

**ROY G. PERRY COLLEGE OF ENGINEERING
CHEMICAL ENGINEERING DEPARTMENT
PRAIRIE VIEW A&M UNIVERSITY**

ASSESSMENT REPORT COVER PAGE

**CHEG 1202 P01 INTRODUCTION TO
COMPUTATIONS IN CHEMICAL ENGINEERING**

FALL 2021 SEMESTER

NAME OF INSTRUCTOR: Dr. Lealon L. Martin

Revised: 12/19/2021

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 - 5.1 Tasks assessing students' ability to apply knowledge of mathematics, science, and engineering. (outcome "D1.1")

Detailed Course Syllabus
(Distributed to Students at the beginning of the Semester)

CHEMICAL ENGINEERING DEPARTMENT
CHEG 1202 P01 INTRODUCTION TO COMPUTATIONS IN
CHEMICAL ENGINEERING

1. Course number and name:	CHEG 1202 Introduction to Computations in Chemical Engineering
2. Credits and contact hours:	2 credit hours; 3 contact hours
3. Instructor's or course coordinator's name:	Dr. Lealon L. Martin
4. Text book: Title:	Fundamental Concepts and Computations in Chemical Engineering
Author:	Vivek Utgikar
Publisher, Year & Edition:	Prentice Hall, 1 st Edition
a. Other Supplemental material	Excel VBA: The Ultimate Beginner's Guide to VBA Programming Step by Step
Author:	David A. Williams
Publisher, Year & Edition:	2 nd Edition
5. Specific course information	
a. Brief description of the content of the course (catalog description)	CHEG 1202 Introduction to Computations in Chemical Engineering. (2-0) Credit 2 semester hours. An introductory course of important chemical engineering concepts and computations. Students will learn how to classify problems based on their mathematical nature. Topics include basic introductory calculations involving material and energy balances, fluid flow phenomena, fundamental thermodynamics and kinetics, and introductory software and simulation tools such as Visual Basic and CHEMCAD.
b. Prerequisites or Co-requisites	CHEG 1101 or equivalent MATH 2413
c. *Indicate whether a required, elective, or selected elective (as per definition provided) course in the program	Required

-
6. a. **Specific goals for the course** specific outcomes of instruction (e.g. The student will be able to explain the significance of current research about a particular topic.)

Students will be able to :

1. Classify simple chemical engineering problems based on their mathematical nature.
2. Formulate and solve basic calculations in simple chemical engineering problems such as material and energy balances.
3. Use software such as Excel and MATLAB to perform simple chemical engineering computations and simulations

- b. **Explicitly indicate which of the student outcomes listed in Outcome D1** or any other outcomes are addressed by the course.

The specific goals for the course specific outcomes listed on the left column will address the following student learning outcomes:

Outcome D1.1

Students will have the ability to identify, formulate, and solve fundamental engineering problems by applying principles of engineering, science, and mathematics

7 Brief list of topics to be covered

Chemical Engineering Profession	(3 hrs)
Chemical Products and Industries	(3 hrs)
Chemical Engineering Curriculum Importance	(3 hrs)
Long Range Plan	
Computations in Chemical Engineering Basic	(4.5 hrs)
Computations in Chemical Engineering Algorithms	(4.5 hrs)
Computer Software: Excel and VBA	(4.5 hrs)
Data Analysis Computations	(4.5 hrs)
Applications of Data Analysis	(3 hrs)
Numerical Differentiation	(6 hrs)
Applications of Numerical Differentiation	(9 hrs)
Computer Software: MATLAB Advanced Calculations (Root-Finding)	(3 hrs)

***Required** courses are required of all students in the program, **elective** courses (often referred to as open or free electives) are optional for students, and **selected elective** courses are those for which students must take one or more courses from a specified group

End of Semester Course Assessment Report

This summary contains the following Information

1. Performance Statistics

- Total number of students in class
- The class average performance (**stated as %**) in each course outcome assessed in this class and the **two previous times course was assessed**.
- The acceptable class average for the class in each outcome area as set by the Chemical Engineering Department.
- Percentage of students who scored below the expected average in each outcome.

2. Implementation Summary

- Brief summary of plans implemented during the semester based on last assessment report

3. Perceived Problems

- Dr. Martin's **critical evaluation** of perceived problems that affected students' performance.

4. New Plans for Addressing Problems

- Instructor's plans for addressing the perceived problems the next time the class is taught.

5. Overall Trend over last three assessment periods

- Instructors summary of overall performance trend for each outcome measured over the last three periods.

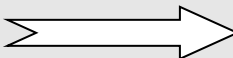
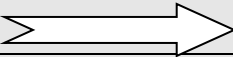
5. Were Expectations Met?

- Answer **YES** if the **class average was above the expected average** and the **stated percentage of students** scored at or above the expected average, else answer NO.

END OF SEMESTER COURSE OUTCOME ASSESSMENT REPORT
CHEG 1202 P01 INTRODUCTION TO COMPUTATIONS IN CHEMICAL ENGINEERING
FALL 2021 SEMESTER

Report Prepared by: Dr. Lealon L. Martin

Report Date: December 19, 2021

Semester	Analysis Type	Number of Students	Outcome D1.1 An ability to apply knowledge of mathematics, science, and engineering.		
			Expected Average	Class Average	% Students Above Expected Average
Fall 2021	Direct	9	75	77	78
Spring 2021	Direct	12	75	82	75
Implementation Summary			The course was modified to focus on very basic calculations and computational methods that students will need in the sophomore- and junior-level engineering courses. Particular attention was paid to understanding multicomponent average calculations, standard deviation and variance calculations, numerical differentiation and integration methods, solutions to linear systems, root-finding. Most importantly, we covered engineering problem-solving method: identify, formulate, and solve as systematic approach to understanding and solving engineering problems. Additionally, students were given projects to introduce them to open-ended problem-solving and technical reporting.		
Perceived Problems			The major problems were: 1. Students faced trouble with the mathematical rigor of the course, especially the application of calculus to real-world problems. 2. Students had trouble with translating physically systems into mathematical descriptions.		
Plans for Addressing Problems			The following is recommended for implementation: 1. Start the course with a review period of basic math, but also including additional review sessions outside of class as refreshers. 2. Two, instead of one project-based assignment.		
Overall Trend over Periods			78% of students performed above average, and increase of 3 percentage points from the previous offering.		
Were Expectations Met?	Average ≥ 70%? and ≥ 70% students avg. ≥ 70%?		YES		

**Grade Sheet Showing
Student and Class Performance in Outcomes
The computed semester average in each outcome
as stated in the Assessment report are
highlighted in boldface**

Grade Sheet Showing Student and Class Performance in Course Outcomes CHEG 1202 Introduction to Computation in Chemical Engineering Spring 2021

Outcome D1.1: Students will have the ability to identify, formulate, and solve fundamental engineering problems by applying principles of engineering, science, and mathematics

		D1.1 Outcomes									
Student											D1.1 Avg
1	100	84	88	105	96	88	75	95	98	82	91
2	100	80	90	105	100	85	75	100	98	80	91
3	0	65	0	0	0	0	60	60	0	0	19
4	0	76	80	0	0	50	50	90	0	30	38
5	100	81	86	105	95	89	73	95	98	98	92
6	100	84	90	105	100	88	70	100	95	92	92
7	100	81	90	105	87	75	80	70	80	85	85
8	100	84	90	92	87	70	72	100	70	85	85
9	100	85	100	105	100	89	75	100	99	85	94
AVERAGE	78	80	79	80	74	70	70	90	71	71	77

OUTCOME SPECIFIC ASSIGNMENTS USED TO ASSESS OUTCOMES

(Provide at least two assignments used to specifically measure each outcome and justify the suitability of the assignments for the outcome being measured)

TASKS FOR OUTCOME D1.1

Students will have the ability to identify, formulate, and solve fundamental engineering problems by applying principles of engineering, science, and mathematics

CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
Introduction to Computation in Chemical Engineering
Instructor: Dr. Lealon L. Martin

Title of Assignment

Homework 1

Outcome Measured Using this Assignment

Outcome D1.1

Students will have the ability to identify, formulate, and solve fundamental engineering problems by applying principles of engineering, science, and mathematics

Check the complex engineering problem characteristics related to this assignment

Brief justification of why this assignment is suitable for this outcome

The students' ability read, comprehend, and condense information into key points.
This is necessary for engineering problem-solving.

ABOVE AVERAGE

FUNDAMENTAL CONCEPTS AND COMPUTATION IN CHEMICAL ENGINEERING BULLET POINT NOTES

What is engineering?

Is the art of organizing forces for technical change

What do engineers really do?

- An engineer solves problems
- An engineer makes things
- An engineer builds and creates machines, processes, structures etc.

Note: If an individual is to succeed in an engineering course and profession, he or she must understand the basic nature of engineering.

1.1 Engineering and engineers

Over 2 centuries engineering has been considered as the practical application on science. The accreditation board of engineering and technology (ABET) defines engineering as:

- The profession in which the knowledge in mathematical and natural science gained by study, experience, and practice is applied with judgement to develop ways to utilize economically the materials and forces of nature for the benefit of mankind.
- Engineering is a process of transforming science into technology. Once science is understood to be foundation of the structure that is technology, engineering can be easily understood as the process of developing and building structure. Engineering thus differs from both science and technology in being an action rather than a concept or an object. The initial starting point of engineering activities is science, and the end result is technology.

Benefits of engineering activities

- 1) Economic impact: It gives commercial benefits through generating revenue and profit through the manufacture of products, provision of services, supply of energy and more.
- 2) For the benefit of society at large: Engineering activities are undertaken to satisfy the demand for products, services, and energy by the society. The public at large is the direct beneficiary, be those in form of power plants, automobiles, machines, or clean environment.
- 3) Application of scientific knowledge: As the ABET definition states, engineering utilize science for practical purposes. Science is essentially a field of discovery where fundamental understanding of processes phenomena is the objective. Such knowledge is obviously beneficial to the engineers; however, an engineering activity can proceed without necessarily having the complete theoretical scientific understanding and framework for the process.
- 4) Engineering activities are conducted in a large scale: science involves discovery of new products, principles, and processes in a lab or research setting. Engineering involves taking this novel discovery and scaling up to make it accessible and affordable to the entire society.

1.2 Engineering disciplines

- The evolution of engineering is essentially a history of civilization. As early humans transitioned from nomadic existence int settlement there rose a need for permanent structures. Civil engineering developed in response to these needs.

- Engineering development was due to the need for accomplishing things beyond what was possible through simple manual labor, leading to simple machines such as Archimedes screw machine for pumping water and transferring material. This evolution has continued with new disciplines appearing over time in response to societal needs based on advances in science and new discoveries.

Big four engineering disciplines

- 1) Mechanical engineering- Deals with development, design, and operations of all types of machines and systems for human convenience and comfort
 - 2) Civil engineering- Deals with the development, design, construction, and operation of the facilities and structures for the society.
 - 3) Electrical engineering- Deals with machines and systems associated with electrical energy
 - 4) Chemical engineering- This discipline grew out of industrial chemistry and need to produce large quantities of chemicals economically.
- An individual with a bachelor's degree in one of the 4 disciplines can successfully go on to pursue graduate studies in many of the other engineering disciplines without needing substantial additional coursework to satisfy prerequisites. A civil, mechanical, or chemical engineer can go on to study and practice environmental engineering.
 - A mechanical engineer can become an industrial, manufacturing, aerospace, or nuclear engineer. Similarly, a chemical engineer can pursue nuclear, biological/agricultural, or petroleum engineering graduate degrees.

1.3 Defining chemical engineering

There is no concise definition that captures the essence of chemical engineering readily available

- ✓ The American Institute of Chemical Engineers (AIChE), the professional society of chemical engineers in the United States, defines chemical engineers as follows:

Individuals who use science and mathematics, especially chemistry, biochemistry, applied mathematics, and engineering principles, to take laboratory or conceptual ideas and turn them into value added products in a cost effective, safe (including environmental) and cutting-edge process.

- ✓ According to Morton M. Denn, Chemical engineering is the field of applied science that employs chemical, physical, and biochemical rate processes for the betterment of humanity.

- Chemical engineering differs from other engineering in having the scientific basis in chemistry in addition to physics and mathematical sciences. Chemical engineering, according to this definition, is the field dealing with the rates of physicochemical processes involving transformations of molecular species. The definition places emphasis on processes and the rates thereof.

An individual can be identified as a chemical engineer, if the following descriptors can adequately describe his/her activities:

- The individual is engaged in an engineering enterprise; that is, he/she is working to apply scientific knowledge to make products, both tangible and intangible, commercially available to the general society.
- The engineering enterprise is based on the transformation of species, involving restructuring of bonds (forces) between them. This restructuring is typically at the atomic level, that is, involving chemical reactions yielding products that are distinct from initial species. However, the transformation may simply involve separations, or restructuring of physical bonds between different species. No new molecular species are generated in such transformations. In other words, the transformations involve altering the affinities between elemental and/or molecular species.

Chemical engineering thus deals generally with systems where chemical reactions take place. These chemical reactions are invariably accompanied by physical separations. Chemical engineers use their knowledge of science and mathematics to ensure that laboratory reactions and separations are scaled up to the industrial level.

1.4 Roles and responsibilities of a chemical engineer

A chemical engineer performs several different tasks in the chemical industry, or an organization engaged in chemical business.

Consider the case of manufacturing a new chemical product or a new manufacturing process for an existing chemical product. Going from conceptualization to commercial operation is an extremely complex and involved process, and any such undertaking typically moves through the following stages:

1. Conceptualization and inception
2. Preliminary economic evaluation
3. Development of data needed for final design
4. Final economic evaluation
5. Detailed design
6. Procurement and construction
7. Start-up and trial runs
8. Production

A chemical engineer is involved in all these activities. Depending on his/her responsibilities, the role of the engineer may include one or a combination of the following:

- Research and development engineer

An engineer who is involved in the initial stages. The research component of the position typically involves working with a chemist to investigate the key concept at the bench scale. The development component involves conceptualization of the process based on the key step. The engineer is responsible for identifying the sequence of upstream and downstream processing steps, evaluating alternatives, and conducting investigations on larger scales.

- Pilot plant engineer

The laboratory investigations typically yield only a few grams of product, while the commercial process may be required to produce thousands of tons of product per day. The laboratory process thus must be scaled by several orders of magnitude. These pilot plants serve two primary purposes: first, they provide validation of the plant design and confirmation of the ability of the organization to successfully operate the process on a large scale; second, they help identify the challenges that arise with the scale-up of the process.

- Design engineer

Sizing of the process equipment and specifying the operational conditions for the process are among the responsibilities of the design engineer. A design engineer, in the chemical engineering field, is mostly a process design engineer who performs detailed calculations of energy and material flows, specifies equipment capacities, and determines the layout of the plant. The design engineer interfaces with the R&D and pilot plant engineers to obtain data and information and interfaces with vendors and fabricators to finalize process equipment specifications. He/she also typically develops cost estimates for the process.

- Start-up, or commissioning, engineer:

The engineer involved in the initial start-up of a new plant is the start-up/commissioning engineer. He/she has the responsibility to ensure that various process units function as designed and the plant can deliver the product having the specified purity and quality at the rated design capacity. Once the initial problems are sorted out and the plant is operating smoothly, the commissioning engineer hands over the responsibility to the production operating personnel.

- Manufacturing/production engineer:

A manufacturing/production engineer provides support to the manufacturing operation, monitoring daily operations to ensure that operations conform to the process design. He/she investigates process deviations, troubleshoots problems, and continually explores opportunities to increase profitability through capacity enhancement, efficiency improvements, and cost minimizations. The manufacturing/production engineer is responsible for plant safety, product quality and reliability, and costs for operations under his/her charge. Additionally, the manufacturing/production engineer works collaboratively with operations, engineering, maintenance, quality, and other departments to ensure plant reliability and production goals are met.

Sales engineer, technical sales engineer, marketing engineer

Despite the different nature of responsibilities, all the engineering positions may be designated simply as process engineers, which is the most common title for the jobs advertised across the chemical industry.

1.5 Employment of Chemical Engineers

The U.S. Department of Labor maintains an extensive database of labor and economic statistics through its Bureau of Labor Statistics (www.bls.gov). The career information about duties, education, training, pay, and current and prospects for practically any occupation can be found in the Occupational Outlook Handbook (www.bls.gov/ooh) published by the Bureau. The handbook lists the myriad industries—chemicals, fuels, energy, food, drugs, electronics, clothing, life sciences, biotechnology, and many others—where chemical engineers find employment. It lists the median pay for the chemical engineering jobs to be \$96,400 (for 2014) and projects a 2% annual growth in the number of jobs. The handbook very likely underestimates the actual number of chemical engineering jobs, with a more realistic number estimated by summing up the number of graduates over an average of 40 years [15]. A National Science Foundation (www.nsf.gov) estimate put the total number of working chemical engineers in 2002 across all occupations at closer to 200,000.

AVERAGE

Name: Chau Truong

CHEG2301-P01

August 30, 2021

Chapter1: The Chemical Engineering Profession

1. Engineering and Engineers

I. Definition of Engineering: Engineering is the process from apply Science to develop Technology for the Benefit of humanity.

- An engineering activities: understanding the benefit of humanity
 - has an economic impact, for example, earning a lot of revenue and profit by creating the new products or supply, or service.
 - serve the demand of all people with different of age or need as improving the old products or supply or service to make people can afford or satisfied. For example, new cars or new phone with more and different options with cheaper price are made.
 - engineering study and discovery the fundamental of standing process and phenomena of the objects to explain and elucidated object under the law of nature to create a new things
 - from a small scale into the large scale of activities. For example, sciences do research and make a small process in the laboratory, after make success full trials they scale up to apply it into society or commercial.
- Technology is the equipment which developed from science knowledge. Or how science use the nature law and make it become an object as technology which can be use by consumer. And technology can be tangible or not.

II. Definition of Engineer: a person who engaged in the practice of engineering by using the knowledge of science to create useful things as technology or a new things but engineer often not discovering new knowledge.

- To be understand clearly, we need to understand the different of engineer and technologist. Technologist is not required to understand how technology is develop, they just need to know how to use it and understand the functions of technology, but engineer need to understand how to use the concept or the fundamental of science to develop.
- Engineer also need to be qualified and license, and study engineering courses to become engineer, these course have a higher level of mathematical and scientific.

