

## Air and Water Pollution Prevention and Control Engineering

### Homework # 2

#### Answers to Selected Problems

1.- At the following link: <http://www.cwp.rpi.edu/~ernesto/F2013/AWPPCE/AdditionalReadings/Silva2013-ERL-APMortality.pdf> you will find a recent journal article reporting research on mortality associated with air pollution. Read the paper carefully through and create a ~ 250 word critical essay relating the contents of the paper to the notion of NAAQS.

Answer: Individual student answers.

2.- The 1-hour NAAQS for carbon monoxide is 40 mg/m<sup>3</sup>. Convert this to ppm at standard temperature y pressure.

Answer:  $C = 40 \text{ mg/m}^3 = 0.04 \text{ g/m}^3$ , dividing by  $M_{CO} = 28 \text{ g/mol}$  yields  $c = C/M = 0.00142 \text{ mol/m}^3$ . From the ideal gas law, the volume of 1 mol of air is  $V = RT/p = 8.3144 (298.15)/101,325 = 0.0244 \text{ m}^3$  and the number of mols in 1 m<sup>3</sup> of air is  $1/V = 40.87 \text{ mol/m}^3$ . The concentration in ppm is then  $(0.00142/40.87) \times 10^6 = 34.7 \text{ ppm}$ .

3.- A solid waste incinerator emits particulate matter at the NSPS rate of 0.18 g/dscm. The incinerator burns 50 metric tons per day and exhausts gases at a ratio of 20 kg per kg of feed at atmospheric pressure and 453 K. Assume that the average molecular weight of the emitted gases is 30 and that they contain 12% CO<sub>2</sub> and 10% H<sub>2</sub>O. What is the daily emission rate of particulate matter?

Answer: Note that dscm stands for "dry standard cubic meter". To obtain "standard cubic meter" of gas must multiply 0.18 by 0.9. To obtain the m<sup>3</sup> at the not standard temperature of 453, must multiply by (298/453). This yields the particulate emission concentration as:  $0.18 (0.9)(298/453) = 0.1065 \text{ g/m}^3$ .

From the ideal gas law, the volume of 1 mol of exhaust gas is  $V = RT/p = 8.3144 (453)/101,325 = 0.037 \text{ m}^3/\text{mol}$  and the volume per g is  $0.037/30 = 0.00123 \text{ m}^3/\text{g}$  and the number of m<sup>3</sup> of exhaust gas produced per day is obtained as  $(0.00123)(50 \times 10^6)(20) = 1.230 \times 10^6 \text{ m}^3/\text{d}$ . Therefore the amount of particulate matter emitted per day is  $= 0.1065(1.230 \times 10^6) = 131,350 \text{ g/d}$ .

4.- Methanol (CH<sub>3</sub>OH) is burned in dry air at an equivalence ratio of 0.75.

(a) Determine the fuel-air mass ratio.

(b) Determine the composition of the combustion products.

Answer: The simplified combustion reaction of methanol with oxygen is

# Pollution Prevention Homework And Design Problems For Engineering Curricula

**Donald L. Wise**



## **Pollution Prevention Homework And Design Problems For Engineering Curricula:**

**Reaction Engineering for Pollution Prevention** R.P. Hesketh, Martin A. Abraham, 2000-02-09 This book defines environmental reaction engineering principles including reactor design for the development of processes that provide an environmental benefit With regard to pollution prevention the focus is primarily on new reaction and reactor technologies that minimize the production of undesirable side products pollutants but the use of reaction engineering as a means of treating wastes that are produced through other means is also considered First is a section on environmentally benign combustion The three papers discuss methods of reducing the formation of PAHs and NO<sub>x</sub> as well as other environmentally sensitive combustion products The next section contains a collection of contributions that involve the use of a catalyst to support the reaction Following this is a section on the use of supercritical fluid solvents as environmentally friendly media for chemical reactions Finally a series of papers is presented in which novel reactor designs are utilized to obtain product yields not possible in conventional reactor systems These include the use of reactor absorber systems reactive distillation and reactive membranes The book concludes with a chapter contributed by the editors which discusses the educational aspects of pollution prevention It is necessary for future generations of engineers to be trained to design processes that are inherently environmentally benign This chapter assembles resource materials for educators which will spark the creative instincts of the researchers using the materials contained within this book to develop new resources for pollution prevention education The broad spectrum of topics included in this book indicates the diversity of this area and the vibrant nature of the ongoing research The possibilities of producing desirable products without the formation of waste byproducts are bounded only by the creativity of the reaction engineer

**Pollution Prevention 1997**, 1997 **Pollution Prevention** David T. Allen, N. Bakshani, Kirsten Sinclair Rosselot, American Institute for Pollution Prevention, 1992 **Industrial Pollution Prevention** Thomas T. Shen, 2013-06-29 Pollution prevention is the current environmental strategy to minimize pollution problems It is a management strategy to establish a society oriented approach towards sustainable development This book is for those who are interested in and responsible for pollution prevention in governments academia industrial plants and consulting services The book will help readers in understanding the principles and practices of industrial pollution prevention It also provides readers with forms worksheets and checklists which will be useful in everyday practice and reading suggestions that support the pollution prevention effort

