

An Advanced Process Analysis System for Improving Chemical and Refinery Processes

Abstract

An advanced process analysis system has been developed to perform comprehensive evaluations on chemical plants and refineries for process improvements. The system integrates programs for on-line optimization, chemical reactor analysis, flowsheeting, pinch analysis and pollution indices. These programs are used interactively and share plant data through a database. Results from applying the system to a Monsanto/IMC Agrico contact process for sulfuric acid include an increased profit, reduced emissions and improvements in the chemical reactors and heat exchanger network which demonstrates the applicability of the system for pollution prevention.

Keywords: on-line optimization, chemical reactor analysis, pinch analysis, pollution index

Introduction

An advanced process analysis system has been developed which is to be used by process and plant engineers to develop innovative and economically viable ways to optimize and modify processes significantly beyond their current capabilities. With this system, process engineers interactively and simultaneously use programs for on-line optimization, chemical reactor analysis, flowsheeting, pinch analysis and pollution indices. The results can be process modifications and controls that reduce wastes and energy consumption, in addition to increased profit and improved efficiency of operations.

An overview diagram of the advanced process analysis system is given in Fig. 1, and referring to this figure, the chemical reactor analysis program (Saleh, Hopper and Walker, 1995) evaluates modifications to have the best chemical reactor type and operating conditions. The flowsheeting program and the EPA pollution index methodology (Cabezas, et al, 1997) identifies pollutants and determines modifications to have the best configuration for separations equipment. The pinch analysis program, THEN, (Knopf, 1993) evaluates modifications to integrate the network of heat exchangers,

are shared by each program. The database structure is shown in Fig. 2.

The program has been developed with industrial and academic collaboration using the Monsanto designed, IMC-Agrico sulfuric acid contact plant. Support has been provided by EPA, and the program will be available through the EPA Technical Assistance Tools program. In the following paragraphs, a brief description will be given of the programs used in the system, and results of applying the program to the IMC Agrico plant will demonstrate the system's capabilities.

Flowsheeting

Process flowsheet development is through an interactive Windows interface. A detailed description is provided in the users manual (Telang, 1998). As the process flow diagram is

Chemical Process Analysis

**Richard Turton, Richard C.
Bailie, Wallace B. Whiting, Joseph A.
Shaeiwitz**

Chemical Process Analysis:

Chemical Process Analysis William L. Luyben, Leonard A. Wenzel, 1988 **Analysis and Synthesis of Chemical Process Systems** K. Hartmann, K. Kaplick, 2016-10-06

The methods used by chemists and chemical engineers for the conception design and operation of chemical process systems have undergone significant changes in the last 10 years. The most important of modern computer aided techniques are process analysis and process system synthesis both of which are closely related. The first part of the book presents the principles of model building simulation and model application. On the basis of an appropriate set of hierarchical levels of chemical systems the general strategy of analysis by deterministic and statistical methods is treated. The second part deals with process system synthesis beginning with reaction path analysis. One of the major features of this part are new methods for the synthesis of reactor networks separation sequences heat exchanger systems and entire chemical process systems by a combined procedure of heuristic rules and fuzzy set algorithms. This procedure which is known as knowledge engineering is an efficient combination of human creativity and theoretically based knowledge. This book which is illustrated by examples should prove extremely useful as a text for a senior graduate course for students of chemistry and chemical engineering and will also be invaluable for chemists and chemical engineers in research and industry and specialists dealing with the analysis and synthesis of process systems.

Process Analysis and Simulation in Chemical Engineering Iván Darío Gil Chaves, Javier Ricardo Guevara López, José Luis García Zapata, Alexander Leguizamón Robayo, Gerardo Rodríguez Niño, 2015-11-27

This book offers a comprehensive coverage of process simulation and flowsheeting useful for undergraduate students of Chemical Engineering and Process Engineering as theoretical and practical support in Process Design Process Simulation Process Engineering Plant Design and Process Control courses. The main concepts related to process simulation and application tools are presented and discussed in the framework of typical problems found in engineering design. The topics presented in the chapters are organized in an inductive way starting from the more simplistic simulations up to some complex problems.