2. Engineering Disciplines

-
- I. There are several disciplines which is divide by the engineering field, but only 4 disciplines are big and grown, and have a lot of people gathering in.
 - Mechanical engineering: deal with development, operation, design machine and system. Mechanical engineering is found everywhere in all industry, and raging from machine, manufacturing, energy transportation, refrigeration, heating systems.
 - Civil engineering: deal with development design, construction. Range from building, dams, highways, canal, system
 - Electrical engineering: deal with machine and system with have electrical energy. For example, run the electricity for all machine systems
 - Chemical engineering: start from chemist industry to large number of chemical economic.
 3. Chemical engineering:
 - I. Definition:
 - Chemical engineering is use chemistry, physic, biochemistry, mathematic transform them to value product which can use for betterment of mankind.
 - Use chemistry, physic and biochemistry, or mathematic mean put all of them from concept or idea and make them into a large scale, but it has to be good affect to the economic and health of engineering.
 - II. Chemical engineer activity:
 - Chemical engineering is dealing with the systems where chemical reaction take place.
 - The activities of chemical engineer:
 - people enjoy engineering industries, they applied their understanding of science to make product
 - base on the transformation of pieces, they restructure of bonds or forces between them, or improve the reaction to make a greater number of product with small times.
 4. Role and Responsibilities of Chemical engineering:
 - > Role of chemical engineering depend on the different task or responsibilities of people in chemistry industry.
 - Research and development engineer: for who is involved in the first stage of project which is conceptualization of idea for new product. These people usually working with chemist to investigate the concept in the laboratory to collect the data and analysist and developed solution to many trial to make it success.

- Pilot plant engineer: people in this place work in commercial process, which can produce a thousand of ton product every day. These engineer serve 2 primary purpose: 1- provide validation of design and conformation of ability to successful run on the large scale. 2- discover the potential of problem, workable or challenge to scale up process.
- Design engineer: who calculated energy, material flows, capacities of product to determine the layout of the plant. They can work with the engineer and suppliers to develop the better cost estimate and the install plant conform to the design.
- Startup and commission, engineer: make sure various process unite function as design and the plant is able to deliver the product with good quality and purity.
- Manufacturing and production engineer: who provide and support manufacturing operation to ensure that operation conform to the process design at beginning. Also, they can find the trouble and problem to make everything smooth and increase profit.

5. Employment of Chemical Engineering.

- Chemical engineering makes more than 90,000\$ per year in 2014, and more than 200,000 people occupation in chemical engineering in 2002.
- ½ of graduated people from chemical engineering pick a fuel sector, biotechnology sector was not as dominant than food sector.
- People who graduated with PhD have more impact than people who hold bachelor's degree by economic impact.

BELOW AVERAGE

Notes over Chap. 1

"The Chemical Engineering Profession"

- Engineering is the profession in which a knowledge of mathematical & natural sciences, gained by study, experience & practice, is applied w/ judgement to develop ways to utilize economically the material & forces of nature for the benefit of mankind.

★ What is Engineering?

Key Points

"Science a reality for the common man"

- An engineering activity has an economic impact associated with it.
- An engineering activity is conducted for the benefit of society at large.
- Engineering involves application of scientific knowledge

★ Engineering is the process of transforming science into tech.

★ The initial starting point of eng. activities is science, and the end result is technology.

★ Each state has its own board of licensed engineers

- Big 4 of Engineering: Mechanical, civil, electrical & chemical
- A civil or chemical eng. can study & practice environmental eng.
→ nuclear, biological/agricultural, petroleum

Def.

Ind. who use science & mathematics, esp. chemistry, biochemistry, applied mathematics, & engineering principles, to take laboratory or conceptual ideas & turn them into value added products in a cost effective, safe, & cutting edge processes.

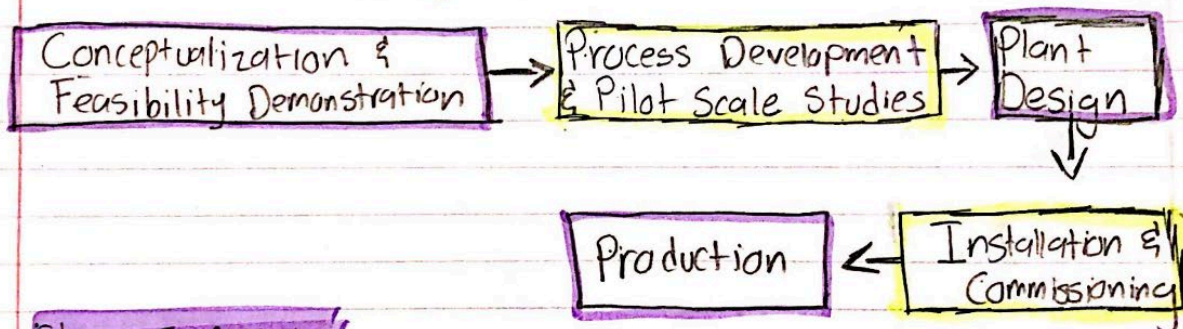
- "Applied science" => taking laboratory or conceptual ideas to a large scale.

- Theme for most definitions of engineering is "The benefit or betterment of humanity"

Roles & Responsibilities of Chem. E.

- ① Conceptualization & inception
- ② Preliminary economic evaluation
- ③ Development of data needed for final design
- ④ Final economic evaluation
- ⑤ Detailed design
- ⑥ Procurement & construction
- ⑦ Start-up & trial runs
- ⑧ Production

Flowchart of Stages:



Chem. E. Activities

- Research & development engineer
- Pilot plant engineer
- Design engineer
- Start-up, or commissioning, engineer
- Manufacturing / production engineer

Employment of Chemical Engineering

- Median Pay: \$96,400 (for 2014) & projects a 2% annual growth in the number of jobs.

CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
Introduction to Computation in Chemical Engineering
Instructor: Dr. Lealon L. Martin

Title of Assignment

Homework 2

Outcome Measured Using this Assignment

Outcome D1.1

Students will have the ability to identify, formulate, and solve fundamental engineering problems by applying principles of engineering, science, and mathematics

Check the complex engineering problem characteristics related to this assignment

Brief justification of why this assignment is suitable for this outcome

This assignment focuses on engineering problem-solving using dimensional analysis and unit conversion as solution methodology.

ABOVE AVERAGE

Carol Alpan

Homework 2: Dimensional Analysis

1 $1 \text{ penny} = 2 \text{ cm}$ $\frac{100,000 \text{ cm}}{1 \text{ km}} \cdot \frac{1 \text{ penny}}{2 \text{ cm}} = \boxed{50,000 \text{ pennies/km}}$

2 Circumference $C = 2\pi r$
 $r = C/2\pi = 25000 \text{ miles}/2\pi = 3978.87 \text{ miles} = \text{radius}$
 $r = 3978.87 \text{ miles} / 1609.34 \text{ meters/mile} = 6.403 \times 10^6 \text{ m}$

Earth's surface area = $4\pi r^2$
 $4\pi (6.403 \times 10^6 \text{ m})^2 = 5.152 \times 10^{14} \text{ m}^2$

ocean surface area 70-75%
 $0.7(5.152 \times 10^{14} \text{ m}^2) = 3.606 \times 10^{14} \text{ m}^2$

Volume of ocean = surface area (depth)
 $3.606 \times 10^{14} \text{ m}^2 (1000 \text{ m}) = 3.606 \times 10^{17} \text{ m}^3 = \text{total volume}$

density of water
 $\frac{1 \text{ g}}{\text{cm}^3} \cdot \frac{(100 \text{ cm})^3}{(1 \text{ m})^3} = 1 \times 10^6 \text{ g/m}^3 = \text{density}$

Mass of Earth's water = Volume $\times$ Density

$\frac{\text{m}}{\text{D/V}} (3.606 \times 10^{17} \text{ m}^3) (1 \times 10^6 \text{ g/m}^3) = \boxed{3.606 \times 10^{23} \text{ g}}$

3 $\Delta H_f (\text{C}_3\text{H}_8) = -2216.65 \text{ kJ/mol} = -5000 \text{ kJ/mol C}_3\text{H}_8$

$\text{mol}(\text{C}_3\text{H}_8) = \frac{-5000 \text{ kJ}}{-2216.65 \text{ kJ}} = 2.256 \text{ mol C}_3\text{H}_8$

molar mass $\text{C}_3\text{H}_8 = 2.256 \text{ mol} (44.1 \text{ g/mol}) = 99.49 \text{ g}$

$\frac{1 \text{ kg}}{1000 \text{ g}} = \frac{99.49 \text{ g}}{1000} = \boxed{0.1 \text{ kg C}_3\text{H}_8}$

energy is being Released since the Heat formation is negative

Jessica Rhone

make sure to write down all equations and a picture before solving

Jessica Rhone

Need to use this formula with diameter included $= 4\pi r^2$; need to use equation volume of a sphere too

AVERAGE

Mohamed Alwan

HW #2

$$1. \frac{1 \text{ Penny}}{2 \text{ cm}} \times \frac{100,000 \text{ cm}}{1 \text{ km}} = 50,000 \text{ Pennies}$$

$$2. 2\pi r = 25000 \text{ miles} \quad r = \frac{25000 \text{ miles}}{2\pi} = 3979 \text{ miles} \quad 1 \text{ mile} = 1.609 \text{ km}$$

$$r = 3979 \text{ miles} \times \frac{1.609 \text{ km}}{1 \text{ mile}} = 6402 \text{ km}$$

$$\frac{4\pi}{3} (6402^3 - 6401^3) = 4188.79 \text{ km}^3$$

$$1 \text{ km}^3 = 1 \times 10^{15} \text{ cm}^3 \quad \square$$

$$4188.79 \text{ km}^3 \times \frac{1 \times 10^{15} \text{ cm}^3}{1 \text{ km}^3} = 418879 \times 10^{15} \text{ cm}^3$$

$$\text{Mass} = \frac{1 \text{ g}}{1 \text{ cm}^3} \times 418879 \times 10^{15} \text{ cm}^3 = 4.18879 \times 10^{18} \text{ g}$$

$$4.18879 \times 10^{18} \text{ g} \times \frac{1 \text{ kg}}{1000 \text{ g}} = 4.18879 \times 10^{15} \text{ kg}$$

$$3. \text{ Molar mass of } C_3H_8 = 44.1 \text{ g/mol}$$

$$\frac{44.1 \text{ g/mol}}{1000 \text{ g/kg}} = 44.1 \times 10^{-3} \text{ kg/mol}$$

$$44.1 \times 10^{-3} \text{ kg/mol} \times 5000 \text{ kg}$$

$$2,216.05 \text{ kg/mol}$$

$$44.1 \times 10^{-3} \text{ kg/mol} \times \frac{5000 \text{ kg}}{2,216.05 \text{ kg/mol}} = 99.2719 \times 10^{-3} \text{ kg}$$

$$99.278 \times 10^{-3} \text{ kg of propane}$$

☐ Jessica Rhone

your steps are correct; just forgot to include the % water by volume. Add this step to your formulation

☐ Jessica Rhone

Is the heat of formation - or + ?
Released or consumed?

BELOW AVERAGE

Dega Hockey

09105121

Intro to Computations in CEE1

Homework

Problem 1

Suppose you want to line pennies up, diameter, until the total length is 1 kilometer. Assume the width of 1 penny is 2 cm. How many pennies will you need? How accurate is this estimation?

$$\begin{array}{l} 1 \text{ km} = 1000 \text{ m} \quad 1 \text{ m} = 100 \text{ cm} \\ 1 \text{ km} = 100,000 \text{ cm} \end{array} \quad \begin{array}{r} 50,000 \text{ pennies} \\ 2 \text{ cm} \overline{) 100,000 \text{ cm}} \\ \underline{10} \end{array}$$

$$1 \text{ km} \times \frac{1000 \text{ m}}{1 \text{ km}} \times \frac{100 \text{ cm}}{1 \text{ m}} = 100,000 \text{ cm}$$

Problem 2

Estimate the mass of the water on the Earth?

- Earth's circumference is 25,000 miles
- Density of water is 1 g/cm^3
- Average Ocean Depth is about 1 km
- Ocean coverage is about 70% - 75%.

Assignment Comments



Need to complete #2. Definitely will be on the midterm. Contact me if you need help.

X

**CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET**

Introduction to Computation in Chemical Engineering

Instructor: Dr. Lealon L. Martin

Title of Assignment

Homework 3

Outcome Measured Using this Assignment

Outcome D1.1

Students will have the ability to identify, formulate, and solve fundamental engineering problems by applying principles of engineering, science, and mathematics

Check the complex engineering problem characteristics related to this assignment

Brief justification of why this assignment is suitable for this outcome

This assignment focuses on engineering problem-solving using dimensional analysis and unit conversion as solution methodology.

ABOVE AVERAGE

Find: Mass $\text{Al}_2\text{O}_3 = ?$ pounds
 (call) Do! what? where? How?
 Estimate the mass (in pounds) of Al_2O_3 in the Earth's moon's crust using D.A.

Fact Pattern:

$$C = 7,000 \text{ miles}$$

$$d_{\text{avg.}} = 2550 \text{ kg/m}^3$$

$$U = \frac{15 \text{ mass } \text{Al}_2\text{O}_3}{100 \text{ mass } \text{Emc}}$$

$$FE = 37 \text{ miles FE}$$

$$FO = 62 \text{ miles FO}$$

Need Equations

$$C = 2\pi R \quad D = \frac{M}{V}$$

$$M_s = U \cdot M_{\text{Al}_2\text{O}_3}$$

$$M_{\text{Al}_2\text{O}_3} = 4\pi R^2$$

Circumference:

$$7000 \text{ mi} \times 1.609 \text{ km} = 11263 \text{ km}$$

$$7000 = 2\pi R \rightarrow R = \frac{C}{2\pi} = \frac{11263 \text{ km}}{2\pi} = 1792.5 \text{ km}$$

$$R = 1792.5 \text{ km}$$

$$M = V \cdot D = (3.3366 \times 10^{18} \text{ m}^3) (2550 \frac{\text{kg}}{\text{m}^3})$$

$$= 8.50833 \times 10^{21} \text{ kg}$$

$$\text{Mass } \text{Al}_2\text{O}_3 = 15\% \Rightarrow \frac{15}{100} \times 8.50833 \times 10^{21} \text{ kg}$$

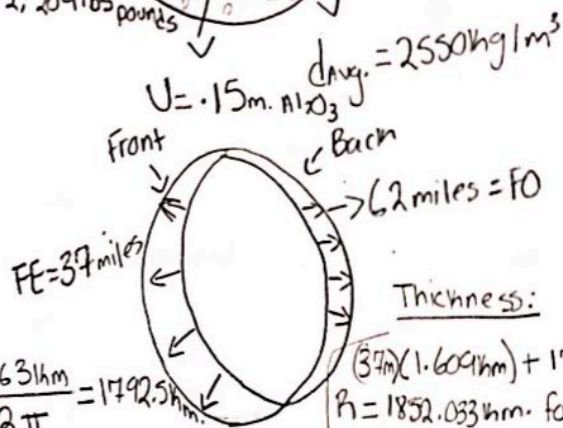
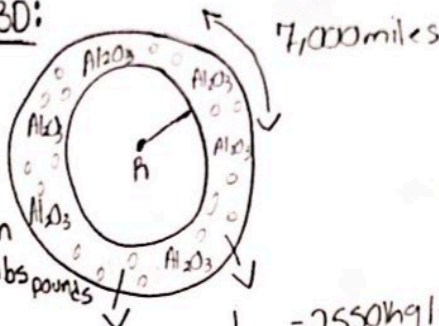
$$= 1.2895 \times 10^{21} \text{ kg}$$

kg $\rightarrow$ Pounds

$$\text{Mass } \text{Al}_2\text{O}_3 \Rightarrow (1.2895 \times 10^{21}) (2.204 \text{ pounds})$$

$$= 2.843 \times 10^{21} \text{ pounds}$$

FBD:



$$\text{Volume: } \frac{2}{3}\pi(R^3 - r^3)$$

$$\frac{2}{3}\pi(1852.033 \text{ km}^3 - 1792.5 \text{ km}^3)$$

$$= 1.24222 \times 10^9 \text{ km}^3$$

$$(62 \text{ mi})(1.609 \text{ km}) + 1792.5 \text{ km}$$

$$R = 1892.258 \text{ km for FO}$$

$$\frac{2}{3}\pi(R^3 - r^3)$$

$$\frac{2}{3}\pi(1892.258 \text{ km}^3 - 1792.5 \text{ km}^3)$$

$$= 2.09439 \times 10^9 \text{ km}^3 \text{ for FO}$$

Volume Total:

$$(1.24222 + 2.09439) \times 10^9 \text{ km}^3$$

$$= 3.33661 \times 10^9 \text{ km}^3$$

$$\Rightarrow 3.3366 \times 10^{18} \text{ m}^3$$

AVERAGE

Submitted Files: (click to load)

[CHEG 1202 HW # 3.pdf](#)

Assessment

Grade out of 100

90

Assignment Comments

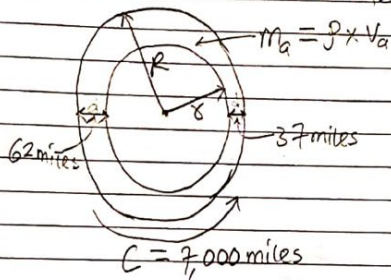


Good steps. Just need to represent the information in X dimensional analysis form.

Jessica Rhone, Oct 13, 2021 at 4:59pm

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M_a = mass of alumina in Earth's moon's Crust [?] Lb
 ρ = average density of moon's Crust [$\frac{\text{kg}}{\text{m}^3}$]
 d = thickness of Crust [miles]
 θ = Composition of alumina in Crust [mass alumina / mass of Crust]
 C = Earth's moon's Circumference [miles]



Given: ρ of moon's Crust 2550 kg/m^3
 Crust thickness 37 miles & 62 miles
 C of Earth's moon = 7,000 miles $\rightarrow$ Assumed

Unknown: mass of Crust (M_c) = ?
 Volume Crust (V_c) = ?
 Radius of Earth (R) = ?

Equations:

$$M_c = \rho V_c$$

$$V = 4\pi R^2 d \text{ for } d \ll R \quad d \text{ not constant}$$

$$V = \frac{4}{3}\pi R^3$$

$$C = 7000 \text{ miles} = 2\pi R$$

$$R = \frac{7000}{2\pi} \text{ miles}$$

Conversions: 1 mile = 1.60934 km

Earth side
 $R = 8 + 37(1.60934) = 1792.22 = 1851.77 \text{ km}$

$V_{\text{out}} = \frac{2}{3}\pi(R^3 - r^3)$
 $= \frac{2}{3}\pi(1851.77^3 - 1792.22^3)$
 $= 1.24271 \times 10^9 \text{ km}^3$

OPPOSITE earth side
 $R = 8 + 62(1.60934) = 1792.22 + 99.779$
 $= 1891.99 \text{ km}$

Volume of Crust (V_{in}) $= \frac{2}{3}\pi(1891.99^3 - 1792.22^3)$
 $= 2.12857 \times 10^9 \text{ km}^3$

Total volume $= (1.24271 \times 10^9 + 2.12857 \times 10^9) \text{ km}^3$
 $= 3.3713 \times 10^9 \text{ km}^3$
 $= 3.3713 \times 10^{18} \text{ m}^3$

Mass Crust $= \text{volume} \times \text{density}$
 $3.3713 \times 10^{18} \text{ m}^3 \times 2550 \frac{\text{kg}}{\text{m}^3}$
 $= 8.5968 \times 10^{21} \text{ kg}$

Mass of alumina $= 15\% \text{ of mass Crust}$
 $= \frac{15}{100} \times 8.5968 \times 10^{21} \text{ kg}$
 $= 1.2895 \times 10^{21} \text{ kg}$

$\text{kg} = 2.20462 \text{ pounds}$
 $= 1.2895 \times 10^{21} \text{ kg} \times \frac{2.20462 \text{ lb}}{1 \text{ kg}}$
 $= 2.843 \times 10^{21} \text{ lb}$

Student Viewed Document: Oct 14, 2021 at 2:57pm

Submitted Files: (click to load)

[CHEG 1202 HW # 3.pdf](#)

Assessment

Grade out of 100

90

Assignment Comments



Good steps. Just need to represent the information in X dimensional analysis form.