Process Engineering for Pollution Control and Waste Minimization Donald L. Wise, 1994-02-15 Offers up to date technical information on current and potential pollution control and waste minimization practices providing industry specific case studies techniques and models

**Sustainability Science and Engineering** Martin A. Abraham, 2005-12-16 Sustainable development is commonly defined as development that meets the needs of the present without compromising the ability of future generations to meet their own needs Sustainability in engineering incorporates ethical and social issues into the design of products and processes that will be used to benefit society as a whole

Sustainability Science and Engineering Volume 1 Defining Principles sets out a series of Sustainable Engineering Principles that will help engineers design products and services to meet societal needs with minimal impact on the global ecosystem Using specific examples and illustrations the authors cleverly demonstrate opportunities for sustainable engineering providing readers with valuable insight to applying these principles This book is ideal for technical and non technical readers looking to enhance their understanding of the impact of sustainability in a technical society Defines the principles of sustainable engineering Provides specific examples of the application of sustainable engineering in industry Represents the viewpoints of current leaders in the field and describes future needs in new technologies *Handbook of Environmental Engineering* Myer Kutz, 2018-07-25 A comprehensive guide for both fundamentals and real world applications of environmental engineering Written by noted experts *Handbook of Environmental Engineering* offers a comprehensive guide to environmental engineers who desire to contribute to mitigating problems such as flooding caused by extreme weather events protecting populations in coastal areas threatened by rising sea levels reducing illnesses caused by polluted air soil and water from improperly regulated industrial and transportation activities promoting the safety of the food supply Contributors not only cover such timely environmental topics related to soils water and air minimizing pollution created by industrial plants and processes and managing wastewater hazardous solid and other industrial wastes but also treat such vital topics as porous pavement design aerosol measurements noise pollution control and industrial waste auditing This important handbook Enables environmental engineers to treat problems in systematic ways Discusses climate issues in ways useful for environmental engineers Covers up to date measurement techniques important in environmental engineering Reviews current developments in environmental law for environmental engineers Includes information on water quality and wastewater engineering Informs environmental engineers about methods of dealing with industrial and municipal waste including hazardous waste Designed for use by practitioners students and researchers *Handbook of Environmental Engineering* contains the most recent information to enable a clear understanding of major environmental issues

Pollution Prevention for Chemical Processes David T. Allen, Kirsten Sinclair Rosselot, 1994 Covers elements of pollution prevention programs identifying pollution prevention options for chemical processes selecting the best pollution prevention options and pollution prevention case study modules with solved problems Suitable for use in short courses training sessions and as a supplementary text in university based engineering design courses 50 charts and tables The Greening of Industrial Ecosystems National Academy of Engineering, Advisory Committee on Industrial Ecology and Environmentally Preferable Technology, 1994-01-01 In the 1970s the first wave of environmental regulation targeted specific sources of pollutants In the 1990s concern is focused not on the ends of pipes or the tops of smokestacks but on sweeping regional and global issues This landmark volume explores the new industrial ecology an emerging framework for making environmental factors an integral part of economic and business decision making Experts on this new frontier explore concepts and

applications including Bringing international law up to par with many national laws to encourage industrial ecology principles Integrating environmental costs into accounting systems Understanding design for environment industrial metabolism and sustainable development and how these concepts will affect the behavior of industrial and service firms The volume looks at negative and positive aspects of technology and addresses treatment of waste as a raw material This volume will be important to domestic and international policymakers leaders in business and industry environmental specialists and engineers and designers Pollution Prevention through Process Integration Mahmoud M. El-Halwagi, 1997-08-19 The environmental impact of industrial waste is one of the most serious challenges facing the chemical process industries From a focus on end of pipe treatment in the 1970s chemical manufacturers have increasingly implemented pollution prevention policies in which pollutants are mitigated at the source or separated and recovered and then reused or sold This book is the first to present systematic techniques for cost effective pollution prevention altering what has been an art that depends on experience and subjective opinion into a science rooted in fundamental engineering principles and process integration Step by step procedures are presented that are widely applicable to the chemical petrochemical petroleum pharmaceutical food and metals industries Various levels of sophistication ranging from graphical methods to algebraic procedures and mathematical optimization numerous applications and case studies and integrated software for optimizing waste recovery systems make Pollution Prevention through Process Integration Systematic Design Tools a must read for a wide spectrum of practicing engineers environmental scientists plant managers advanced undergraduate and graduate students and researchers in the areas of pollution prevention and process integration Allows the reader to establish pollution prevention targets for a process and then develop implementable cost effective solutions Contains step by step procedures that can be applied to environmental problems in a wide variety of process industries Integrates pollution prevention with other process objectives Author is internationally recognized for pioneering work in developing mass integration science and technology

