

Chapter 4 – Material Balances

Note: Be sure to read carefully through all the examples in this chapter. The key concepts are best learned by problem solving.

Material balances: material balances express the constraint of conservation of mass, as applied to a process.

Batch process: In a batch process, raw materials are fed into the process at the outset. The process then runs for some length of time, producing product, but no product is removed, and no additional raw materials are input (but energy may be input or withdrawn), while the process runs. At the end, the product is removed. The bottom line is that no mass enters or leaves while the process is running.

Continuous process: In this type of process, raw materials continuously enter and product continuously leaves the process.

Semibatch process: A semibatch process does not fall fully under either “batch” or “continuous” classification.

Steady-state operation: Under steady-state, the values of all variables associated with the process do not change with time. That is, at any given location in the process, the values of temperature, pressure, composition, flow rates, etc. are independent of time. Even though a process may be steady state, it is important to realize that temperature, flow rates, or other variables may, and typically do, change from one *location* to another (e.g. from one process stream to another).

Transient or unsteady-state operation: If some process variables change with time, then the process is transient. A process must be either steady-state or transient.

Batch and semibatch processes must be transient. Continuous processes may be transient or steady-state.

Example: How would you classify the following processes?

- i). a soda can is opened and goes flat with time.
- ii). hot and cold water flows come together and mix to deliver a continuous, constant temperature output water flow
- iii). A car engine burns fuel at a constant rate. What else must be true for the engine to be operating at steady-state?

Chapter 4 Material Balances Note

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Basic Principles and Calculations in Chemical Engineering David M. Himmelblau, James B. Riggs, 2022-07-27 The 1 Guide to Chemical Engineering Principles Techniques Calculations and Applications Revised Streamlined and Modernized with New Examples Basic Principles and Calculations in Chemical Engineering Ninth Edition has been thoroughly revised streamlined and updated to reflect sweeping changes in the chemical engineering field This introductory guide addresses the full scope of contemporary chemical petroleum and environmental engineering applications and contains extensive new coverage and examples related to biotech nanotech green environmental engineering and process safety with many new MATLAB and Python problems throughout Authors David M Himmelblau and James B Riggs offer a strong foundation of skills and knowledge for successful study and practice guiding students through formulating and solving material and energy balance problems as well as describing gases liquids and vapors Throughout they introduce efficient consistent learner friendly ways to solve problems analyze data and gain a conceptual application based understanding of modern processes This edition condenses coverage from previous editions to serve today s students and faculty more efficiently In two entirely new chapters the authors provide a comprehensive introduction to dynamic material and energy balances as well as psychrometric charts Modular chapters designed to support introductory courses of any length Introductions to unit conversions basis selection and process measurements Strategies for solving diverse material and energy balance problems including material balances with chemical reaction and for multi unit processes and energy balances with reaction Clear introductions to key concepts ranging from stoichiometry to enthalpy Coverage of ideal real gases multi phase equilibria unsteady state material humidity psychrometric charts and more Self assessment questions to help readers identify areas they don t fully understand Thought discussion and homework problems in every chapter New biotech bioengineering nanotechnology green environmental engineering and process safety coverage Relevant new MATLAB and Python homework problems and projects Extensive tables charts and glossaries in each chapter Reference appendices presenting atomic weights and numbers Pitzer Z 0 Z 1 factors heats of formation and combustion and more Easier than ever to use this book is the definitive practical introduction for students license candidates practicing engineers and scientists Supplemental Online Content available with book registration Three additional chapters on Heats of Solution and Mixing Liquids and Gases in Equilibrium with Solids and Solving Material and Energy Balances with Process Simulators Flowsheeting Codes Nine additional appendices Physical Properties of Various Organic and Inorganic Substances Heat Capacity Equations Vapor Pressures Heats of Solution and Dilution Enthalpy Concentration Data Thermodynamic Charts Physical Properties of Petroleum Fractions Solution of Sets of Equations Fitting Functions to Data Register your book for convenient access to downloads updates and or corrections as they become available See inside book for details *GATE Notes - Chemical Engineering* Mocktime Publication, GATE Notes Chemical Engineering Gate Exam Pattern Gate syllabus Gate Previous

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Chemical Engineering Design Gavin Towler, Ray Sinnott, 2007-11-26 Bottom line For a holistic view of chemical engineering design this book provides as much if not more than any other book available on the topic Extract from Chemical Engineering Resources review Chemical Engineering Design is one of the best known and widely adopted texts available for students of chemical engineering It deals with the application of chemical engineering principles to the design of chemical processes and equipment Revised throughout this US edition has been specifically developed for the US market It covers the latest aspects of process design operations safety loss prevention and equipment selection among others Comprehensive in coverage exhaustive in detail it is supported by extensive problems and a separate solutions manual for adopting tutors and lecturers In addition the book is widely used by professions as a day to day reference Provides students with a text of unmatched relevance for the Senior Design Course and Introductory Chemical Engineering Courses Teaches commercial engineering tools for simulation and costing Comprehensive coverage of unit operations design and economics Strong emphasis on HS E issues codes and standards including API ASME and ISA design codes and ANSI standards 108 realistic commercial design projects from diverse industries **Electrochemical Engineering** Thomas F. Fuller, John N. Harb, 2018-02-15 A Comprehensive Reference for Electrochemical Engineering Theory and Application From chemical and

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Notes on Chemical Reactor Analysis (Ch.E. 131, 132) Rutherford Aris,1961 *The Annotated Revised Statutes of the State of Ohio* Ohio,1905 **The Annotated Revised Statutes of the State of Ohio** Oberlin Historical and Improvement Organization,Ohio,Clement Bates,1906 *Engineering Magazine* ,1913 **Factory and Industrial Management** John Robertson Dunlap,Arthur Van Vlissingen,John M. Carmody,1913 **Industrial Management** John R. Dunlap,1913 **Notes on Machine Design** Charles Henry Benjamin,1895 **Elementary Principles of Chemical Processes** Richard M. Felder,Ronald W. Rousseau,2000 CD ROM contains Index of learning styles Instructional tutorials Visual encyclopedia of chemical engineering equipment E Z Solve Physical Properties database

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