Jessica Rhone, Oct 13, 2021 at 4:59pm

[Download Submission Comments](#)

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BELOW AVERAGE

Home work #3

7000 miles - Km

$$2 \times \frac{22}{7} \times \pi = 7000 \times 1.60934$$

$$\pi = 1792.22 \text{ Km}$$

same { $R = \text{For the side facing earth}$
 $R = 1851.77 \text{ Km}$
 $V = \text{of the crust}$

$$1.24271 \times 10^9 \text{ Km}^3$$

same { $R = \text{side Not facing the earth}$
 $R = 1891.99 \text{ Km}$
 $V = \text{of the crust}$

$$V = 2.12857 \times 10^9 \text{ Km}^3$$

Total Volume of the crust

$$(1.24271 \times 10^9 \text{ Km}^3 + 2.12857 \times 10^9 \text{ Km}^3)$$

$$= 3.3713 \times 10^9 \text{ Km}^3$$

Volume x Density = Mass of crust

$$3.3713 \times 10^9 \text{ Km}^3 \times 2550 \frac{\text{Kg}}{\text{m}^3}$$

$$= 8.5968 \times 10^{21} \text{ Kg}$$

Mass of Alumina 15%

$$1 \text{ Kg} = 2.20462 \text{ pounds}$$

$$1.2895 \times 10^{21} \text{ Kg} \times 2.20462 \text{ lbs}$$

$$= 2.843 \times 10^{21} \text{ pounds}$$

$$\frac{15}{100} \times 8.5968 \times 10^{21} \text{ Kg}$$

$$= 1.2895 \times 10^{21} \text{ Kg}$$

Assignment Comments



Make sure to write out all formulas needed to solve and X add a labeled picture.

Jessica Rhone, Oct 13, 2021 at 4:39pm

**CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
Introduction to Computation in Chemical Engineering
Instructor: Dr. Lealon L. Martin**

Title of Assignment

Homework 4

Outcome Measured Using this Assignment

Outcome D1.1

Students will have the ability to identify, formulate, and solve fundamental engineering problems by applying principles of engineering, science, and mathematics

Check the complex engineering problem characteristics related to this assignment

Brief justification of why this assignment is suitable for this outcome

This assignment focuses on engineering problem-solving using basic calculus concepts.

ABOVE AVERAGE

Kefah Mongare HW #4

1. Given: Demand
 Price @ \$7 = 1000 Customers
 Price @ \$6 = 1200 Customers

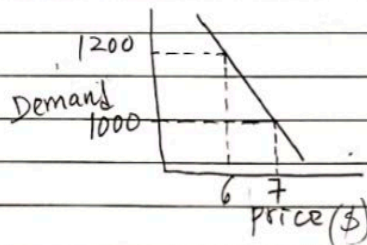
$$y = mx + C$$

y = Demand

m = Δ of demand with Cost

C = initial Price

x = Demand



$$m = \frac{1200 - 1000}{6 - 7} = -200$$

$$y = -200x + C$$

$$D = -200P + C$$

$$1000 = -200 \times 7 + C$$

$$C = 1000 + 1400 = 2400$$

$$D = -200P + 2400$$

Total revenue = Total demand $\times$ Price per person

$$= (-200P + 2400)P = -200P^2 + 2400P$$

$$\text{Max revenue } \frac{d}{dP} (\text{Total revenue}) = 0$$

$$\frac{d}{dP} (-200P^2 + 2400P) = 0$$

$$= -400P + 2400 = 0$$

$$\frac{400P}{400} = \frac{2400}{400} = 6 = \$6$$

To maximize revenue price will be kept at \$6

2. $P = 100 - 0.01x$

$$C(x) = 50x + 10,000$$

$$E(P) = \frac{-P f'(P)}{f(P)} = \frac{P(-50)}{-50P + 10,000} = \frac{P}{-P + 200}$$

$$3. \quad \frac{dT}{dz} = \left(\frac{1-\delta}{\delta} \right) \frac{Mg}{R}$$

$$PV = nRT$$

$$P = \frac{nRT}{V}, \quad \frac{n}{V} = M$$

$$P = MRT$$

$$\frac{dP}{dz} = \frac{dP}{dT} \cdot \frac{dT}{dz}$$

$$\frac{d(TP^{\frac{1-\delta}{\delta}})}{dP} = 0$$

$$P^{\frac{1-\delta}{\delta}} \frac{dT}{dP} + T \frac{dP^{\frac{1-\delta}{\delta}}}{dP} = 0$$

$$P^{\frac{1-\delta}{\delta}} \cdot \frac{dT}{dP} + T \left(\frac{1-\delta}{\delta} \right) \frac{P^{\frac{1-2\delta}{\delta}}}{P^{\frac{1-\delta}{\delta}}}$$

$$= -T \left(\frac{1-\delta}{\delta} \right) P^{\frac{1-2\delta}{\delta}}$$

$$\frac{dT}{dP} = -TP^{\frac{1-2\delta}{\delta}} \cdot \left(\frac{1-\delta}{\delta} \right)$$

$$\frac{dP}{dz} = \frac{dP}{dT} \cdot \frac{dT}{dz} = \left(\frac{1-\delta}{\delta} \right) \frac{Mg}{R} \cdot \frac{1}{-TP^{\frac{1-2\delta}{\delta}} \left(\frac{1-\delta}{\delta} \right)}$$

$$= -\frac{Mg}{RT P^{\frac{1-\delta}{\delta}}} = -\frac{Mg}{R}$$

Constant

$$\frac{dP}{dz} = -MgP = -MPg$$

$$4. \quad a = 32 \text{ ft/s}^2, \quad t = 2 \text{ s}$$

$$a = \frac{dv}{dt}$$

$$\int a dt = \int dv, \quad \int a dt = v$$

$$(a) \quad at = v \quad t = 2 \text{ s}$$

$$v = at$$

$$v = 32 \text{ ft/s}^2 (2 \text{ s}) = 64 \text{ ft/s}$$

$$v = \frac{dh}{dt}$$

$$b) \quad \int v dt = \int dh$$

$$vt = h$$

$$s = vt = 64 \text{ ft/s} (2 \text{ s}) = 128 \text{ ft}$$

$$(c) \quad \text{Total distance travelled by ball} = (h \times 2)$$

$$= 128 \text{ ft} \times 2 = 256 \text{ ft}$$

$$\int_{t=0}^{t=f} v dt = vt \Big|_{t=0}^{t=f} = 64 \Big|_0^t = 256$$

$$64t = 256$$

$$t = \frac{256}{64} = 4 \text{ seconds}$$

$$(d) \quad v(t) = at = 32t$$

$$\text{upward velocity} = 64 \text{ ft/s}$$

$$\text{downward velocity} = -32(4) = -128 \text{ ft/s}$$

$$\text{final velocity} = -128 \text{ ft/s} + 64 \text{ ft/s} = -64 \text{ ft/s}$$

$$= -64 \text{ ft/s} \text{ retardation}$$

$$= 64 \text{ ft/s}$$

AVERAGE

CEDRIC SANTOVIDA

Homework 4

①

Tour price that should be charged per person to maximize the total revenue each week?

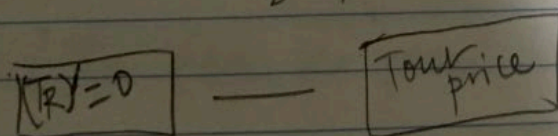
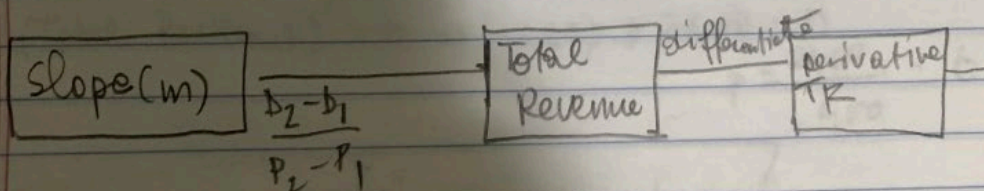
1. Tour price = \$7/Person (P_1) } Regular Price
Customer = 1000 week (D_1)

Tour price = \$6/Person (P_2) } Lowered Price
Customers = 1200 week (D_2)

We also know demand equation is linear.
rise over run

Let's consider the slope $(m) = \frac{D_2 - D_1}{P_2 - P_1}$

We also know Total Revenue (TR) is equal to the total demand $\times$ Price per person



2

elasticity of demand ?

Demand function $p = 100 - 0.01x$

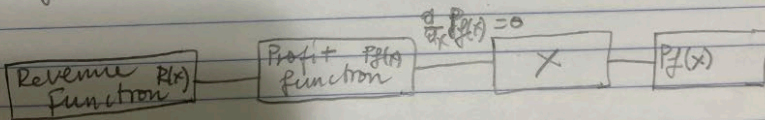
Cost function $c(x) = 50x + 10,000$

Revenue function is $x(p)$, let's call it $R(x)$

The Profit function will be $P_f(x) = \underset{\text{Revenue}}{R(x)} - \underset{\text{Cost}}{C(x)}$

To maximize profit, $\frac{d}{dx} P_f(x) = 0$ to find x and

plug it back in the $P_f(x)$ function.



Solve:

$$R(x) = x(p(x)) = x(100 - 0.01x) = 100x - 0.01x^2$$

$$\text{Profit function } (P_f(x)) = R(x) - C(x) = (100x - 0.01x^2) - (50x + 10,000)$$

$$(P_f(x)) = 50x - 0.01x^2 - 10,000$$

For max Profit, $(P_f(x))' = 0$

$$50 - 0.02x = 0 \quad \Rightarrow \quad -0.02x = -50$$

$$x = 2500$$

Jessica Rhone

Revenue function should be different equation; -5

Reply

let's find cost function at $x=2500$

$$C(x) = 50(2500) + 10000 = \boxed{135000}$$

$$P_p(2500) = 50(2500) - 0.01(2500)^2 - 10000$$
$$P_p(x) = \boxed{52500}$$

The demand is elastic.

■ Jessica Rhone

Answer is inelastic -5

BELOW AVERAGE

CEDRIC SANTHOVIDI

Homework 4

①

Tour price that should be charged per person to maximize the total revenue each week?

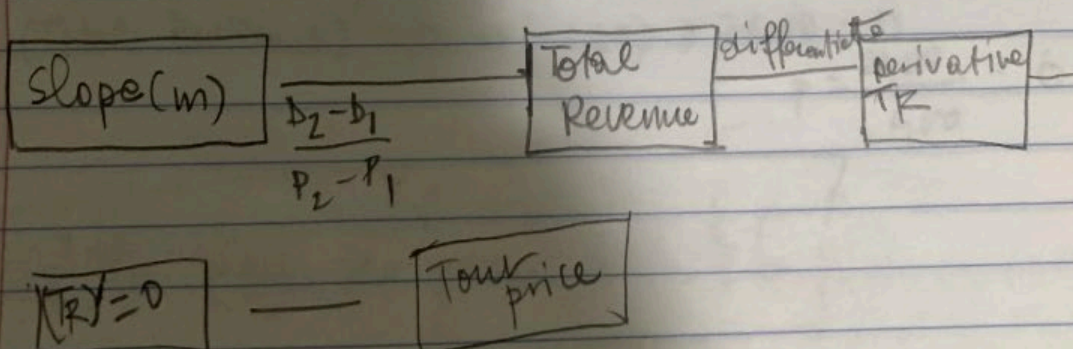
Tour price = \$7/Person (P_1) } Regular Price
Customer = 1000 Week (D_1) }

Tour price = \$6/Person (P_2) } Lowered Price
Customers = 1200 Week (D_2) }

We also know demand equation is linear!
Rise over Run

Let's consider the slope (m) = $\frac{D_2 - D_1}{P_2 - P_1}$

We also know Total Revenue (TR) is equal to the total demand $\times$ Price per person



Solve!

$$\frac{D_2 - D_1}{P_2 - P_1} = \frac{1200 + 1000}{6 - 7} = -2000$$

$$D = mp + C \Rightarrow -2000p + C$$

the line goes through (D_1, P_1) & (D_2, P_2)

$$\Rightarrow 1000 = -2000(7) + C$$

$$C = 1000 + 14000 = 15000$$

$$\Rightarrow D = -2000p + 15000 \quad (1)$$

$$\begin{aligned} \text{Total Revenue} &= \text{Total demand} \times \text{price per person} \\ &= (-2000p + 15000) \times P \\ &= -2000p^2 + 15000p \end{aligned}$$

For maximize Revenues let's do the derivative and set equal to zero:

$$(\text{Total Revenue})' = (-2000p^2 + 15000p)' = -4000p + 15000$$

$$\begin{aligned} (\text{Total Revenue})' = 0 &\Rightarrow -4000p + 15000 = 0 \\ p &= \frac{15000}{4000} = 3.75 \end{aligned}$$

So the price per person is \$3.75

2

Elasticity of demand ?

Demand function $p = 100 - 0.01x$

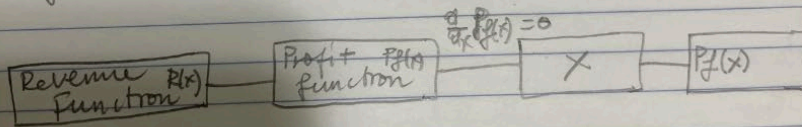
Cost function $C(x) = 50x + 10000$

Revenue function is $x(P_x)$, let's call it $R(x)$

The Profit function will be $P_f(x) = \underset{\text{Revenue}}{R(x)} - \underset{\text{Cost}}{C(x)}$

To maximize profit, $\frac{d}{dx} P_f(x) = 0$ to find x and

plug it back in the $P_f(x)$ function.



Solve:

$$R(x) = x(P(x)) = x(100 - 0.01x) = 100x - 0.01x^2$$

$$\text{Profit function } (P_f(x)) = R(x) - C(x) = (100x - 0.01x^2) - (50x + 10000)$$

$$(P_f(x)) = 50x - 0.01x^2 - 10000$$

For max Profit, $(P_f(x))' = 0$

$$50 - 0.02x = 0 \quad \Rightarrow \quad -0.02x = -50$$

$$\boxed{x = 2500}$$

Jessica Rhone

Revenue function should be different equation; -5

Reply

let's find cost function at $x = 2500$

$$C(x) = 50(2500) + 10000 = \boxed{135000}$$

$$P_D(2500) = 50(2500) - 0.01(2500)^2 - 10000$$

$$P_D(x) = \boxed{52500}$$

the demand is elastic.

□ Jessica Rhone

Answer is inelastic -5

4

Given

Max height : ?

Time to max height = 2 second

acceleration 32 ft/s^2

- the initial velocity is zero (thrown from ground at $t=0$).

Also to find velocity we can use the anti-derivative of acceleration.

$$\int_0^t 32 \, dt = \left[32t \right]_0^t = 32t - 0 = 32t$$

$$v = 32t$$

- Maximum height reached by the ball :

is the height is the distance traveled by ball which is antiderivative of velocity.

$$\int_0^2 32t \, dt = \left[16t^2 \right]_0^2 = 16 \times 4 = 64 \text{ ft}$$

- t to reach the ground

$d=0$ when ball hits ground so :

$$\text{So } t = 85$$

$$16t^2 - 32t + 64 = 0$$

$$16(1 - 8)(4 - 8) = 0$$

Jessica Rhone

Initial velocity should be different;
should be first derivative -3

CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
Introduction to Computation in Chemical Engineering
Instructor: Dr. Lealon L. Martin

Title of Assignment

Exam 1: Midterm

Outcome Measured Using this Assignment

Outcome D1.1

Students will have the ability to identify, formulate, and solve fundamental engineering problems by applying principles of engineering, science, and mathematics

Check the complex engineering problem characteristics related to this assignment

Assignment problem	
x	Application of mathematics
x	Application of Chemical Engineering Thermodynamics Principles

Brief justification of why this assignment is suitable for this outcome

This assignment focuses on engineering problem-solving using dimensional analysis and unit conversion as solution methodology and basic calculus concepts.

ABOVE AVERAGE

ROY G. PERRY COLLEGE OF ENGINEERING
INTRODUCTION TO COMPUTATIONS IN CHEMICAL ENGINEERING CHEG 1202
COURSE ASSIGNMENT GRADING AND OUTCOME ASSESSMENT SHEET FOR
FALL 2021 SEMESTER

ABET OUTCOME a: Ability to apply the knowledge of mathematics, science, and engineering.
Assignments that test competency in this area will include problems that test a student's ability to apply knowledge of and solve differential calculus applied to physical and engineering problems.

Name: Jerina Mnyagara

Title of Assignment: Exam 1 Due Date: Oct. 19/2021

Description of Performance Criteria Being Assessed	Max for this Assignment	Your Score
(D.1) Ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics <i>This assignment tests students' knowledge and application of intermediate mathematics and involves their competency in applying and solving problems using the Identify, Formulate, and Solve methodology as applied to real world problems</i>		
TOTAL	100	73

Introductions to Computations in Chemical Engineering CHEG 1202-P01

Fall 2021 - Exam 1

October 19, 2021

Answer all questions. Read the information given in each problem carefully and follow instructions. You will be graded based on your ability to apply knowledge of intermediate mathematics to general applications using the problem-solving method: IDENTIFY, FORMULATE, SOLVE. Show clearly each step of your calculation. Clarity of presentation would ensure that you do not lose all the points for a calculation if you should make a mistake.