Process Analysis and Design for Chemical Engineers William Resnick, 1981 *Chemical Process Analysis and Design Using Computers* Working Party on the Use of Computers in Chemical Engineering. Symposium, 1982 *Analysis, Synthesis and Design of Chemical Processes* Richard Turton, Richard C. Bailie, Wallace B. Whiting, Joseph A. Shaeiwitz, 2008-12-24

The Leading Integrated Chemical Process Design Guide Now with New Problems New Projects and More More than ever effective design is the focal point of sound chemical engineering. Analysis Synthesis and Design of Chemical Processes Third Edition presents design as a creative process that integrates both the big picture and the small details and knows which to stress when and why. Realistic from start to finish this book moves readers beyond classroom exercises into open ended real world process problem solving. The authors introduce integrated techniques for every facet of the discipline from finance to operations new plant design to existing process optimization. This fully updated Third Edition presents entirely new problems at the end of every chapter. It also adds extensive coverage of

batch process design including realistic examples of equipment sizing for batch sequencing batch scheduling for multi product plants improving production via intermediate storage and parallel equipment and new optimization techniques specifically for batch processes Coverage includes Conceptualizing and analyzing chemical processes flow diagrams tracing process conditions and more Chemical process economics analyzing capital and manufacturing costs and predicting or assessing profitability Synthesizing and optimizing chemical processing experience based principles BFD PFD simulations and more Analyzing process performance via I O models performance curves and other tools Process troubleshooting and debottlenecking Chemical engineering design and society ethics professionalism health safety and new green engineering techniques Participating successfully in chemical engineering design teams Analysis Synthesis and Design of Chemical Processes Third Edition draws on nearly 35 years of innovative chemical engineering instruction at West Virginia University It includes suggested curricula for both single semester and year long design courses case studies and design projects with practical applications and appendixes with current equipment cost data and preliminary design information for eleven chemical processes including seven brand new to this edition

Introduction to Chemical Processes: Principles, Analysis, Synthesis Regina M. Murphy, 2007 Loaded with intriguing pedagogy this text is essential to a student's first course in Chemical Engineering

Industrial Chemical Process Analysis and Design Mariano Martín Martín, 2025-12-08 Industrial Chemical Process Analysis and Design Second Edition uses chemical engineering principles to explain the transformation of basic raw materials into major chemical products The book discusses traditional processes to create products like nitric acid sulphuric acid ammonia and methanol as well as more novel products like bioethanol and biodiesel In addition to providing full code and datasets for download detailed discussion of advanced technology this edition also contains three new chapters Firstly covering polymers including H and L D PE PMMA PC biobased and full analysis of each including full code for modelling across popular software Secondly evaluating phosphoric acid production and fertilizers and Finally the third new chapter focuses on blast furnaces outlining not only the traditional technologies using C as reducing agent but also analysis of novel technologies using hydrogen This book will be a comprehensive guide to students and academics working with the latest techniques in process optimization at graduate level and above including some upper undergraduate researchers This book will also be very valuable for academics looking to teach or lecture in chemical process engineering This book will also be a very useful resource for anyone within the process industry to introduce the analysis of novel technologies as well as the modelling examples including recent software such as python gProms or even Excel or Matlab to solve reactor modelling and units operation but also process simulators applied to typical chemical processes Integrates principles of chemical engineering unit operations and chemical reactor engineering to understand process synthesis and analysis Includes historical perspectives and traces the improving efficiencies of commercially important chemical production processes Provides a systematic analysis of the processes building on thermodynamics kinetics mass and energy balances

reactor engineering and unit operations Details different software packages to solve the examples from general purpose ones such as EXCEL or new ones like Python to specialized ones such as process simulators CHEMCAD or gProms Features worked examples and end of chapter problems with solutions to show the application of concepts discussed in the text

