process Modeling Task Force, 2014 Revised edition of An Introduction to process modeling for designers prepared by the Design of Municipal Wastewater Treatment Plants MOP 8 Task Force of the Water Environment Federation 2009

*Microbial Community Analysis* Thomas E. Cloete, N. Y. O. Muyima, 1997-01-01

Microbial Community Analysis surveys the vast amount of theoretical and practical knowledge on the design of biological treatment systems It describes the different types of biological wastewater systems the role of microbial diversity in these systems and how this affects design and operation methods for studying microbial community dynamics and mathematical modelling of these systems Contents Biological methods for the treatment of wastewaters Biodiversity and microbial interactions in the biodegradation of organic compounds Microbial population dynamics in biological wastewater treatment plants Molecular techniques for determining microbial community structures in activated sludge Principles in the modelling of biological wastewater treatment plants Practical considerations for the design of biological wastewater treatment systems Scientific and Technical Report No 5

**Handbook of Ecological Models used in Ecosystem and Environmental Management** Sven Erik Jorgensen, 2016-04-19 It is estimated that roughly 1000 new ecological and environmental models join the ranks of the scientific literature each year The international peer reviewed literature reports some 20 000 new models spanning the period from 1970 2010 Just to keep abreast of the field it is necessary to design a handbook of models that doesn't merely list them

Guidelines For Using Activated Sludge Models Scientific Technical Report: Bestsellers in 2023 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 fascinating narratives that have captivated audiences this year.

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Guidelines For Using Activated Sludge Models Scientific Technical Report : Taylor Jenkins Reid's "The Seven Husbands of Evelyn Hugo" This intriguing historical fiction novel unravels the life of Evelyn Hugo, a Hollywood icon who defies expectations and societal norms to pursue her dreams. Reid's captivating storytelling and compelling characters transport readers to a bygone era, immersing them in a world of glamour, ambition, and self-discovery.

Discover the Magic : 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 spins a tale of resilience, survival, and the transformative power of nature, captivating readers with its evocative prose and mesmerizing setting.

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The novel begins with Richard Pappen, 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 brilliant and suspenseful novel that will keep you guessing until the very end. The novel is a warning tale about the dangers of obsession and the power of evil.

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