1. (50 points) The Earth's mantle is a layer of silicate rock, containing large amounts of magnesium oxide (MgO or "magnesia"), located between the Earth's crust and the Earth's outer core. Estimate the mass (in kg) of magnesia in the Earth's upper mantle using dimensional analysis. Assume the following:
 - Earth's circumference is 25,000 miles
 - Average density of the upper mantle is 3.4 g/cm^3
 - The upper mantle starts at about 25 km below the Earth's crust downward to about 400 km below the Earth's crust
 - The upper mantle is about 38.73% magnesia on a mass basis

Extra information:

- 1 mile = 1.6 km
- Circumference of a sphere = $\pi \times \text{diameter of the sphere}$
- Volume of a shell of with some thickness = $4\pi \times (\text{radius of the sphere})^2 \times \text{thickness}$ (for instances when the thickness is much much smaller than the radius)

2. (50 points) Suppose that you want to extract magnesia (MgO) from the Earth's mantle, but you realize that the magnesia in the Earth's mantle can only be mined in an alloy form with iron oxide (FeO) – meaning that MgO and FeO comprise a mixture. Assume that the MgO/FeO alloy is on an equal mass basis. If you want to extract two (2) U.S. tons of MgO per year, how many moles of MgO/FeO alloy must you mine from the Earth's mantle per day?

Extra information:

- Molar Masses: $\text{MgO} = 40.3044 \frac{\text{lbs}}{\text{lb-mol}}$; $\text{FeO} = 71.844 \frac{\text{lbs}}{\text{lb-mol}}$
- 1 ton = 2000 lbs.
- 1 year = 365 days

ii: Estimate the mass (in kg) of magnesia in the Earth's upper mantle using dimensional analysis.

#1

How 43/50 where

(Identify)

Given: Earth's circumference: 25,000 miles

Average density of the upper mantle 3.4 g/cm^3

Upper mantle starts about 25 km below Earth's crust downward to 400 km below Earth's crust

Upper mantle is about 38.73% magnesia on a mass basis

$\theta = 38.73\% \rightarrow .3873$

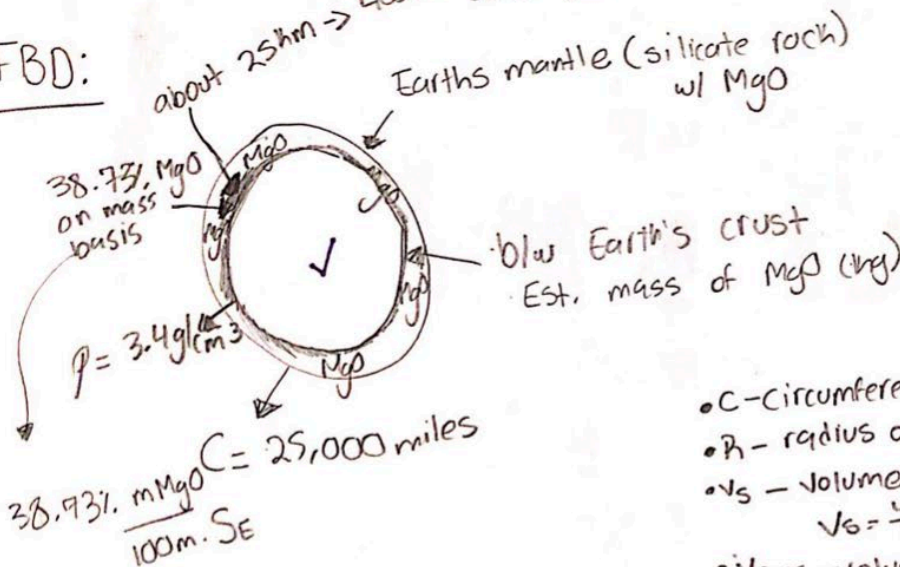
Formula: $C = \pi \cdot \text{diameter}$

V of shell w/ thickness $= 4\pi r^2 (\text{thickness})$

Unit: 1 mile = 1.6 km

$M = D \cdot V$ $D = \frac{M}{V}$

FBD:



- C - Circumference of a circle
- R - radius of a circle
- V_s - Volume of a sphere
 $V_s = \frac{4}{3}\pi r^3$
- V_{sur} - volume of surface
 $V_{sur} = 4\pi r^2$

1

rate:
→ $\frac{1}{h}$

↓
 d

↓ of shell w/ thickness
↓
 θ

→ $m = \rho \times V_w$
↓
 ρ_{MgO}

Jerina Mnyapara
MMgO (mg)

• $M_i \rightarrow km$

• $g \rightarrow kg$

SI: mass = kg

*C

Solve:

$$V = (.3873 \text{ MgO}) (4\pi R^2 d)$$

$$r = \frac{\text{circumference}}{2\pi}$$

$$= \frac{(.25000 \text{ miles}) (1.6 \text{ km} \cdot \cancel{\text{mi}^{-1}})}{2\pi} \Rightarrow 6.283 \times 10^{-4} \text{ km.}$$

↳ volume of surface?

$$\Rightarrow \left(\frac{1g}{\cancel{\text{cm}^3}} \right) \left(\frac{1kg}{1 \times 10^3 g} \right) \left(\frac{(1 \times 10^5 \cancel{\text{cm}^3})}{(1 \text{ km})^3} \right) (.3873 \text{ MgO}) (4\pi) \cdot$$

$$(6.283 \times 10^{-4} \cancel{\text{kg}})^2 (1 \cancel{\text{km}})$$

$$\Rightarrow 1.921 \times 10^{12} \text{ kg} \cdot \text{MgO}$$

(2)

... page 3

$$= \frac{4}{3} \pi r^3 \quad \frac{dv}{dr} = \left(\frac{4}{3} \pi r^2 \right)^3 = \boxed{4\pi r^2}$$

Jerina Mnyapara

$$dv = 4\pi r^2 dr \quad V_s = 4\pi r^2 d$$

$$\frac{C}{2\pi} = \frac{2\pi R}{2\pi} \rightarrow R = \frac{C}{2\pi}$$

$$V_s = 4\pi R^2 d = 4\pi \left(\frac{C}{2\pi} \right)^2 d$$

$$\theta = \frac{V_w}{V_s} = .3873 \text{ MgO}$$

$$V_w = .3873 V_s$$

* Needed diff b/w surface & upper mantle

* Needed V of upper mantle.

$$\frac{25,000 \text{ C-mi}}{1 \text{ C-mi}} \cdot \frac{\frac{1}{2} R \text{ -mi}}{1 \text{ R-mi}} \cdot \frac{1.6 R \text{ -km}}{1 \text{ R-km}} \cdot \frac{4\pi (2 \times 6.283 \times 10^4 \text{ km}^5 \text{ -surf.})}{1 \text{ R-km}}$$

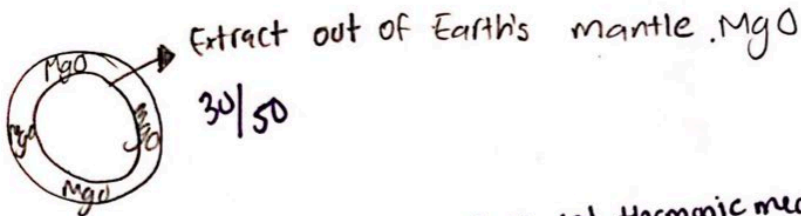
$$\frac{.3873 \text{ km}^3 \text{ MgO}}{1 \text{ km}^3 \text{ surf}} \cdot \frac{(10^5 \text{ cm}^3 \text{ MgO})^3}{1 \text{ km}^3 \text{ MgO}} \cdot \frac{1 \text{ g MgO}}{1 \text{ cm}^3 \text{ MgO}} \cdot \frac{10^3 \text{ kg MgO}}{1 \text{ g MgO}}$$

$$\Rightarrow \boxed{1.223 \times 10^{17} \text{ kg MgO}}$$

* Part of Question 1!

(3)

ify: / Goal: IF you want to extract Jering Mnyapara
 200(2) U.S tons of MgO per year, how many moles
 of MgO/FeO alloy must you mine from the Earth's
 mantle per day?



* Needed Harmonic mean formula

Given: • MgO & FeO comprise a mixture

• Molar Masses: $MgO = 40.3044 \frac{lbs}{lb-mol}$, $FeO = 71.844 \frac{lbs}{lb-mol}$

- ✓ • 1 ton = 2000 lbs
 • 1 year = 365 days

Assume: MgO/FeO alloy is on an equal basis
 ✓

Two(2) U.S tons of MgO	2000 lbs	$40.3044 \frac{lbs}{lb-mol}$
	1 ton	1 molar mass $MgO = 1.612 \times 10^5$

Two(2) U.S tons of FeO	2000 lbs	$71.844 \frac{lbs}{lb-mol}$
	1 ton	1 molar mass $FeO = 2.874 \times 10^5$

$(1.612 \times 10^5) + (2.874 \times 10^5) = 4.486 \times 10^5 \text{ lb-mol} \dots FeO \& MgO \text{ per year}$
 $(4.486 \times 10^5 \text{ lb-mol} = FeO \& MgO \text{ per year}) \left(\frac{365 \text{ days}}{1 \text{ year}} \right)$

(4)

$\Rightarrow 4.637 \text{ lb-mol} \text{ } MgO/FeO \text{ alloy}$

AVERAGE

Mass of Magnesia in Earth's upper mantle = ? Kg

Earth Circumference = 25,000 miles ✓
 density upper mantle = 3.4 g/cm^3

Upper mantle = 38.73% Magnesia

under crusts crust from 25 to 400 = 375 km

45/50

$$\frac{25,000 \text{ miles}}{1} \times \frac{1.6 \text{ km}}{1 \text{ mile}} = 40,000 \text{ km}$$

$$\frac{375 \text{ km}}{1} \times \frac{1 \text{ mile}}{1.6 \text{ km}} = 234.375 \text{ miles}$$

Volume of Earth's crust $V = 4\pi (3978.875 \text{ miles})^2 \times 234.375 \text{ miles} = 4.66 \times 10^{10} \text{ miles}^3$

diameter of Earth's crust

$$\frac{25000 \text{ miles}}{\pi} = \frac{\pi d}{\pi}$$

$$d = 7957.75 \text{ miles}$$

$$\frac{40,000 \text{ km}}{2\pi} = 6366.2 \text{ km}$$

* needed diameter
 diff b/w crust &
 upper mantle

$$\frac{7957.75}{2} = R = 3978.875 \text{ miles}$$

$$V = 4\pi (6366.2 \text{ km})^2 \times 375 \text{ km} = 1.91 \times 10^{11} \text{ km}^3$$

$$1.91 \times 10^{11} \text{ km}^3 \times \frac{1 \times 10^{15} \text{ cm}^3}{1 \text{ km}^3} = 1.91 \times 10^{26} \text{ cm}^3$$

$$1.91 \times 10^{26} \text{ cm}^3 \times \frac{3.4 \text{ g}}{1 \text{ cm}^3} = 6.494 \times 10^{26} \text{ g}$$

$$\frac{38.73\%}{100\%}$$

2. 18.25 miles

$$\frac{75000}{2\pi} = 3978.87 \text{ m/s}$$

$$3978.87 \text{ m/s} \cdot \frac{1.6 \text{ km}}{1 \text{ m}} = 6366.192 \text{ km}$$

$$1.91 \times 10^{26} \text{ g} \times \frac{33.73}{100} = 7.4 \times 10^{25} \text{ g}$$
$$7.4 \times 10^{23} \text{ kg}$$

Mass of magnesium in Earth's upper mantle is $7.4 \times 10^{23} \text{ kg}$

$MgO = 40.3044$ 30/60

$FeO = 71.844$ * Need harmonic mean formula!

$$\frac{40.3044}{2} = 20.1522 \text{ } MgO$$
$$= 56.0772$$

$$\frac{71.844}{2} = 35.922 \text{ } FeO$$

$$56.0772 \frac{165}{16 \text{ mol}} \times \frac{2 \text{ tons}}{4000 \text{ lb}} = .6780 \frac{\text{tons}}{16 \text{ mol}} \times \frac{365 \text{ days}}{1 \text{ year}} = 20.5 \text{ tons}$$

$$117.1484 \frac{MgO}{FeO} \frac{165}{16 \text{ mol}} \times \frac{2 \text{ tons}}{4000 \text{ lb}} = .0561 \frac{\text{tons}}{16 \text{ mol}} \times \frac{365 \text{ days}}{1 \text{ year}} = 16.2 \text{ tons}$$

$$\frac{20.1522}{2} = 10.0761$$
$$= 78.0371 \frac{MgO}{FeO} \frac{165}{16 \text{ mol}} \times \frac{2 \text{ tons}}{4000 \text{ lb}} \times \frac{365 \text{ days}}{1 \text{ year}} = 5.1 \text{ tons}$$

$$\frac{35.922}{2} = 17.961$$

$$\frac{10.0761}{2} = 5.03805$$
$$= 14.01855 \frac{MgO}{FeO} \frac{165}{16 \text{ mol}} \times \frac{2 \text{ tons}}{4000 \text{ lb}} \times \frac{365 \text{ days}}{1 \text{ year}} = 2.55 \text{ tons}$$

$$\frac{17.961}{2} = 8.9805$$

$$10.95890411 \frac{MgO}{FeO} \frac{165}{16 \text{ mol}} \times \frac{2 \text{ tons}}{4000 \text{ lb}} \times \frac{365 \text{ days}}{1 \text{ year}} = 7 \text{ tons}$$

must mix 10.95890411 moles of MgO/FeO

$$21$$

$$31 \quad 40.3644 \frac{\text{MgO}}{16 \text{ mol}} \times \frac{7 \text{ tons}}{4000 \text{ lb}} = 0.701572 \frac{\text{tons}}{16 \text{ mol}}$$

$$2 \quad = 0.86072$$

$$31 \quad 71.544 \frac{\text{FeO}}{16 \text{ mol}} \times \frac{7 \text{ tons}}{4000 \text{ lb}} = 0.35972 \frac{\text{tons}}{16 \text{ mol}}$$

1.

2

4.

2

BELOW AVERAGE

ROY G. PERRY COLLEGE OF ENGINEERING
INTRODUCTION TO COMPUTATIONS IN CHEMICAL ENGINEERING CHEG 1202
COURSE ASSIGNMENT GRADING AND OUTCOME ASSESSMENT SHEET FOR
FALL 2021 SEMESTER

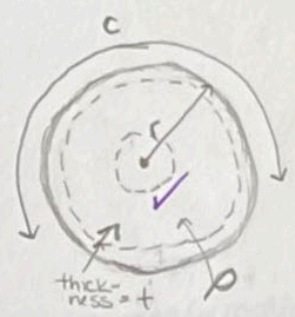
ABET OUTCOME a: Ability to apply the knowledge of mathematics, science, and engineering.
Assignments that test competency in this area will include problems that test a student's ability to apply knowledge of and solve differential calculus applied to physical and engineering problems.

Name: De'ja Hoskey

Title of Assignment: Exam 1 Due Date: October 19th, 2021

Description of Performance Criteria Being Assessed	Max for this Assignment	Your Score
(D.1) Ability to identify, formulate, and solve engineering problems by applying principles of engineering, science, and mathematics <i>This assignment tests students' knowledge and application of intermediate mathematics and involves their competency in applying and solving problems using the Identify, Formulate, and Solve methodology as applied to real world problems</i>		
TOTAL	100	60

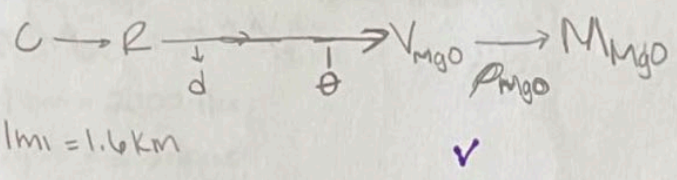
Earth's circumference $C = 25,000$
 averaged density of the $\rho_{MgO} = 3.4 \text{ g/cm}^3$
 Upper mantle
 upper mantle starts 25 km below crust to 400 km below
 upper mantle is 38.73% magnesia on mass basis
 Find: M_{MgO} - mass of magnesia
 in kg



35/50 * needed volumetric diff. b/w crust & upper mantle

t = thickness

Formulate



$1 \text{ mi} = 1.6 \text{ km}$

C = circumference of circle
 r = radius of circle
 V_s = volume of shell
 V_{MgO} = volume of MgO

Solve

t ?

$$C = 2\pi r \Rightarrow r = \frac{C}{2\pi} \quad C = 40000 \text{ km} \quad r = \frac{40000 \text{ km}}{2\pi} \quad t = 400 - 25$$

$$V_s = 4\pi r^2 t = 4\pi \left(\frac{C}{2\pi}\right)^2 t$$

$$\rho = \frac{m}{V} \Rightarrow V_{MgO} = 4\pi (6366.2)^2 375 \quad r = 6366.2 \quad V_{MgO} = 1.9 \times 10^{18} \text{ cm}^3$$

$$V_s = 4\pi r^2 t$$

$$C = 2\pi r \Rightarrow \pi \cdot d$$

$$r = \frac{C}{2\pi}$$

25,000 C-mi	1.6 C-km		$M = 6.49356322 \times 10^{11} \text{ g MgO}$	$\frac{1 \text{ kg MgO}}{10^3 \text{ g MgO}}$
1 C-mi	1.6 km			

$g \text{ } 1000g = 1Kg \quad \frac{2}{649,350,000 \text{ kg MgO}} \quad ?$

4
MgO/FeO is mixture

MgO/FeO alloy = mass basis

$$MM_{MgO} = 40.3044 \frac{\text{lbs}}{\text{lb mol}}$$

$$MM_{FeO} = 71.844 \frac{\text{lbs}}{\text{lb mol}}$$

Find: n_{MgO} — moles of MgO per day

25/50

* Needed harmonic mean formula

Formulate

$$MM_{MgO} = 40.3044 \frac{\text{lbs}}{\text{lb mol}} \quad n = \frac{m}{MM}$$

$$MM_{FeO} = 71.844 \frac{\text{lbs}}{\text{lb mol}} \quad n = \frac{m}{MM}$$

$$1 \text{ ton} = 2000 \text{ lbs}$$

$$1 \text{ year} = 365 \text{ days}$$

n = moles
 m = mass
 MM = molar mass

Solve

$$40.3044 \text{ MM}_{MgO}$$

$$71.844 \text{ MM}_{FeO}$$

$$n = \frac{2000 \text{ lbs}}{40.3044 \text{ lb/mol}}$$

$$n = 49.6223 \text{ lb/mol MgO}$$

$$\frac{49.6223 \text{ lb/mol MgO/FeO}}{1 \text{ year}} \times \frac{1 \text{ year}}{365 \text{ days}} = 0.1359 \text{ lb/mol MgO}$$

**CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
INTRODUCTION TO COMPUTATIONS IN CHEMICAL
ENGINEERING
FALL 2021**

Instructor: Dr. Lealon L. Martin

Title of Assignment

Project 1

Outcome Measured Using this Assignment

Assignment problem	
x	Application of “Identify, Formulate, and Solve” methodology
x	Application of Chemical Engineering Thermodynamics Principles

Check the complex engineering problem characteristics related to this assignment

Outcome D1.1

Students will have the ability to identify, formulate, and solve fundamental engineering problems by applying principles of engineering, science, and

Brief justification of why this assignment is suitable for this

The student’s ability to apply new knowledge as needed, using appropriate learning strategies based on an “identify, formulate, and solve” methodology.