Cleaner Production - A Training Resource Package United Nations Environment Programme, 1996-12 Fundamentals of Environmental Engineering Danny Reible, 2025-07-31 Numerous new technologies and approaches have been developed since the first publication of Fundamentals of Environmental Engineering This newly revised and updated edition continues to have a focus on fundamental concepts and on mass and energy material balances but it eliminates some of the least used concepts and allows space for new and more common aspects of environmental engineering practice Expanding its use at the junior level the author explains current environmental engineering issues including emerging contaminants and management of air water soil and sediment pollution Features Provides up to date information on a variety of emerging contaminants and new technologies for air and water pollution Discusses some of the more common aspects of environmental engineering practice and eliminates some of the least used and difficult concepts Explains the mathematics of mass and energy balances to guide environmental assessment in a way that doesn't follow traditional civil engineering oriented introductory textbooks

Updated coverage for a one semester course with new problems that emphasize practical field orientated applications for environmental engineers Undergraduate students in environmental civil energy industrial and chemical engineering will find that this textbook is an excellent overview of the fundamentals that environmental engineers should understand Professionals involved with the environment such as regulators researchers academics and practitioners concerned with the protection and management of the environment will also find this textbook to be an invaluable resource Green Engineering David T. Allen, David R. Shonnard, 2001-09-06 A chemical engineer's guide to managing and minimizing environmental impact Chemical processes are invaluable to modern society yet they generate substantial quantities of wastes and emissions and safely managing these wastes costs tens of millions of dollars annually Green Engineering is a complete professional's guide to the cost effective design commercialization and use of chemical processes in ways that minimize pollution at the source and reduce impact on health and the environment This book also offers powerful new insights into environmental risk based considerations in design of processes and products First conceived by the staff of the U S Environmental Protection Agency Green Engineering draws on contributions from many leaders in the field and introduces advanced risk based techniques including some currently in use at the EPA Coverage includes Engineering chemical processes products and systems to reduce environmental impacts Approaches for evaluating emissions and hazards of chemicals and processes Defining effective environmental performance targets Advanced approaches and tools for evaluating environmental fate Early stage design and development techniques that minimize costs and environmental impacts In depth coverage of unit operation and flowsheet analysis The economics of environmental improvement projects Integration of chemical processes with other material processing operations Lifecycle assessments beyond the boundaries of the plant Increasingly chemical engineers are faced with the challenge of integrating environmental objectives into design decisions Green Engineering gives them the technical tools they need to do so **Advances in Chemical Engineering**, 1995-01-31 Advances in Chemical Engineering Volume 19 reflects the major impact of chemical engineering on medical practice with chapters covering polymer systems for controlled release receptor binding and signaling and transport phenomena in tumors Other key topics include oil refining pollution prevention in engineering design and atmospheric dynamics *Food Industry Wastes* Maria R. Kosseva, 2013-01-31 *Preventive Environmental Management* Shyam R. Asolekar, R. Gopichandran, 2005 With reference to India **Resources and References** Donna S. Kocurek, Bayle Woodside, 1995-12-31 This guide book provides references and resources for the complex field of hazardous waste and hazardous materials management The book is divided into general topics such as air quality industrial wastewater pollution prevention and risk assessment under hazardous waste management and chemical hazards emergency planning and hazard communication under hazardous materials management Each individual section includes a list of annotated bibliographies of the most recent books by major publishers as well as established standard references Following the annotated titles are additional references of books and documents by

publishers technical associations and governmental agencies primarily the U S Environmental Protection Agency In general only references from 1986 onward are included since the technology and regulations affecting hazardous waste and materials are constantly evolving Additional resources included in the book are video tapes for training and instruction information services and databases libraries agency contacts technical journals and a list of publishers and ordering information This book will be a useful reference to professionals in the environmental field who need an extensive but concise source of technical information and contacts The book will be a valuable addition to individual libraries and will fill a current reference void in university libraries and technical libraries in industry and government At present there are very few technical bibliographies in the field and none has covered topics related to hazardous materials and hazardous waste as extensively as this book

*Elementary Principles of Chemical Processes* Richard M. Felder, Ronald W. Rousseau, Lisa G. Bullard, 2020-08-11 This best selling text prepares students to formulate and solve material and energy balances in chemical process systems and lays the foundation for subsequent courses in chemical engineering The text provides a realistic informative and positive introduction to the practice of chemical engineering

Environmentally Conscious Materials and Chemicals Processing Myer Kutz, 2007-03-16 The third volume of the Wiley series Environmentally Conscious Material and Chemically Processing focuses on environmentally preferable approaches to designing and developing material and chemical processing The book reflects the hierarchy of design from tools for evaluating environmental hazards of industrial materials and chemicals through to the economics of environmental improvement projects Major topics covered include Chemical Manufacturing Materials substitutions Engineering processes products and systems to reduce environmental impacts approaches for evaluating emissions and hazards of chemicals and processes Environmental regulations Properties and fates of environmental contaminants and others

**Industrial Pollution Prevention Handbook** Harry Freeman, 1995 This book provides information and techniques for implementing the pollution prevention P2 environmental strategy preferred by government and industry It focuses on the latest technologies for preventing or reducing the creation of new waste streams by improving management practices boosting efficiency replacing toxic materials in the production process or modifying the products themselves

## Unveiling the Energy of Verbal Art: An Psychological Sojourn through **Pollution Prevention Homework And Design Problems For Engineering Curricula**

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