



## FILMTEC Membranes

### Water Chemistry and Pretreatment: Silica Scale Prevention

#### Silica Scale Prevention

Dissolved silica ( $\text{SiO}_2$ ) is naturally present in most feed waters in the range of 1–100 mg/L. The prevailing forms of silica are meta silicic acids as  $(\text{H}_2\text{SiO}_3)_n$  with low  $n$  numbers. Since silicic acid is a weak acid, it is mostly in the undissociated form at or below a neutral pH. Supersaturated silicic acid can further polymerize to form insoluble colloidal silica or silica gel, which can cause membrane scaling. The maximum allowable  $\text{SiO}_2$  concentration in the concentrate stream is based on the solubility of  $\text{SiO}_2$ .

The scaling potential for the concentrate stream will be quite different from that of the feed solution because of the increase in the concentration of  $\text{SiO}_2$  and the change in pH. It can be calculated from the feed water analysis and the RO operating parameters.

As the pH exceeds neutral, silicic acid dissociates into the silicate anion ( $\text{SiO}_3^{2-}$ ). This can react with calcium, magnesium, iron, manganese or aluminum to form insoluble silicates.

It was indicated that aluminum is the most powerful precipitant of silicic acid /12/, and the occurrence of silica scaling is mostly correlated with the occurrence of aluminum or iron /13/. It has been reported that, when  $\text{Al}^{3+}$  and  $\text{Fe}^{3+}$  coexist in the pretreated feed water, silica is precipitated even below its saturation /14, 15/. Both  $\text{Al}^{3+}$  and  $\text{Fe}^{3+}$ , therefore, must be less than 0.05 mg/L in the feed water, even if the silica level is below saturation. Since  $\text{Al}^{3+}$  and  $\text{Fe}^{3+}$  salts are used for coagulation in municipal and other industrial water processing, frequent and accurate measurements of these ions are needed even though the feed water itself does not contain high levels of aluminum and iron ions. Fouling with metal silicates may occur from a chemical reaction and precipitation process (scaling), and also from colloidal fouling with submicron particles entering the membrane system. Feed water acidification and preventive acid cleanings are possible measures in cases of a metal silica scaling potential. If colloidal silica and silicates are present in the feed water, a flocculation/filtration process and/or a fine grade prefilter (1  $\mu\text{m}$  or less) should be chosen.

The scaling potential of soluble silica (silicic acid) in the absence of trivalent metal cations can be calculated as follows. The calculation requires the following data for the feed solution (after acid addition, if acid is used for control of calcium carbonate):

- $\text{SiO}_2$  concentration
- Temperature
- pH
- Total alkalinity

#### Calculation /16/

1. The  $\text{SiO}_2$  concentration in the concentrate stream is calculated from the  $\text{SiO}_2$  concentration in the feed solution and the recovery of the reverse osmosis system:

$$\text{SiO}_{2,c} = \text{SiO}_{2,f} \left( \frac{1}{1-Y} \right)$$

where:

$\text{SiO}_{2,c}$  = silica concentration in concentrate as  $\text{SiO}_2$ , mg/L

$\text{SiO}_{2,f}$  = silica concentration in feed as  $\text{SiO}_2$ , mg/L

$Y$  = recovery of the reverse osmosis system, expressed as a decimal

2. Calculate the pH of the concentrate stream from the pH of the feed stream using the procedure given in [Calcium Carbonate Scale Prevention \(Section 2.4.2\)](#).