ABOVE AVERAGE

MEMORANDUM

Date: October 19th, 2021

To: Dr. LEALON L. Martin

From: Chau Truong

Re: Midterm Exams - Finding the character mixing time and concentration in feed storage tank of an Impeller mixer.

Introduction

An impeller mixer makes use of a feeder storage tank with sodium chloride solution which is fed to a smaller vessel with pure liquid water, which dilutes it. Also, the concentration of NaCl solution is Unknown. The fluid leaving the smaller vessel is then passed through an electrical conductivity meter (EC meter) to find the character mixing time and the unknown concentration of NaCl of the system as shown in figure below.

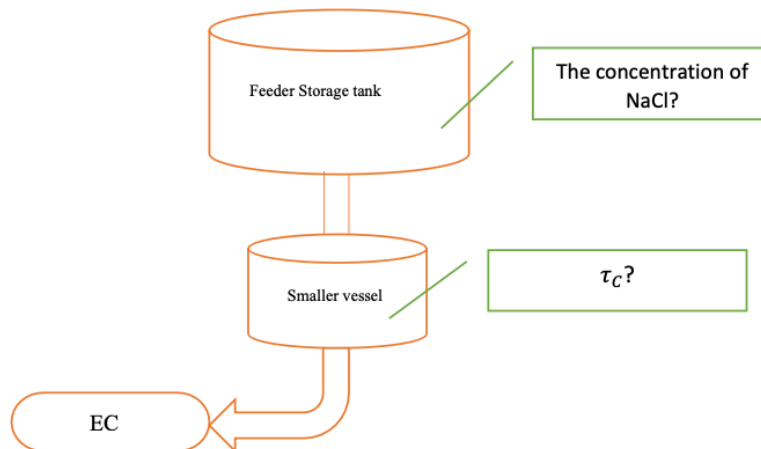


Figure 1: The Impeller Mixer

Objectives

1. To develop the model that best describes the mean EC-C calibration curve.
2. To convert the mean EC data into NaCl concentration
3. To develop the linearization model.
4. To determine the change of NaCl concentration Data using the linearized model.
5. To evaluate the efficiency of the mixer by Finding T_c , and the concentration of NaCl in the feed storage tank C_f

Results

1. The first objective was to develop a model that the best describes the mean EC-calibration curve. Before that, we should find the mean EC of 3 trials, the variance and standard deviation, they can be seen in the table 1.

Table 1: Find the geometric mean, variance, standard deviation, show error bar.

N	sample time(s)	electrical conductivity of the Vessel Mixture(mS)			variance	standard deviation
		trial 1	trial 2	trial 3		
	x				y	
1	0	0.01	-0.01	0.02	0.0	0.0008
2	10	203.6	203.7	203.9	203.7	0.0233
3	20	305.2	350.1	350.3	350.2	0.0100
4	30	457.4	457.3	457.0	457.2	0.0433
5	40	535.9	535.6	535.4	535.6	0.0633
6	50	592.9	593.1	593.0	593.0	0.0100
7	60	634.9	635.0	635.0	635.0	0.0033
8	70	665.4	665.6	665.8	665.6	0.0400
9	80	688.3	688.1	688.0	688.1	0.0233
10	90	704.5	704.4	704.6	704.5	0.0100
11	100	716.3	716.5	716.5	716.4	0.0133
12	110	725.2	725.2	725.4	725.3	0.0133
13	120	731.8	731.6	731.7	731.7	0.0100
14	130	736.3	736.5	736.8	736.5	0.0633

Figure 2 below shows the geometric mean electrical conductivity of the vessel mixture at the times, and the error bar.

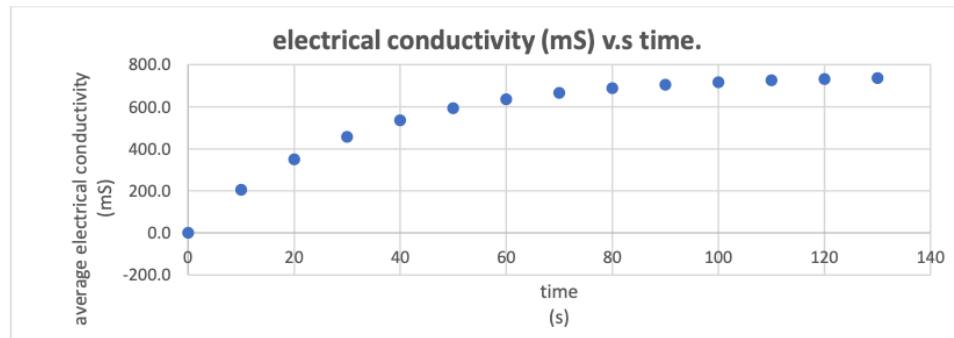


Figure 2: average electrical conductivity (mS) vs Time (s)

- The second aim was to convert the EC data into NaCl concentration using calibration model, and the data presented as shown below:

Table 2: Converted EC data into NaCl concentration data.

N	Mean EC (mS)-y	C (moles NaCl/L)-x	x*y	y*y	x*x	Fitting Parameters	Value	C-model
1	0	0	0	0	0	m	1491.4	3.6
2	80	0.05	4	6400	0.0025	b	3.6	78.17
3	155	0.1	15.5	24025	0.01	r	1.0	152.74
4	230	0.15	34.5	52900	0.0225			227.31
5	300	0.2	60	90000	0.04			301.88
6	375	0.25	93.75	140625	0.0625			376.45
Sum	1140	0.75	207.75	313950	0.1375			
sum^2	1299600	0.5625						

The mean vs concentration NaCl are presented in the figure 3 below.

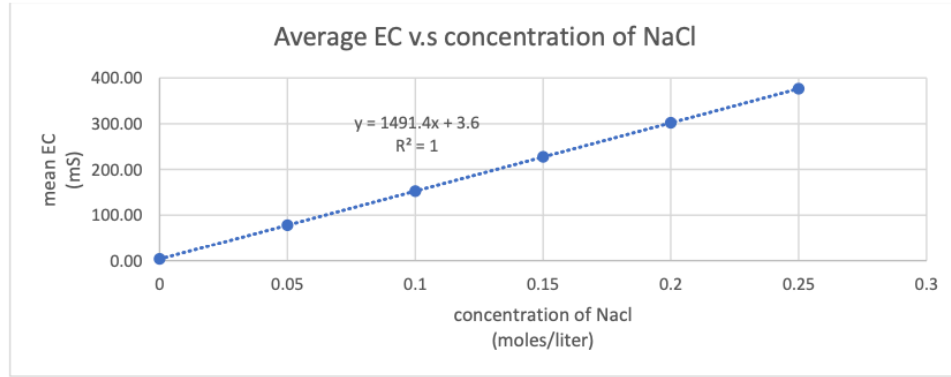


Figure 3: The graph showing the converted EC data into NaCl concentration using the new model

C-model:

$$y = 1491.4x + 3.6$$

$$\text{or: } EC_{(t)} = 1491.4 C_{(t)} + 3.6$$

$$\text{So } C_{(t)} = \frac{EC_{(t)} - 3.6}{1491.4}$$

3. The third objective was to linearize the model.

The model provided was $C_{(t)} = C_f(1 - e^{-\frac{t}{\tau_c}})$, with C_f = unknown (M)

$$C_{(t)} = C_f - C_f * e^{-\frac{t}{\tau_c}}$$

$$\frac{dC_{(t)}}{dt} = \frac{C_f}{\tau_c} * e^{-\frac{t}{\tau_c}}$$

The process of linearization included: $\ln\left(\frac{dC_{(t)}}{dt}\right) = -\frac{1}{\tau_c}t + \ln\left(\frac{C_f}{\tau_c}\right)$

linearization equation: $Y = mt + b$

Assume: $Y_{(t)} = \ln\left(\frac{dC_{(t)}}{dt}\right)$; $m = -\frac{1}{\tau_c}$; and $b = \ln\left(\frac{C_f}{\tau_c}\right)$

4. The fourth objective was to use the linearized model above and the relationship between EC and concentration NaCl in figure 3 of to transform the change of NaCl concentration Data with time $Y_{(t)} = \ln\left(\frac{dC(t)}{dt}\right)$. This was achieved through the table3 and 4 below:

Table 3: Transformed NaCl concentration Data vs time

n	sample time(s)	Geometric mean	concentration of NaCl	dc(t)/dt	ln[dCt/dt]
	t		C(t)=(EC(t)-3.6)/1491.4	c'(t)	y=ln[dCt/dt]
1	0	0.0		-0.0024	
2	10	203.7		0.1342	0.01174
3	20	350.2		0.2324	0.00850
4	30	457.2		0.3041	0.00622
5	40	535.6		0.3567	0.00455
6	50	593.0		0.3952	0.00333
7	60	635.0		0.4234	0.00243
8	70	665.6		0.4439	0.00178
9	80	688.1		0.4590	0.00130
10	90	704.5		0.4700	0.00095
11	100	716.4		0.4779	0.00070
12	110	725.3		0.4839	0.00051
13	120	731.7		0.4882	0.00038
14	130	736.5		0.4914	

Using the data revealed from the table above and perform regression in table 4

Table 4: linearized regression data of concentration.

n	sample time(s)	ln[dCt/dt]				Fitting Parameters	Value
	t	y	y*t	t*t	y*y	m	-0.0313
1	10	-4.4447	-44.447	100	19.755	b	-4.1
2	20	-4.7678	-95.357	400	22.732	r	-1.0
3	30	-5.0807	-152.421	900	25.813		
4	40	-5.3920	-215.681	1600	29.074		
5	50	-5.7041	-285.203	2500	32.536		
6	60	-6.0182	-361.094	3600	36.219		
7	70	-6.3310	-443.172	4900	40.082		
8	80	-6.6422	-531.377	6400	44.119		
9	90	-6.9603	-626.431	8100	48.446		
10	100	-7.2682	-726.825	10000	52.827		
11	110	-7.5754	-833.289	12100	57.386		
12	120	-7.8873	-946.475	14400	62.209		
sum	780.00	-74.07	-5261.769	65000	471.200		
sum*2	608400.00	5486.66					

The figure 4 below was a new Y- model that show the change of NaCl concentration while the time was changing.

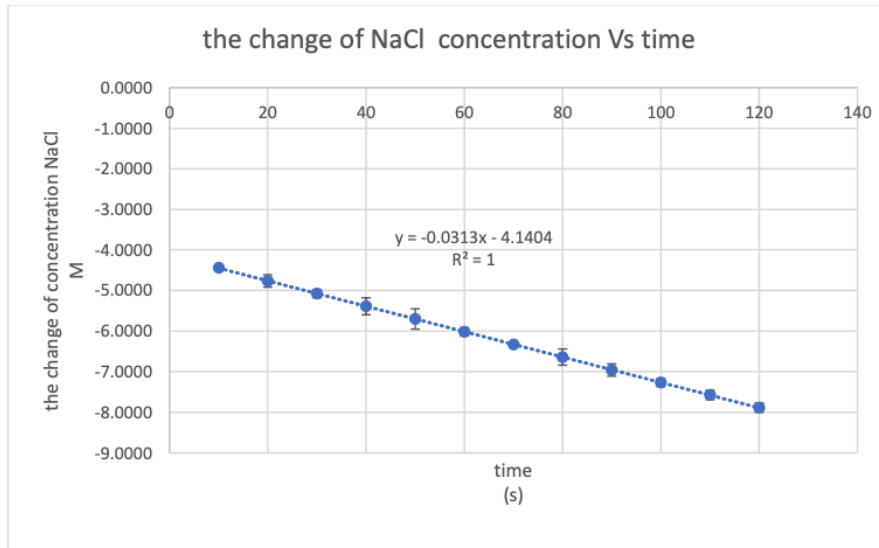


Figure 4: A graph showing the change in concentration vs. Time

- The last objective was to evaluate the efficiency of the mixer by Finding τ_c , and the concentration of NaCl in the feed storage tank. This was achieved by using the formulas obtained in the previous parts as follows:

$$-\frac{1}{\tau_c} = m \quad \text{Hence,}$$

$$\tau_c = \frac{-1}{m} \text{ but } m = -0.0313$$

$$\tau_c = 32$$

$$b = \ln\left(\frac{C_f}{\tau_c}\right) = -4.1$$

$$\frac{C_f}{\tau_c} = e^{-4.1} \Rightarrow C_f = \tau_c * e^{-4.1} = 0.51 \text{ M}$$

Discussion

From the given data in table 1, the data sample time (s) portrays an exponential growth $10s$, $10s*2=20s$, $10s*3=30s$, so the geometric mean can be use. The variance and standard deviations are used to measure the degree of dispersion in the given data set in order to eliminate any data set that might be an outlier. After calculated the geometric mean, variance, standard deviations, the Figure 2 is used to describe the relationship between the two variables which is non-linear, and the independent variable on x-axis is sample time in seconds while the dependent variable on y-axis is electrical conductivity. Also, the error bar does not show up on the plot because the standard deviations are every small than the means.

Table 2 consists of dependent variable, the mean electrical conductivity and independent variable, standard concentrations of NaCl in moles for each liter. The relationship between the variables is linear, so no need to transform. To get a new C model, I need to use linear regression to find parameters b, m and r in order to form the equation $y = mx + b$ as shown in figure 3. The equation of this relationship is $y = 1491.4x + 3.6$ where 1491.4 is the slope and 3.6 the y intercept, beside that I can tell the y-intercept is true because I can see a line almost cross the origin. This model for transformed standard concentration of NaCl and mean electrical conductivity has r of 1.0 bigger than 0.9. This shows b and m are good to use to present the new concentration of NaCl (x-axis) and EC (y-axis) model $C_{(t)} = \frac{EC_{(t)} - 3.6}{1491.4}$. Also, on the figure 3, I did use the error bar and it didn't show up on the vertical line because the standard deviation is smaller than the mean EC. Therefore, the error bar will not show up if I do it right.

The equation provided was $C_{(t)} = C_f(1 - e^{-\frac{t}{\tau_c}})$ is non-linear, which is then harder to model how each value is changing. In the equation, $C_{(t)}$ is the independent variable of time t, C_f was

unknown and τ_c is the characteristic mixing time. First of all, I use differentiation rule to convert the model, then transform the model by taking the log on both sides, and finally after linearization model, I got $Y = \ln\left(\frac{dC(t)}{dt}\right)$, $m^* = -\frac{1}{\tau_c}$; and $b^* = \ln\left(\frac{C_f}{\tau_c}\right)$.

To find $Y = \ln\left(\frac{dC(t)}{dt}\right)$, the change of concentration by time, I needed to transform the concentration NaCl with time by using the connection between the relationships of mean EC with time and the means EC with concentration NaCl. After got the concentration data depend on time, I used central derivative to compute the data points by formula $(C_3 - C_1)/(t_3 - t_1)$, then using logarithm to find data Y as showed in table 3.

The table 4 describes the relationship between the two variables, Y(t) is the dependent variable, the t is the independent variable, and right now I use the formula of linear regression to find parameter b, m and r, then I find $m = -0.0313$, $b = -4.1$. The coefficient of determination r is -1, and $|r| = 1 \geq 0.9$, so we can know equation $Y = -0.00313t - 4.1$ is the best fit to present the change of NaCl concentration while the time was changing, and b and m are reasonable to use to find τ_c and C_f . In the figure 4, I did use the error bar by the standard deviation, and they were show up.

Base on the $m = -0.0313$, I can calculate τ_c which already denoted above $m = -\frac{1}{\tau_c}$, τ_c is found to be 32 s, which is small value, highlighting that the vessel is a good at mixing in a dilution process, and I also use $b = \ln\left(\frac{C_f}{\tau_c}\right)$ to find the concentration NaCl in the feed storage tank by taking exponent e n both sides, and using τ_c and b which was found so $C_f = 0.51$ M.

Conclusion and recommendation

The results highlighted that the impeller mixer was good efficient in diluting the NaCl because of the low $\tau_c = 32s$. The low T_c could be a result of adequate time for NaCl of the feeder tank dilute in the smaller vessel. Perhaps the τ_c could have been better if shorter time was given between opening the large feeder tank's vessels and opening of the smaller vessel's valves, or the impeller need to rotate faster, to get it dilute faster.

AVERAGE

Memorandum

Date: October 26, 2021

To: Dr. Lealon L. Martin

From: Kefah Mongare

Re: Midterm Exam (Determining the characteristic mixing time of an impeller mixer inside a small vessel ~~that is~~ placed in a feed tank containing an aqueous sodium chloride solution)

Introduction ← underline

A small vessel with an impeller mixer is filled with pure water and placed adjacent to the base of a feed tank containing aqueous solution of sodium chloride with constant concentration. A feed tube^{is} connected from the bottom of the feed tank to the top small vessel where the NaCl solution is allowed to flow through into the small vessel when its valve is open. When NaCl solution mixes with pure water in the small vessel, the mixture is allowed to flow through the second tube that passes through the electrical conductivity meter reader into the discharge drain. As this process goes on, the impeller mixer is turned on at the same time. The electrical conductivity measurements are taken at equal time intervals as shown in table 1. The process shown in figure 1 below shows a feed storage tank containing 0.22 M sodium hydroxide solution and tube with adjustable valve going into the small vessel that contains pure water and an impeller mixer. From the small vessel, another tube with an adjustable valve goes through a meter measuring the electrical conductivity when NaCl solution flows through the pure water as the impeller mixer is turned on and the valves are open. The last tank is where mixture of NaCl solution and water are discharged/drained to.

Sample Time (s)	Trial 1	Trial 2	Trial 3
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← Add Table 1 on top + center

0	0.01	-0.01	0.02
10	58	59	57.5
20	102.9	103.7	103.9
30	141.6	141.2	141.4
40	172.4	173.9	173.3
50	199.4	199.1	199.1
60	221.3	221.7	221.8
70	239.7	240	240.1
80	255.6	255	254.6
90	268	268.5	266.9
100	278.1	279.4	278.7
110	287.7	287.7	287.4
120	294.3	293	295.3
130	300.1	300.6	301

← move to results

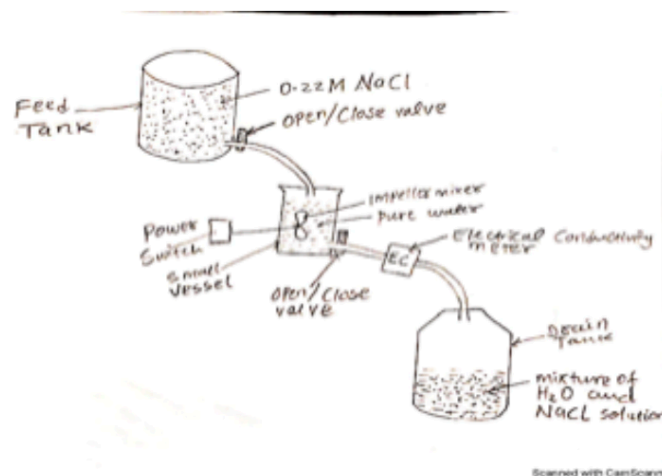


Figure 1: Vessel Mixing Example
(Describe in 2 sentences) ←

Objectives

- To develop a model best describes the mean electrical conductivity and concentration calibration curve
- To convert the electric conductivity data into NaCl concentration data using the calibration model
- To linearize the given equation that relates the concentration as a function of time exponentially
- Use the linearized model to transform the NaCl

as shown in Table 3 below. The graph of electrical conductivity verses time was a curve as shown in ~~Figure~~ Figure 3 below. Figure 2 above has the model equation that relates concentration C (moles NaCl per liter) with mean electric conductivity EC(mS).