Risk Analysis and Reduction in the Chemical Process Industry J.M. Santamaría Ramiro, P.A. Braña Aísa, 2012-12-06
Concern for the environment has become one of the big issues in modern society and one of the chief concerns is the environmental impact of modern industrial production A particularly sensitive issue is the possibility of accidents in industries where there may be severe consequences for people property and the environment At one time the nuclear industry was seen as the most likely to be the cause of significant environmental damage but after the occurrence of several major accidents such as Seveso Flixborough and Bhopal that concern extends to much of the chemicals industry Pressure from society reflected by strong legislation coupled with a greater understanding of the impact that chemical processing operations can have has led to the adoption of higher profile safety and environmental management programs within the chemical industry Under these programmes existing and new processes are rigorously examined to determine the possible causes and consequences of failure and the results used to improve the process to make failure less likely Any process audit aimed at improving safety or lessening the environmental impact cannot be carried out using intuition or experience alone so the discipline of risk analysis has grown as a collection of tools and methods which can be utilized to give a quantitative assessment of the risks involved in operating any given process In this new book the authors present risk analysis and reduction in a clear and unified way emphasizing the various different methods which can be used together in a global approach to risk analysis in the chemical process industries Originally conceived as a text book for graduate level courses in chemical engineering the clear presentation and thorough coverage will ensure that anyone involved in risk assessment environmental impact assessment or safety planning will find this book an invaluable source of reference

Analysis, Synthesis, and Design of Chemical Processes Richard Turton, 2012 Process design is the focal point of chemical engineering practice the creative activity through which engineers continuously improve facility operations to create products that enhance life Effective chemical engineering design requires students to integrate a broad spectrum of knowledge and intellectual skills so they can analyze both the big picture and minute details and know when to focus on each Through three previous editions this book has established itself as the leading resource for students seeking to apply what they ve learned in real world open ended process problems The authors help students hone and synthesize their design skills through expert coverage of preliminary equipment sizing flowsheet optimization economic evaluation operation and control simulation and other key topics This new Fourth Edition is extensively updated to reflect new technologies simulation techniques and process control strategies and to include new pedagogical features including concise summaries and end of chapter lists of skills and knowledge Pub desc

Chemical Process Analysis David Mautner Himmelblau, Kenneth B.

Bischoff,1965 *Guidelines for Chemical Process Quantitative Risk Analysis* CCPS (Center for Chemical Process Safety),1999-10-15 Chemical process quantitative risk analysis CPQRA as applied to the CPI was first fully described in the first edition of this CCPS Guidelines book This second edition is packed with information reflecting advances in this evolving methodology and includes worked examples on a CD ROM CPQRA is used to identify incident scenarios and evaluate their risk by defining the probability of failure the various consequences and the potential impact of those consequences It is an invaluable methodology to evaluate these when qualitative analysis cannot provide adequate understanding and when more information is needed for risk management This technique provides a means to evaluate acute hazards and alternative risk reduction strategies and identify areas for cost effective risk reduction There are no simple answers when complex issues are concerned but CPQRA2 offers a cogent well illustrated guide to applying these risk analysis techniques particularly to risk control studies Special Details Includes CD ROM with example problems worked using Excel and Quattro Pro For use with Windows 95 98 and NT