# Tech Manual Excerpt Dow

**Concepción Jiménez-González, David J.  
C. Constable**

## **Tech Manual Excerpt Dow:**

*Technical Manual* United States. War Department, 1943      **Desalination** National Research Council, Division on Earth and Life Studies, Water Science and Technology Board, Committee on Advancing Desalination Technology, 2008-09-14 There has been an exponential increase in desalination capacity both globally and nationally since 1960 fueled in part by growing concern for local water scarcity and made possible to a great extent by a major federal investment for desalination research and development Traditional sources of supply are increasingly expensive unavailable or controversial but desalination technology offers the potential to substantially reduce water scarcity by converting the almost inexhaustible supply of seawater and the apparently vast quantities of brackish groundwater into new sources of freshwater Desalination assesses the state of the art in relevant desalination technologies and factors such as cost and implementation challenges It also describes reasonable long term goals for advancing desalination technology posits recommendations for action and research estimates the funding necessary to support the proposed research agenda and identifies appropriate roles for governmental and nongovernmental entities      **Water Management** Iqbal M. Mujtaba, Thokozani Majozi, Mutiu Kolade Amosa, 2018-11-05 Exponential growth in population and improved standards of living demand increasing amount of freshwater and are putting serious strain on the quantity of naturally available freshwater worldwide Water Management Social and Technological Perspectives discusses developments in energy efficient water production management wastewater treatment and social and political aspects related to water management and re use of treated water It features a scientific and technological perspective to meeting current and future needs discussing such technologies as membrane separation using reverse osmosis the use of nanoparticles for adsorption of impurities from wastewater and the use of thermal methods for desalination The book also discusses increasing the efficiency of water usage in industrial agricultural and domestic applications to ensure a sustainable system of water production usage and recycling With 30 chapters authored by internationally renowned experts this work offers readers a comprehensive view of both social and technological outlooks to help solve this global issue      *Desalination Sustainability* Hassan Arafat, 2017-06-09 Desalination Sustainability A Technical Socioeconomic and Environmental Approach presents a technical socioeconomic and environmental approach that guides researchers and technology developers on how to quantify the energy efficiency of a proposed desalination process using thermodynamics based tools The book offers the technical reader an understanding of the issues related to desalination sustainability For example technology users such as public utility managers will gain the ability and tools to assess whether or not desalination is a good choice for a city or country Readers will learn new insights on a clear and practical methodology on how to probe the economic feasibility of desalination using simple and effective tools such as levelized cost of water LCOW calculation Decision makers will find this book to be a valuable resource for the preliminary assessment of whether renewable powered desalination is a good choice for their particular setting Presents the issues related to desalination

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understanding of the various facets of desalination      **Pharmaceutical Water** William V. Collentro, 2016-04-19 A major new work on all aspects of water the most used raw material ingredient in the pharmaceutical and biotechnology industries used as an excipient in pharmaceutical formulations as a cleaning agent and as a separately packaged product diluent Drawing on the author's extensive field experience with more than 400 pharmaceutical and related water      Development of Predictive Tools for Membrane Ageing Pierre LeClech, 2014-03-15 This study increases our current understanding on the degradation ageing mechanisms occurring on porous membranes used in the water and wastewater industries Accelerated membrane degradation was obtained through both static and consecutive ageing protocols on the pilot scale and a range of carefully selected characterisation and analytical techniques was used to characterise the nascent changes faced by the membrane material The report covers four interrelated sections Critical assessment of characterisation techniques Static accelerated ageing Consecutive accelerated ageing Consecutive ageing of industrially aged membranes This final report summarises the aims objectives outcomes and limitations of the individual work packages along with some recommendations for future work This book is co published with Water Research Australia      **Green and Sustainable Chemistry and Engineering** Concepción Jiménez-González, David J. C. Constable, 2025-07-02 The first textbook to fully integrate Green and Sustainable Chemistry and Engineering now in its second edition Green and Sustainable Chemistry and Engineering addresses key concepts and processes from an industrial and manufacturing perspective Using an integrated systems oriented approach this invaluable single volume resource bridges the divide between chemistry process design and engineering as well as environment health safety and life cycle considerations This revised new edition discusses trends in chemical processing that can lead to more sustainable practices explores new methods in the design of greener chemical synthesis addresses sustainability challenges and implementation issues and more Up to date examples and new practical exercises based on the broad experience of the authors in applied and fundamental research corporate consulting and education are incorporated throughout the text Designed to advance green chemistry and green engineering as disciplines in the broader context of sustainability Green and Sustainable Chemistry and Engineering Illustrates the role of green and sustainable chemistry and engineering in the adoption of sustainable practices Describes the components of chemistry supporting the design of sustainable chemical reactions and reaction pathways Presents an approach to materials selection promoting the sustainability of chemical synthesis without diminishing efficiency Highlights key concepts that support the design of more sustainable chemical processes Provides background and context for placing a particular chemical process in the broader chemical enterprise Includes access to a companion website with a solutions manual and supplementary resources Green and Sustainable Chemistry and Engineering A Practical Design Approach Second Edition remains an ideal textbook for graduate and senior level courses in Chemistry and Chemical Engineering and an invaluable reference for chemists and engineers in manufacturing and R D especially those working in fine chemicals and pharmaceuticals      *Green Chemistry and*