Using Figure 2 model equation, $y = 0.0007x$, where y = concentration and x = mean electric conductivity. I converted the calculated electrical conductivity mean from Table 3 to NaCl concentration data by substituting my calculated electrical conductivity mean in place of x to find y as shown in Table 4

replace
w/
using

Table 3: Add Title

	Electrical Conductivity of the Vessel Mixture (mS)					
Sample Time (s)	Trial 1	Trial 2	Trial 3	Mean (GM)	Variance	Standard Deviation
0	0.01	-0.01	0.02	-0.0125992	0.00079	0.028108617
10	58	59	57.5	58.163333	0.58335	0.763773531
20	102.9	103.7	103.9	103.4991	0.28	0.529151419
30	141.6	141.2	141.4	141.39991	0.04	0.200000033
40	172.4	173.9	173.3	173.1989	0.57	0.75498464
50	199.4	199.1	199.1	199.19995	0.03	0.173205092
60	221.3	221.7	221.8	221.59989	0.07	0.264575163
70	239.7	240	240.1	239.93327	0.04333	0.208166613
80	255.6	255	254.6	255.06634	0.25333	0.503322459
90	268	268.5	266.9	267.79917	0.67	0.818535915
100	278.1	279.4	278.7	278.73283	0.42333	0.650641005
110	287.7	287.7	287.4	287.59997	0.03	0.173205086
120	294.3	293	295.3	294.19849	1.33	1.153257737
130	300.1	300.6	301	300.56644	0.20333	0.45092506

$$\begin{aligned}
 C(t) &= C_f (1 - e^{-\frac{t}{\tau_c}}) \\
 \frac{C(t)}{C_f} - 1 &= -e^{-\frac{t}{\tau_c}} \\
 1 - \frac{C(t)}{C_f} &= e^{-\frac{t}{\tau_c}} \\
 \ln \left[1 - \frac{C(t)}{C_f} \right] &= \ln e^{-\frac{t}{\tau_c}} \\
 \ln \left(1 - \frac{C(t)}{C_f} \right) &= -\frac{1}{\tau_c} t
 \end{aligned}$$

$$\begin{aligned}
 \ln \left(1 - \frac{C(t)}{C_f} \right) &= -\frac{1}{\tau_c} t \\
 y &= mx + b \\
 y &= \ln \left(1 - \frac{C(t)}{C_f} \right), \quad m = -\frac{1}{\tau_c} \\
 x &= t \\
 b &= 0 \\
 -\frac{1}{\tau_c} &= -0.0222 \\
 \therefore \tau_c &= \frac{1}{0.0222} = 45.045 \\
 \tau_c &= \frac{45.045}{5}
 \end{aligned}$$

← Try to write as a equation using word

The next

Next objective was to use the linearized model to transform the NaCl concentration data. From the linearized equation in the figure 4 above, I transformed concentration of NaCl from Table 4 above by putting the values in place of $C(t)$ in the dependent variable y . $C_f = 0.22M$ is constant, t is the time from Table 1.

After transforming the data, I performed linear regression to find the best model fit as shown in Table 6 below.

Linearized data(Y)	X*Y	X ²	Y ²	Model
3.83846E-05	0	0	1.47338E-09	0.005312
-0.195045813	-1.95046	100	0.038042869	-0.18422
-0.378811042	-7.57622	400	0.143497806	-0.37375
-0.56351523	-16.9055	900	0.317549414	-0.56327
-0.750089247	-30.0036	1600	0.562633878	-0.7528
-0.933669798	-46.6835	2500	0.871739292	-0.94233
-1.124349424	-67.461	3600	1.264161627	-1.13186
-1.313012495	-91.9109	4900	1.724001812	-1.32139
-1.501016894	-120.081	6400	2.253051717	-1.51092
-1.692216654	-152.299	8100	2.863597203	-1.70045
-1.891801	-189.18	10000	3.578911024	-1.88997
-2.089209495	-229.813	12100	4.364796314	-2.0795
-2.266430825	-271.972	14400	5.136708684	-2.26903
-2.473602405	-321.568	16900	6.118708856	-2.45856

Table 5: Add Title

The

Final objective was to perform regression on the transformed data to find τ after doing the regression. I plot a graph using the model from Table 5 above as the dependent variable and time t as dependent variable as shown in figure 4 below. The slope of the

Table 4: Add Title

GM Mean EC(Ms)	C(moles NaCl per liter)
-0.01259921	-8.44477E-06
58.16333271	0.038984668
103.4990967	0.069371506
141.3999057	0.094774975
173.1989024	0.116088633
199.1999498	0.133516145
221.5998947	0.148529976
239.9332731	0.160818141
255.0663357	0.170961257
267.7991655	0.179495589
278.7328271	0.186824006
287.5999652	0.192767311
294.1984926	0.197190053
300.5664411	0.201458246

The next objective was to linearize the given exponential equation. Table 5 below shows the linearized model

graph is the inverse of τ_c to find τ_c . I determined the inverse of the slope as shown in figure 4 above. ($\tau_c=45.04/s$)

Discussion

Conclusion and recommendations

which table? The first data table shows the relationship between electrical conductivity and time, plotting the mean of the 3 trials with time results to curve. To find the characteristic mixing time, I had to find a linear model that best relates the electrical conductivity with the mean concentration of NaCl solution. Given table 2 which shows the mean electrical conductivity for aqueous NaCl at standard conditions, I was able to convert my mean electrical conductivity data from table 3 to concentration data in table 4. After linearizing the given equation as shown in table in table 5, I transformed NaCl concentration data to fit in the linearized model as shown in table 6. I plot a graph of the linearized model with time and result was figure 4 four above. The slope of the figure 4 above is the inverse of τ_c . To find τ_c I took the inverse of the slope. The results ~~is confirmed by~~ because the slope ~~that~~ is expected to be a negative since the dependent variable involves natural log (ln). From figure 4 above....

— Add more to discussion :

- Errors and expand on them
- Issues w/ calculations
- Ways to fix errors
- What you learned from the project?

BELOW AVERAGE

Memorandum

Date: October 19, 2021

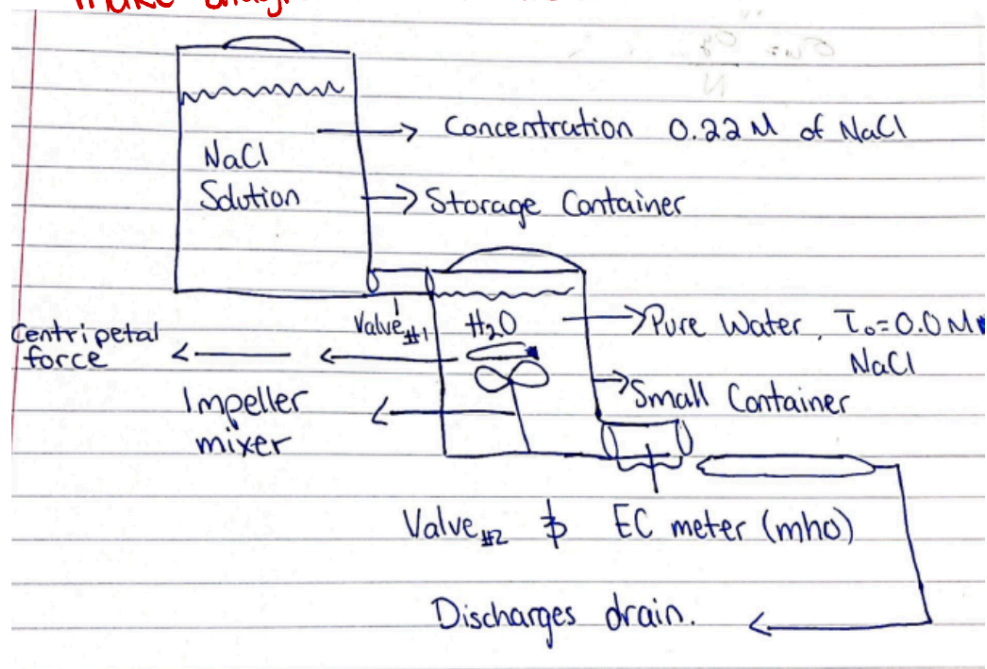
To: Dr. Lealon L. Martin

From: Alexander Ortiz

Re: "Application of the Scientific Method/Engineer Thought Process; Identify, Formulate & Solve during the analytical test of a mixer inside a vessel under specific circumstances".

Introduction: The purpose of this experiment is to check the performance of the mixer that resides inside the small container connected to a storage container that holds NaCl solution and an "Electro conductivity, or EC" device through two valves with an open/close lid, one for the storage container and one for the EC device. The validation is done through series of measurements of electroconductivity in a way that if the ohm measured are increasing constantly in pair with the concentration of NaCl then the mixer is performing well because the pure water inside the small container is slowly being replaced with NaCl which is better electric conductor than pure water until reaching the same concentration of NaCl as the storage container.

make diagram with microsoft word



Objectives.

1. Determine

- Determine if the solution leaving the small container while the mixer is on is affecting the electro conductivity value either in a positive, negative, or neutral way with a constant concentration of NaCl mole per liter of 0.22M from storage container to small container to the discharge valve.

2. Formulate

- This can change in electro conductivity value (mohm) can be determine by opening and closing both valves at the same time every 10 seconds. Upon completing 1 minute and 30 seconds, repeat at least 2 more trials and get the mean of EC and compare to the concentration of moles NaCl per liter (Molar) "table #2". If the solution NaCl was correctly mixed, we will notice that the values of EC would be increase as each lap of 10 seconds is completed due to the pure water either being pushed out through valve # 2 and/or the solution of pure water being mixed with NaCl until reaching the point of "Saturated Solution". Once the values of EC are obtained, the maximum value of Molar concertation (moles NaCl per liter) would be the same as the storage container that holds pure NaCl solution since the is equal to . Since the results would not be on pair as the ones showing on the table #2, a standardize of the graph process is needed for table #2 to obtain the slope that can be used later to obtain any concentration at t time. This would be used later on after obtaining the linearize equation of T/T_c) to obtain the "characteristic mixing time, T_c " value that would determine if the mixer were displaying a good performance at T-time.

3. Evaluate & Results

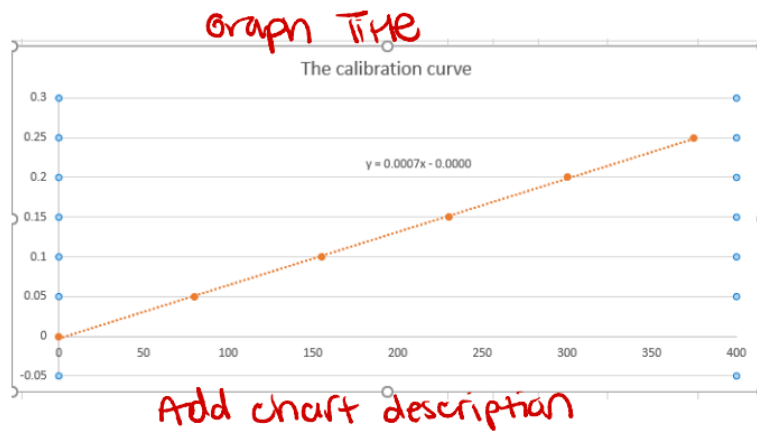
- We start by first using the date from table #2 "The calibration curve" to obtain our x_1 and y_1 values.

Table #2; The Calibration Curve

Mean EC (mS)	C (moles NaCl per liter)
0	0
80	0.05
155	0.1
230	0.15
300	0.2
375	0.25

From table 2, X is assigned to Mean EC (mS) while Y is assigned to C (Moles NaCl per liter)

- By plotting the values from above, we can use obtain the graph on figure #1 which meets the next objective of stablishing a model on which can be described EC-C calibration curve and develop the linearization by obtaining "" format from figure #1.



- c. As displayed on figure #1, we have obtained the calibration model that allows to convert EC data into NaCl contraction data, the m, x and b for tooon which we can give x any time value while y would represent the concentration of mole NaCl per liter.
- d. Now that we have obtained an equation on which allows to determine the concentration of NaCl at any given time, we can use this to obtain the “characteristic mixing time, T_c ” which will determine if indeed the mixer is meeting the requirements. First, we start by linearizing the model that express the concentration of NaCl inside the small container as a function of time, .

- e. We start with the original equation $C(t) = C_f (1 - e^{-t/T_c})$ and it is transformed into a linear equation by linearizing the equation as showing on figure #2

Figure #2

Linearization

$$C(t) = C_f (1 - e^{-t/T_c})$$

$$\ln C(t) = \ln C_f + \ln(1 - e^{-t/T_c})$$

$$\ln C(t) = \ln C_f + \ln(1) - \ln(e^{-t/T_c})$$

$$\ln [C(t)] = \ln (C_f) + 0 - \left(-\frac{t}{T_c}\right)$$

and let $y = \ln [C(t)]$

$$x = \left(-\frac{t}{T_c}\right)$$

$$b = \ln [C_f]$$

Type all equations

- f. Upon obtaining that new formula, we substitute now x_2 and y_2 as showing on figure#3

$$\text{let } y = \ln[c(t)]$$

$$x = \left(-\frac{t}{\tau_c}\right)$$

$$b = \ln[f]$$

Type all equations

- g. At this point, the same intervals of 10 seconds per sample is used while conducting the electrical conductivity of the vessel mixture (mS) table #2

Table #2, Electrical Conductivity of the Vessel Mixture (mS)

Electrical Conductivity of the Vessel Mixture (mS)			
Sample Time (s)	Trial 1	Trial 2	Trial 3
0	0.01	-0.01	0.02
10	58	59	57.5
20	102.9	103.7	103.9
30	141.6	141.2	141.4
40	172.4	173.9	173.3
50	199.4	199.1	199.1
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100	278.1	279.4	278.7
110	287.7	287.7	287.4
120	294.3	293	295.3
130	300.1	300.6	301

Add Table description and explanation

- h. Now we solve for τ_c , as we see increasing the value, it will prove that our mixer from the small container is working properly.

Discussion.

To determine if the mixer was working properly, it is needed a way to measure how well the solution is being mixed. One way to do it is by comparing the electrical conductivity of two substances which have different resistance as they are being release from the container that has the mixer and letting the solutions passed through a EC "electrical conductivity meter". On this case, pure water (H_2O) and sodium chloride ($NaCl$). By Nature, $NaCl$ is a better conductor than water due to the ionic bond of the two atoms that makes up this molecule. By letting the solution that is being release passed through the EC, we obtain a value on which we can later compare to the given standard value table #1 "Calibration curve". It is intuitive that as we are recording a higher number of mS from the solution that passes through the EC, we are getting a stronger concentration for $NaCl$ per liter, this indicates that the mixer inside the small container is working properly, however; to determine the instantaneous value of concentration at any given time, we can obtain the mean value from our standard values from table #1 and later use to determine the characteristic mixing time value that would quantify the performance of the mixer. This can be obtain once we have got our linear equation and determine the m, x and b value from the values and graph from table #1 and solving for τ_c from the equation $y = mx + b$ which after a period of T, the limit for the concentration on the small container for $NaCl$ mole per liter would be the same as the concentration of $NaCl$ mole per liter that was given for the storage container which on this case is 0.22M since the solution would become saturated solution

Conclusion and Recommendations

Unfortunately my results could not prove that the mixer indeed works properly due to making a mistake while plotting my data. I accidentally made the mistake of plotting the date from table #2 and using that graph to obtain the linear equation that later was used to find the concentration at any given time thus making my value for c_c incorrectly by making the result of c_c super bigger instead of getting a small number.

**CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
INTRODUCTION TO COMPUTATIONS IN CHEMICAL
ENGINEERING**

FALL 2021

Instructor: Dr. Lealon L. Martin

Title of Assignment

Exam 2

Outcome Measured Using this Assignment

Outcome D1.1

An ability to identify, formulate, and solve fundamental engineering problems.

Check the complex engineering problem characteristics related to this assignment

Assignment problem	
x	Application of “Identify, Formulate, and Solve” methodology
x	Application of Chemical Engineering Thermodynamics Principles

Brief justification of why this assignment is suitable for this outcome

The student’s ability to apply new knowledge as needed, using appropriate learning strategies based on an “identify, formulate, and solve” methodology.

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ROY G. PERRY COLLEGE OF ENGINEERING
INTRODUCTION TO COMPUTATIONS IN CHEMICAL ENGINEERING GNEG 2021
COURSE ASSIGNMENT GRADING AND OUTCOME ASSESSMENT SHEET FOR FALL 2021

ABET OUTCOME a: Ability to apply the knowledge of mathematics, science, and engineering.

Assignments that test competency in this area will include problems that test a student's ability to apply knowledge of and solve differential calculus applied to physical and engineering problems.

Name: CEDRIC SANTHOVIDI

Title of Assignment: Final EXAM Due Date: 12/2/2021

Description of Performance Criteria Being Assessed	Max for this Assignment	Your Score
(a.2) Ability to apply the knowledge of intermediate mathematics <i>This assignment tests students' knowledge and application of intermediate mathematics and involves their competency in applying and solving problems involving differential and integral calculus as applied to real world problems</i>		
TOTAL	100	100

Introduction to Computations in Chemical Engineering CHEG 1202

(Fall 2021) Exam 2

Due November 30, 2019 @ 12:30 pm IN CLASS

Answer all questions. Read the information given in each problem carefully and follow instructions. You will be graded based on your ability to apply knowledge of intermediate mathematics involving differential and/or integral calculus. Show clearly each step of your calculation. Clarity of presentation would ensure that you do not lose all the points for a calculation if you should make a mistake. Work each problem, being careful to IDENTIFY, FORMULATE, and SOLVE for maximum credit.