Analysis, Synthesis, and Design of Chemical Processes, Fifth Edition Richard Bailie C.. Wallace Whiting B.. Joseph Shaeiwitz A.. Richard Turton. Debangsu Bhattacharyya,2018 **Chemical Process Engineering Volume 1** Rahmat Sotudeh-Gharebagh,A. Kayode Coker,2022-05-03 Written by two of the most prolific and respected chemical engineers in the world this groundbreaking two volume set is the new standard in the industry offering engineers and students alike the most up to date comprehensive and state of the art coverage of processes and best practices in the field today This first new volume in a two volume set explores and describes integrating new tools for engineering education and practice for better utilization of the existing knowledge on process design Useful not only for students professors scientists and practitioners especially process chemical mechanical and metallurgical engineers it is also a valuable reference for other engineers consultants technicians and scientists concerned about various aspects of industrial design The text can be considered as a complementary text to process design for senior and graduate students as well as a hands on reference work or refresher for engineers at entry level The contents of the book can also be taught in intensive workshops in the oil gas petrochemical biochemical and process industries The book provides a detailed description and hands on experience on process design in chemical engineering and it is an integrated text that focuses on practical design with new tools such as Excel spreadsheets and UniSim simulation software Written by two industry and university s most trustworthy and well known authors this book is the new standard in chemical biochemical pharmaceutical petrochemical and petroleum refining Covering design analysis simulation integration and perhaps most importantly the practical application of Microsoft Excel UniSim software this is the most comprehensive and up to date coverage of all of the latest developments in the industry It is a must have for any engineer or student s library

Chemical Processes: Design, Synthesis and Analysis Rose Torres,2021-10-19 A chemical process is a method used to change the composition of one or more chemicals or materials In a chemical process one or several chemical unit operations may be involved These may

include oxidation reduction hydrolysis dehydration alkylation esterification polymerization nitrification catalysis etc Process design chemical synthesis and chemical analysis are central to chemical engineering and chemical processes While chemical synthesis involves the selection of compounds and reactions to synthesize a product process design determines the sequencing of units for the desired transformation of a material Chemical analysis is concerned with the identification separation and quantification of matter The objective of this book is to give a general view of the different aspects of chemical processes and their significance It includes some of the vital pieces of work being conducted across the world on various topics related to process design chemical synthesis and chemical analysis The topics covered in this book offer the readers new insights in the field of chemical engineering

Process Analysis, Design, and Intensification in Microfluidics and Chemical Engineering Harrson Silva Santana, João Lameu da Silva Jr, Silva Júnior Silva Jr., Osvaldir Pereira Taranto, 2019 Microfluidics represent great potential for chemical processes design development optimization and chemical engineering bolsters the project design of industrial processes often found in large chemical plants Together microfluidics and chemical engineering can lead to a more complete and comprehensive process Process Analysis Design and Intensification in Microfluidics and Chemical Engineering provides emerging research exploring the theoretical and practical aspects of microfluidics and its application in chemical engineering with the intention of building pathways for new processes and product developments in industrial areas Featuring coverage on a broad range of topics such as design techniques hydrodynamics and numerical modelling this book is ideally designed for engineers chemists microfluidics and chemical engineering companies academicians researchers and students

Evaluating Process Safety in the Chemical Industry J. S. Arendt, D. K. Lorenzo, A. F. Lusby, 1989

Encyclopedia of Chemical Processing and Design John J. McKetta Jr, 1980-01-01 Written by engineers for engineers with over 150 International Editorial Advisory Board members this highly lauded resource provides up to the minute information on the chemical processes methods practices products and standards in the chemical and related industries

Analysis, Synthesis, and Design of Chemical Processes Richard Turton, 2009

Chemical Process Design Alexandre C. Dimian, Costin Sorin Bildea, 2008-04-09 This practical how to do book deals with the design of sustainable chemical processes by means of systematic methods aided by computer simulation Ample case studies illustrate generic creative issues as well as the efficient use of simulation techniques with each one standing for an important issue taken from practice The didactic approach guides readers from basic knowledge to mastering complex flow sheets starting with chemistry and thermodynamics via process synthesis efficient use of energy and waste minimization right up to plant wide control and process dynamics The simulation results are compared with flow sheets and performance indices of actual industrial licensed processes while the complete input data for all the case studies is also provided allowing readers to reproduce the results with their own simulators For everyone interested in the design of innovative chemical processes

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