*Engineering* Concepción Jiménez-González, David J. C. Constable, 2011-04-12 The past present and future of green chemistry and green engineering From college campuses to corporations the past decade witnessed a rapidly growing interest in understanding sustainable chemistry and engineering *Green Chemistry and Engineering A Practical Design Approach* integrates the two disciplines into a single study tool for students and a practical guide for working chemists and engineers In *Green Chemistry and Engineering* the authors each highly experienced in implementing green chemistry and engineering programs in industrial settings provide the bottom line thinking required to not only bring sustainable chemistry and engineering closer together but to also move business towards more sustainable practices and products Detailing an integrated systems oriented approach that bridges both chemical syntheses and manufacturing processes this invaluable reference covers Green chemistry and green engineering in the movement towards sustainability Designing greener safer chemical synthesis Designing greener safer chemical manufacturing processes Looking beyond current processes to a lifecycle thinking perspective Trends in chemical processing that may lead to more sustainable practices The authors also provide real world examples and exercises to promote further thought and discussion The EPA defines green chemistry as the design of chemical products and processes that reduce or eliminate the use or generation of hazardous substances Green engineering is described as the design commercialization and use of products and processes that are feasible and economical while minimizing both the generation of pollution at the source and the risk to human health and the environment While there is no shortage of books on either discipline *Green Chemistry and Engineering* is the first to truly integrate the two

*Technical Communication* Michael H. Markel, Mike Markel, 2012-01-04 This volume provides students with accessible and easy to follow strategies for tackling the major types of documents from writing reports to job applications Interactive exercises are included to provide engaging scenarios for writing practice LEED v4 AP O+M MOCK EXAM Gang Chen, 2017-08-01 Pass the LEED AP O M Exam Get Your Building LEED Certified Fight Global Warming and Save Money The USGBC released LEED v4 in GreenBuild International Conference and Expo in November 2013 The GBCI started to include the new LEED v4 content for all LEED exams in June 2014 We have incorporated the new LEED v4 content in this book LEED Leadership in Energy and Environmental Design is one of the most important trends in development and is revolutionizing the construction industry It has gained tremendous momentum and has a profound impact on our environment From this book you will be able to 1 Identify your weakness through practice questions 2 Learn to work well under the pressure of timed tests 3 Check your responses against the solutions 4 Understand the solutions for the difficult questions through the explanations 5 Fully understand the scope difficulty level and format of the LEED AP O M Exam 6 Learn how to pass the LEED AP O M Exam There is NO official GBCI book on the LEED AP O M Exam LEED v4 AP O M Mock Exams fills in the blanks and demystifies LEED The book includes 200 questions and simulates the real exam in every aspect including scope difficulty level format and number of questions in each LEED category It includes questions answers and explanations This

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Coffey,2009-01-23 The FileMaker Pro 10 desktop database lets you do almost anything with the information you give it especially with this book as your guide Clear thorough and accessible FileMaker Pro 10 The Missing Manual helps you get in build your database and get the results you need whether you re running a business pursuing a hobby or planning your retirement It s the ideal guide for non technical and experienced folks alike Each chapter in this fully updated edition covers the latest timesaving features of FileMaker Pro 10 including saved finds and a redesigned toolbar that reveals information and features more clearly than ever You ll learn how to import information from the new Bento consumer database Mac only write scripts to make your database even easier to use and send email without leaving FileMaker With this book you will Get your first database running in minutes and perform basic tasks right away Catalog people processes and things with streamlined data entry and sorting tools Use your data to generate reports correspondence and other documents with ease Create connect and manage multiple tables and set up complex relationships that display just the data you need Crunch numbers search text or pin down dates and times with dozens of built in formulas Outfit your database for the Web and import and export data to other formats You ll also get objective advice on which features are really useful and which aren t To make the most of this database you need FileMaker Pro 10 The Missing Manual the book that should have been in the box

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