1. (30 POINTS) The marginal revenue function for a product is $44 - 5x$. The marginal cost is $3x + 20$, and the cost of producing 80 units is \$11400.
 - (a) Find the profit function.
 - (b) Find the profit or loss from selling 100 units.
2. (30 POINTS) A company determines their marginal cost for production, in dollars per item is $\frac{4}{\sqrt{x}} + 2$ when producing x thousand items. Assume that there is no cost if no items are produced. Find the cost (in dollars) of increasing production from 4 thousand items to 5 thousand items.
3. (40 POINTS) PV Excursions, LLC offers sightseeing tours of the Prairie View A&M campus and nearby area. One tour, priced at \$7 per person, had an average demand of about 1000 customers per week! When the price was lowered to \$6, the weekly demand jumped to about 1200 customers!! Assuming that the demand equation is linear, find the tour price that should be charged per person to maximize the total revenue each week.

M2.

Problem 1

a) Find the profit function $P(x)$?

Given:

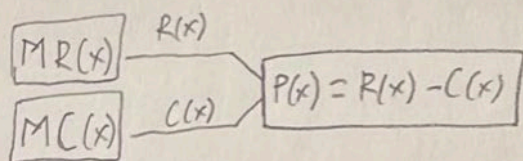
$MR(x)$ or Marginal revenue function $= 44 - 5x$

$MC(x)$ or Marginal cost function $= 3x + 20$

$R(x)$ = Revenue function $= \int MR(x) \, dx$?

$C(x)$ = Cost function $= \int MC(x) \, dx$?

$$P(x) = R(x) - C(x)$$



Solve

$$R(x) = \int MR(x) = \int (44 - 5x) dx = 44x - \frac{5x^2}{2} + C$$

$$R(x) = 44x - \frac{5x^2}{2} \quad \text{since } R=0 \text{ at } x=0 \Rightarrow C=0$$

$$C(x) = \int MC(x) = \int (3x + 20) dx = \frac{3x^2}{2} + 20x + C$$

$$\text{We have } x = 80 \Rightarrow C(80) = 11400$$

$$\Rightarrow C(x) = \frac{3(80)^2}{2} + 20(80) + C$$

$$\Rightarrow 11400 = \frac{3(80)^2}{2} + 1600 + C \Rightarrow C = 200$$

$$\Rightarrow C(x) = \frac{3x^2}{2} + 20x + 200 \quad \checkmark$$

$$P(x) = R(x) - C(x)$$

$$P(x) = 44x - \frac{5x^2}{2} - \frac{3x^2}{2} - 20x - 200$$

$$P(x) = 24x - 4x^2 - 200 \quad \checkmark$$

b) Profit or loss at $x = 100$ units:

$$P(100)?$$

$$P(100) = 24(100) - 4(100)^2 - 200$$

$$P(100) = -37800$$

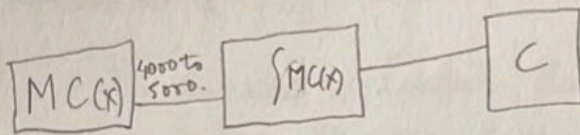
there will be a loss of 37800. $\checkmark$

Cost in dollars of increasing production C ?

Given

$$MC(x) \text{ or marginal cost production} = \frac{4}{\sqrt{x}} + 2$$

Limits of increase from 4000 to 5000.



Solve

$$\begin{aligned} C &= \int_{4000}^{5000} \left(\frac{4}{\sqrt{x}} + 2 \right) dx = \left[8\sqrt{x} + 2x \right]_{4000}^{5000} \checkmark \\ &= (8\sqrt{5000} + 2(5000)) - (8\sqrt{4000} + 2(4000)) \checkmark \\ &= 2059.7 \checkmark \end{aligned}$$

$$C = \$2059.7$$

or Price P that should be change for max total revenue? ^(Problem 3)

Given

Current fare Price = \$7/person (P_1)

Number of customers per week = 1000 cstr/week (D_1)

Lowered Price (P_2) = \$6

Demand at P_2 is $D_2 = 1200$ cstr/week

Since the demand is linear, the slope (m) can be written as:

$$\text{slope}(m) = \frac{D_2 - D_1}{P_2 - P_1} \quad \text{Rise over Run}$$

The line can be written as: (demand, price)

$$D = \left(\frac{D_2 - D_1}{P_2 - P_1} \right) P + C$$

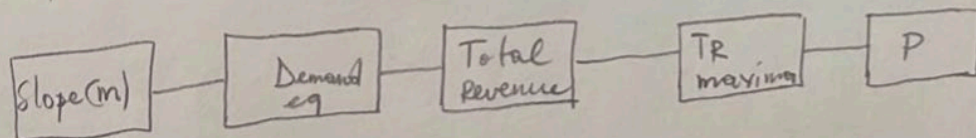
The total revenue will be:

Total demand $\times$ Price/person

$$T_R = D \times P$$

To maximize revenue each week we need to find a maxima of the Total revenue function:

$$\frac{d}{dP}(T_R) = 0 \quad \text{and find } P$$



$$m = \frac{D_2 - D_1}{P_2 - P_1} = \frac{1200 - 1000}{6 - 7} = -200$$

$$D = mP + C = -200P + C$$

Demand = 1000 cstr/week at $P = \$7$

$$\Rightarrow 1000 = -200(7) + C \Rightarrow C = 1000 + 1400$$

$$C = 2400$$

$$D = -200P + 2400$$

$$TR = D \times P = (-200P + 2400) \times P$$

Maxima

$$\frac{d}{dP}(TR) = \frac{d}{dP}(-200P^2 + 2400P) = 0 \checkmark$$

$$\Rightarrow -400P + 2400 = 0$$

$$400P = 2400$$

$$P = \frac{2400}{400} = 6 \checkmark$$

The tour price that should be charged for maximum total revenue is \$6. $\checkmark$

AVERAGE

Mohamad Alwan

100

Marginal Revenue function $R'(x) = 44 - 5x$

Marginal Cost function $C'(x) = 3x + 20$

The Cost of producing 80 unit ($x=80$) is \$11400

$$\text{Profit} = \text{Revenue} - \text{Cost} = R(x) - C(x) = P(x)$$

$\uparrow$ $\uparrow$
 $R'(x)$ $C'(x)$

Revenue function $R(x) = \int R'(x) dx = \int 44 - 5x dx = 44x - \frac{5x^2}{2} + C$

Cost function $C(x) = \int C'(x) dx = \int 3x + 20 dx = \frac{3x^2}{2} + 20x + C$

$$C(80) = \frac{3(80)^2}{2} + 20(80) + C = 11400 \quad \Rightarrow C = 200$$

$$R_C) = 44 \cdot (x) - \frac{5x^2}{2} + C = 0 \quad \Rightarrow C = 0$$

$$R(x) = 44x - \frac{5x^2}{2}, \quad C(x) = \frac{3x^2}{2} + 20x + 200 \quad \checkmark$$

Profit function $P(x) = R(x) - C(x)$

$$44x - \frac{5x^2}{2} - \frac{3x^2}{2} - 20x - 200$$

$$P(x) = 24x - 4x^2$$

Profit or loss from 100 units

$$x = 100 \quad P(x) = 24x - 4x^2$$

$$P(100) = 24 \cdot 100 - 4(100)^2 = -37600$$

Loss of \$37600 $\checkmark$

Marginal Cost function $C'(x) = \frac{4}{\sqrt{x}} + 2$ when x

$$4000 < x < 5000$$

$$\text{Assuming } C(x) = C(0) = 0$$

$$\text{Cost function } C(x) = \int \left(\frac{4}{\sqrt{x}} + 2 \right) dx = 2x + 8\sqrt{x} + C \quad \checkmark$$

$$C(0) = 2(0) + 8\sqrt{0} + C = 0 \quad \Rightarrow C = 0$$

$$C'(x) = \frac{4}{\sqrt{x}} + 2 \quad \text{when production goes from } 4000 \text{ to}$$

$$C(x) = \int_{4000}^{5000} \left(\frac{4}{\sqrt{x}} + 2 \right) dx = (2x + 8\sqrt{x}) \Big|_{4000}^{5000} = 2060 \quad \checkmark$$

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OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
INTRODUCTION TO COMPUTATIONS IN CHEMICAL
ENGINEERING
FALL 2021**

Instructor: Dr. Lealon L. Martin

Title of Assignment

Final Project

Outcome Measured Using this Assignment

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Assignment problem	
x	Application of "Identify, Formulate, and Solve" methodology
x	Application of Chemical Engineering Thermodynamics Principles

ABOVE AVERAGE

Memorandum

Date: November 30, 2021

To: Dr. Lealon L. Martin

From: Carol Akpan

Re: Final Project Regressing NaCl Mixing Vessel finding Vessel Concentration and Solving the Mixing Time according to Electrical Conductivity.

95/100

Introduction

A feed storage tank full of concentrated NaCl is mixed with pure water into an Electrical Conductivity tank to record the milli-siemens (mS) mixing of time in seconds (s) according to the concentration of the solution in moles. The experiment in Introduction to CHEG models a vessel mixing experiment of sodium chloride to determine the concentration of the NaCl solution in the first feed tank and find the characteristic mixing time of the vessel. The system in *Figure 1* features the illustration of the mixing vessel system. *Figure 1* shows a feed storage tank filled with NaCl solution, sent through open/close pipes that lead to a smaller vessel containing pure water. The sodium chloride solution combines with the water by an impeller mixer and then is measured by an electrical conductivity meter by the milli siemens (mS). Finally, the solution of NaCl and water passes out of the EC meter and is discarded down a drain. *Figure 2* and *Figure 3* are the modeled given data from the fact pattern. *Figure 2* indicates a linear trend calibration curve concentration (mol/L) mean EC (mS), whereas *Figure 3* is sourced from the EC measurements from the mixture over three trials concerning time (s) and (mS).

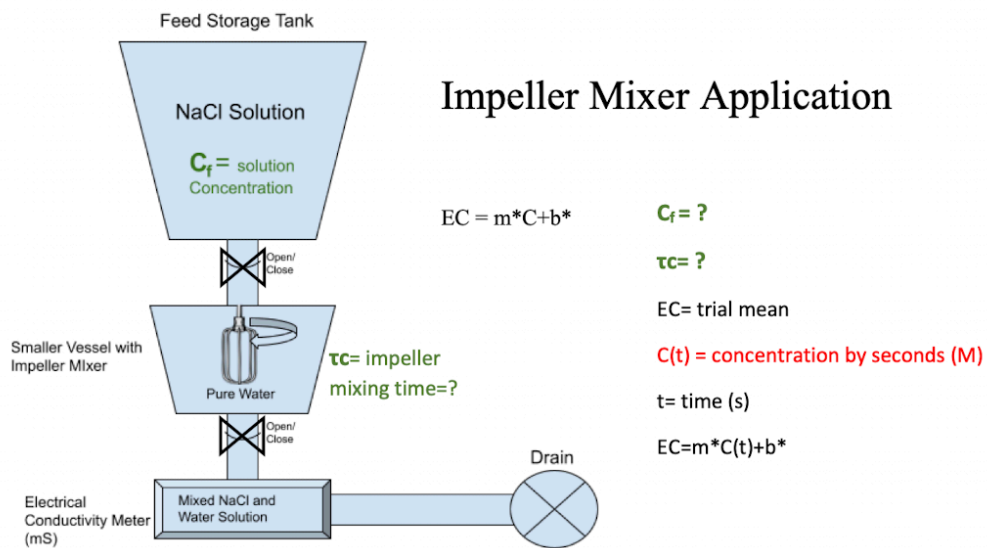


Figure 1: Illustration of feed tank with NaCl, a small water vessel with an impeller mixer complete with Electrical Conductivity meter and drainage.

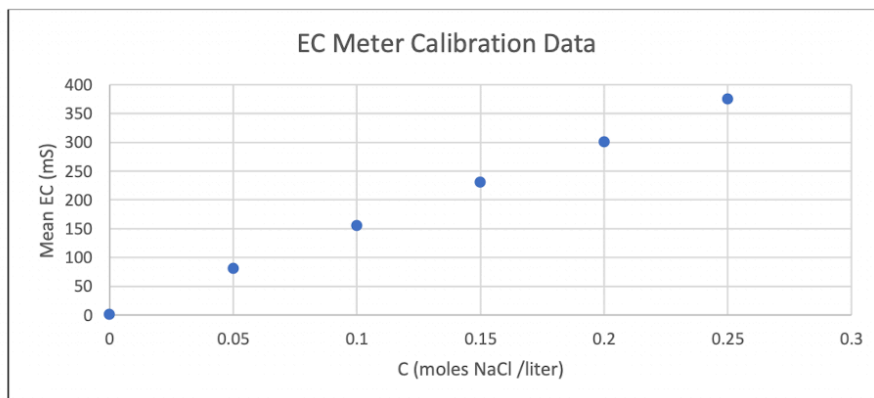


Figure 2: Elected EC Meter calibration for the aqueous NaCl and water solution at standard concentrations reveals a linear trend.

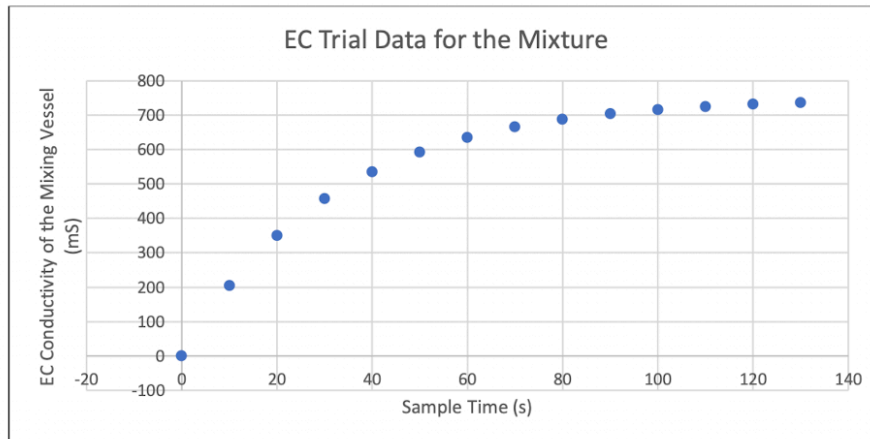


Figure 3: Given electrical conductivity trials data for the NaCl and water mixture by time.

Objectives

- In conjunction with Excel, regress calibration curve and EC trial data.
- Find $C(t)$ with EC regression
- Linearize the model $C(t) = C_f(1 - e^{-t/\tau_c})$
- Derive the linearized model to find the axis by removing the constants C_f and τ_c .
- Compute the goal τ_c with the slope of the derived linear model.
- With τ_c , calculate the C_f with the b^* from $EC = m \cdot C(t) + b^*$.

Results

The goal of the impeller small vessel mixing experiment was to find the initial concentration of the sodium chloride solution in the feed storage tank and find the mixing time in seconds of the impeller mixer τ_c . The results of the NaCl concentration in the feed storage tank C_f is 0.051M. The resulted impeller mixing time τ_c is 31.99 seconds.

The first objective was to determine the line that best fits the calibration curve $EC = 1491.43C(t) + 3.57$ presented below in *Figure 4* by processing the linear regression of the provided information from *Figure 2*. Figure 5, in continuation of the first objective, the best fit line for the given information is found by using linear regression based on the standard deviation of the geometric trial mean from *Figure 3* is Mixture = $3.83t + 181.95$.

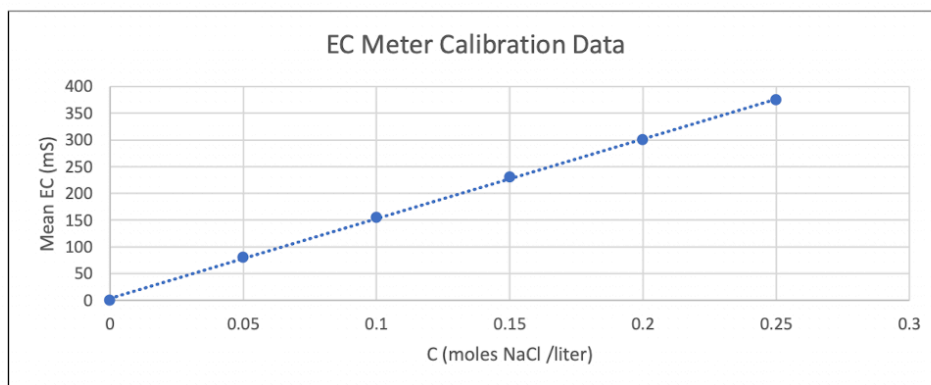


Figure 4: Computed Calibration curve slope, intercept, and linear regression of the best fit line according to the given linear trend data set in *Figure 2*.

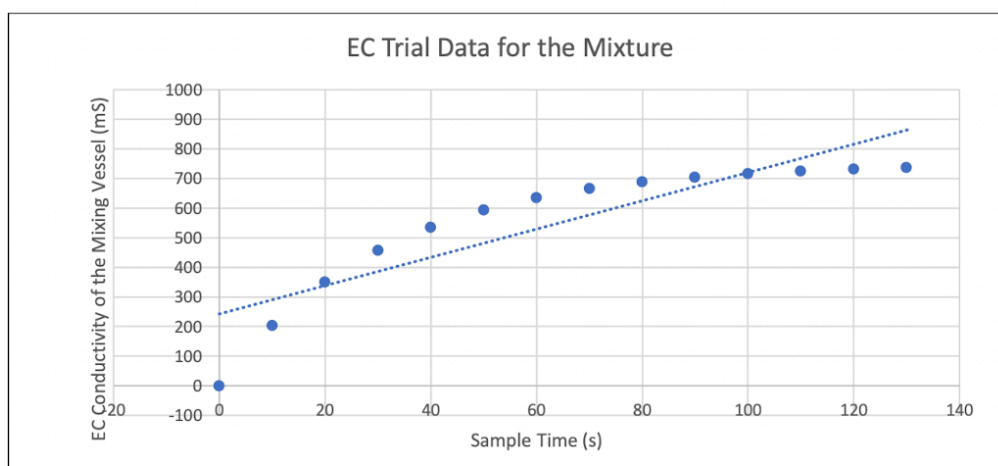


Figure 5: Computed EC measurement data slope, intercept, and linear regression of the best line that fits the given data from *Figure 3* to form a linear trend line.

Table 1 below shows the table of the EC with the regression data found from the raw calibration curve. The m^* is the slope of the calibration curve, while the b^* is the y-intercept of the same model equation.

Table 1: Defined C(t) from regression line of the EC trial mean data with the calibration curve regression and derivative of C(t).

EC = $m^*C(t) + b^*$			
t	EC	C(t)	C'(t)
0	0.006666667	-0.002390166	DNE
10	203.7333333	0.134208174	0.011740198
20	350.2	0.232413793	0.008498563
30	457.2333333	0.304179438	0.006216635
40	535.6333333	0.356746488	0.004551564
50	593	0.395210728	0.00333014
60	634.9666667	0.423349298	0.002433908
70	665.6	0.443888889	0.001782407
80	688.1333333	0.458997446	0.001304119
90	704.5	0.469971264	0.000948755
100	716.4333333	0.477972542	0.000696201
110	725.2666667	0.483895275	0.000511814
120	731.7	0.488208812	0.000377714
130	736.5333333	0.491449553	DNE

The next objective was to construct a linearized equation of the given model by using standard logarithmic rules. *Figure 6* below reveals the step procedure of the log methods.

$C(t) = C_f(1 - e^{-t/\tau_c})$
$C(t)/C_f = 1 - e^{-t/\tau_c}$
$\ln(C(t)/C_f) = \ln(1 - e^{-t/\tau_c})$
$\ln(1 - C(t)/C_f) = \ln 1 - \ln e^{-t/\tau_c}$
$\ln(1 - C(t)/C_f) = 0 - \ln e^{-t/\tau_c}$
$\ln(1 - C(t)/C_f) = -t/\tau_c$

Figure 6: Linearization of the model $C(t) = C_f(1 - e^{-t/\tau_c})$ to locate the x and y values necessary for finding the NaCl concentration and small vessel mixing time.

The final objective is to derive the linearized model and separate the constants C_f and τ_c from the equation. Then, find the derivative of the natural log $C(t)$ and linear regression with t . With the resulting regression, insert the m^* slope $-1/\tau_c$ with the b^* expression to find the C_f . Below, Figure 7 shows the resulting regression of the final model. The slope is the τ_c , and the C_f is found by the τ_c and the b^* .

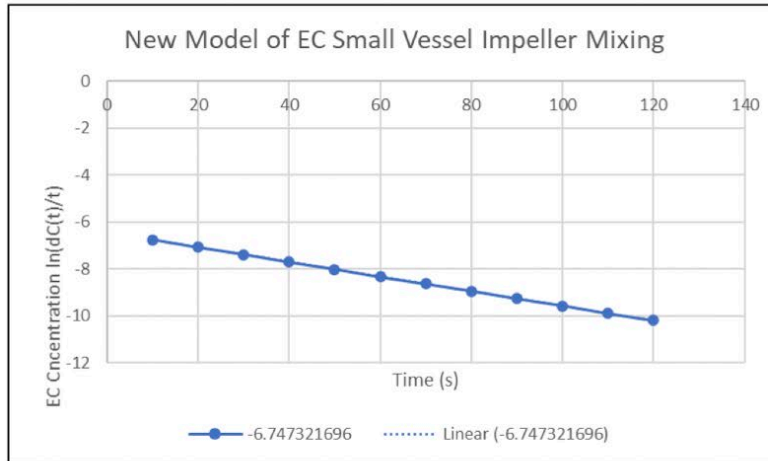


Figure 7: Final regression model of the resulting τ_c slope and C_f demonstrates the impeller mixing time slope to the storage feed tank concentration.

Description

The overall goal of this vessel mixing experiment is to find the concentration C_f of the sodium chloride in the feed storage tank and to find the mixing time τ_c of the small vessel with the impeller mixer. Distinguished given information and variables to evaluate the experiment is shown below

Goals

τ_c = impeller mixing time of small vessel (s)

C_f = NaCl concentration in the feed storage tank (M)

Variables

$C(t)$ = [NaCl] concentration calibration by time (M)

t = time (s)

$EC = m \cdot C(t) + b^*$

$C(t) = C_f(1 - e^{-t/\tau_c})$

Figure labeling?

$$EC(t) \Rightarrow EC = m^*C + b^* \Rightarrow C(t) \Rightarrow C'(t) t' \Rightarrow \ln(d/dt(C(t)/t)) \Rightarrow m^*b^* \Rightarrow T_c \Rightarrow C_f$$

The formulated pathway is to find the $EC(t)$ from the trial means information, use the calibration curve model regression equal to the EC , then find the $C(t)$ with the combination of the EC trial data and the calibration curve data and derive the $C(t)$ and t . After that, use the given $C(t)$ model to find the linearization of the equation and separate the constants, which in this case are the goals of the linear model. Next, take the derivative of the $C(t)$ and t as well as the natural log. With that data, perform a final regression to find the resulting m^* and b^* of the $\ln$ derived $C(t)$ and t . Finally, find the τ_c from the slope and use that information to find the C_f .

Using the platform Excel, the information to find the τ_c and C_f was entered chronologically. Given the initial problem, the linear line was drawn in Figure 2 and was used to find the close trend line demonstrated in Figure 4. To find the linear regression line, find the C mol/L (x^2), Mean EC (y^2), and $C \times EC$ ($x \times y$) based on the given C (moles NaCl per liter and mean EC (mS) data. Since the calibration curve data could not form a standard deviation, use it to find the m^* and b^* according to its mathematical formulas. The m^* calculated was 1491.429, which is the positive slope of the calibration curve and the b^* was 3.57, which indicated the intercept of the linear line. To check if the computed linear trend line was within limits, use the regression formula that resulted in $r = 0.999$, which is within the absolute greater than 0.9 and proves that the linear trend line is inside the boundaries. Then, using the same method as previously stated in this case, time (x^2), EC Mix (y^2), and time $\times$ EC Mix (xy), I found the linear trend line for the trial mean data. Before finding the m^* , b^* , and regression, calculate the best mean from the three given trials. The best means that fit the impeller mixer experiment is the geometric mean because the data trend from the trial data illustrated an exponential curve represented by a log exponential model and will not exceed because the system if the C_f is fixed; overtime to forever, the overall EC concentration will reach the C_f value and remain constant without exceeding that value. Next, find the variance σ^2 and the Standard Deviation σ using the mathematical formulas for both for each of the fourteen data sets. Finally, the resulted linear trend from the mean trial data slopes m^* is a positive 3.83, b^* form of intercept is 181.95.

Then find the $C(t)$ using both the calibration curve and EC trial data. IN the formation $EC = m^*C(t) + b^*$, I set the EC as the trial best mean equal to the m^* and b^* of the calibration curve m^* and b^* . Then, find the respecting $C(t)$ values that corresponded to the EC equation by each EC trial mean data.

With the newly computed trend lines ready, linearize the model $C(t) = C_f(1 - e^{-t/\tau_c})$ to determine what the final model should represent. As shown in Figure 6, the logarithmic step-by-step process is detailed below to show how the final model of the impeller NaCl concentration experiment should represent.

$C(t) = C_f(1 - e^{-t/\tau_c})$ First bring the constant C_f to one side

$C(t)/C_f = \ln(1 - e^{-t/\tau_c})$ Then, take the $\ln$ and get t isolated

$\ln(C(t)/C_f) = \ln(1 - e^{-t/\tau_c})$ Take $\ln$ of both sides

$\ln(1 - C(t)/C_f) = \ln 1 - \ln e^{-t/\tau_c}$ Log rule $\ln 1 = 0$ and $\ln e$ will cancel out

$\ln(1 - C(t)/C_f) = -t/\tau_c$ Resulted linearized model

The next objective is to find the derivative of the linearized model $\ln(1 - C(t)/C_f) = -t/\tau_c$ and remove the constants C_f and τ_c to find the x and y-intercepts. With calculus knowledge, set the x and y values to be $C(t)$ as my y and t as my x. Then, I took the derivative of the $C(t)$ and t shown in *Table 1* because I knew I could find that information with numerical differentiation. Like $x = y$, I set $C(t) = t$ and put the two on one side. Next, use the roots of the linearized $C(t)$ model and took the natural log of the $C(t)$ of the t like $\ln(d/dt(C(t)/t))$.

After that, I created a chart and to hold the first derivative of the $C(t)$ points with the numerical differentiation central method on Excel along with the derivative of the t, the divisor of $C'(t)$ by t', and finally, the $\ln$ of the derivative $C(t)$ divided by t all through Excel. With the latest information gathered, I created my final regression diagram appeared in Figure 7 with the x-axis values as time in seconds from the previous trial records and the y-axis as the new $\ln(d/dt(C(t)/t))$.

After all, with the regressed concluding model, I found the slope m^* as -0.031 and the intercept b^* as -6.44 . My regression came to be -0.999 , which is within the limits of greater than or equal to the absolute of 0.9 . This shows that the information gathered is genuinely the best regression. I used the derived $C(t)$ model knowledge to show that τ_c is the $-1/\tau_c$ of the slope. Therefore, I put the $m^* -0.31$ as the τ_c , and it gave me the resulting m^* slope of 31.998 as the τ_c . Finally, I put the τ_c multiplied by the e of the b^* , which was -6.44 , to find the last goal NaCl feed storage tank concentration. The C_f of the data was 0.05 M of sodium chloride in the feed tank.

Conclusion and Recommendations

The goal of the impeller small vessel mixing experiment was to find the initial concentration of the NaCl solution in the feed storage tank C_f is 0.05 M and find the mixing time in seconds of the impeller mixer τ_c is 31.998 seconds. From completing this model, I learned how to make linear regression from raw data and check with regression if the line was a good fit. I learned how to take numerical differentiation on a set of points without the appearance of the equation. I realized the impact of taking the derivative and natural log of information as a form of transformation to an equation. My records reveal that the impeller mixing time was a small resulting timeframe, which assumes that the impeller mixer had a good blend. If this experiment were to be conducted again, I would include another electrolyte instead of NaCl. For example, we can test the difference in impeller mixing times of a strong acid like HBr, strong base like KOH, or another salt to see a difference in mixing time. Another option that could be explored is if the impeller mixer was swapped by a vibration technique to see if rapid vibration could possibly be the better mixer.

complete with Electrical Conductivity meter and drainage.

Figure 2: Elected EC Meter calibration for the aqueous NaCl and water solution at standard concentrations reveals a linear trend.

Figure 3: Given electrical conductivity trials data for the NaCl and water mixture by time.

Objectives

- In conjunction with Excel, regress calibration curve and EC trial data.
- Find $C(t)$ with EC regression
- Linearize the model $C(t) = C_f(1 - e^{-t/\tau_c})$
- Derive the linearized model to find the axis by removing the constants C_f and τ_c .
- Compute the goal τ_c with the slope of the derived linear model.
- With τ_c , calculate the C_f with the b^* from $EC = m \cdot C(t) + b^*$.

Results

The goal of the impeller small vessel mixing experiment was to find the initial concentration of the sodium chloride solution in the feed storage tank and find the mixing time in seconds of the impeller mixer τ_c . The results of the NaCl concentration in the feed storage tank C_f is 0.051M. The resulted impeller mixing time τ_c is 31.99 seconds.

The first objective was to determine the line that best fits the calibration curve $EC = 1491.43C(t) + 3.57$ presented below in *Figure 4* by processing the linear regression of the provided information from *Figure 2*. *Figure 5*, in continuation of the first objective, the best fit line for the given information is found by using linear regression based on the standard deviation of the geometric trial mean from *Figure 3* is $Mixture = 3.83t + 181.95$.

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curve. The m^* is the slope of the calibration curve, while the b^* is the y-intercept of the same model equation.

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130	736.5333333	0.491449553	DNE

The next objective was to construct a linearized equation of the given model by using standard logarithmic rules. *Figure 6* below reveals the step procedure of the log methods.

Linearization
$C(t) = C_f(1 - e^{-t/\tau_c})$
$C(t)/C_f = 1 - e^{-t/\tau_c}$
$\ln(C(t)/C_f) = \ln(1 - e^{-t/\tau_c})$
$\ln(1 - C(t)/C_f) = \ln(1 - e^{-t/\tau_c})$
$\ln(1 - C(t)/C_f) = 0 - \ln e^{-t/\tau_c}$
$\ln(1 - C(t)/C_f) = -t/\tau_c$

Figure 6: Linearization of the model $C(t) = C_f(1 - e^{-t/\tau_c})$ to locate the x and y values necessary for finding the NaCl concentration and small vessel mixing time.

The final objective is to derive the linearized model and separate the constants C_f and τ_c from the equation. Then, find the derivative of the natural log $C(t)$ and linear regression with t . With the resulting regression, insert the m^* slope $-1/\tau_c$ with the b^* expression to find the C_f . Below, *Figure 7* shows the resulting regression of the final model. The slope is the τ_c , and the C_f is found by the τ_c and the b^* .

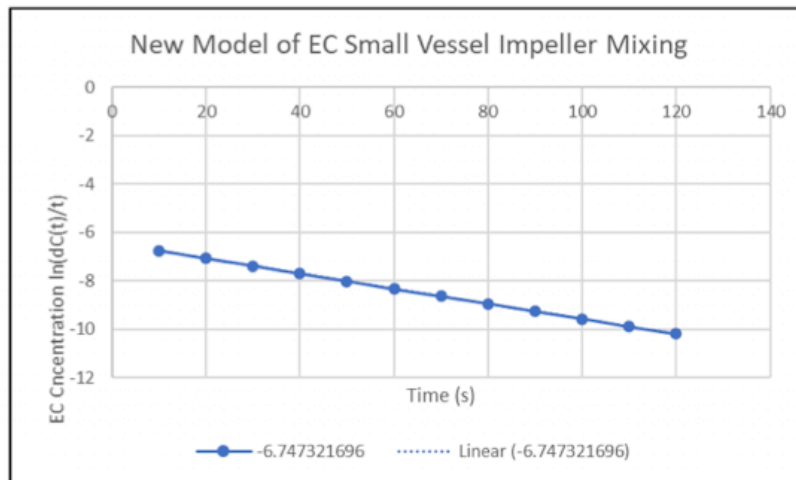


Figure 7: Final regression model of the resulting τc slope and C_f demonstrates the impeller mixing time slope to the storage feed tank concentration.

Description

The overall goal of this vessel mixing experiment is to find the concentration C_f of the sodium chloride in the feed storage tank and to find the mixing time τc of the small vessel with the impeller mixer. Distinguished given information and variables to evaluate the experiment is shown below

Goals

τc = impeller mixing time of small vessel (s)

C_f = NaCl concentration in the feed storage tank (M)

Variables

$C(t)$ = [NaCl] concentration calibration by time (M)

t = time (s)

$EC = m \cdot C(t) + b$

$C(t) = C_f (1 - e^{-t/\tau c})$

AVERAGE

Memorandum

Date: December 2, 2021

To: Dr. Lealon L. Martin

From: Alexander Ortiz

Re: "Application of the Scientific Method/Engineer Thought Process; Identify, Formulate & Solve during the analytical test of a mixer inside a vessel under specific circumstances".

Introduction: The purpose of this experiment is to check the performance of the mixer that resides inside the small container connected to a storage container that holds NaCl solution and an "Electrical conductivity, or EC" device through two valves with an open/close lid, one for the storage container and one for the EC device. The validation is done through series of measurements of the concentration of NaCl mixed with water base on the electrical conductivity readings from the sample that is release from the mixer vessel into the EC device. If the concentration of NaCl is mixed well, then we should see a higher number on the EC device.

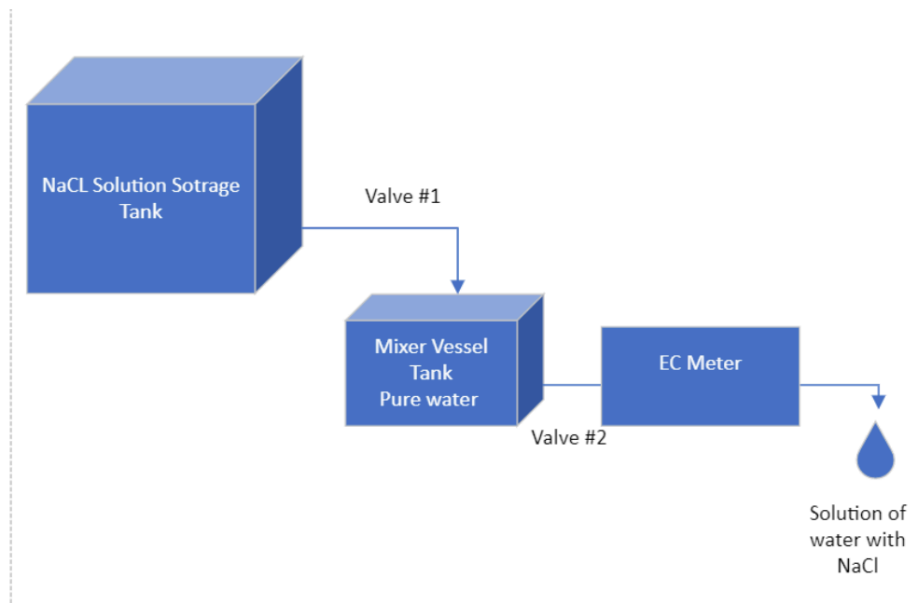
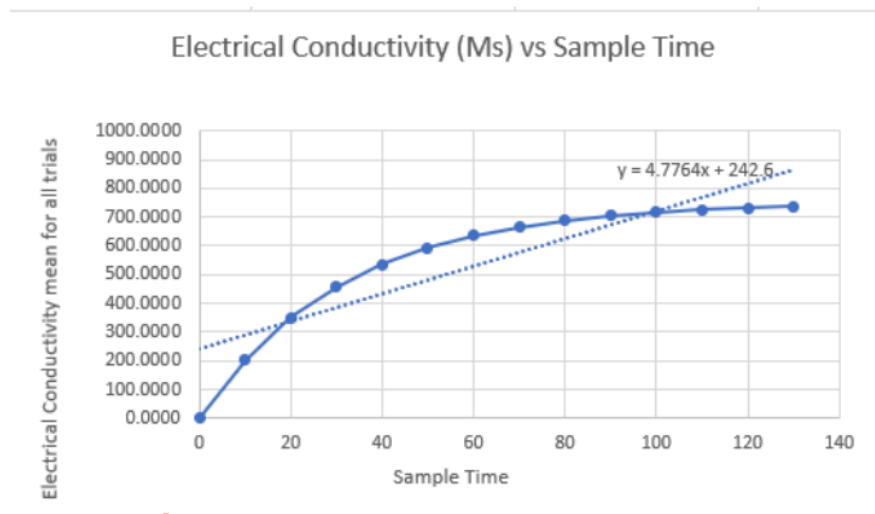


Figure 1

Objectives.

1. Determine
 - a. Determine the characteristic of mixing time to see how well the mixer is performing.
2. Formulate
 - a. We want to determine the t_c value to find out how well the mixer is working, in order for us to do it we will need the following;
 - i. Molarity of the NaCl solution inside the Storage/Feed tank
 - ii. Concentration of the aqueous solution from the mixer small vessel
3. Evaluate & Results
 - a. We start by first using the data from table #1 "The calibration curve" to obtain our x_1 and y_1 values.

Table #1: The Calibration Curve



From Table 2, X is assigned to time while Y is assigned to Mean EC (mS) that was obtained through Arithmetic mean from the three trials from Table #2

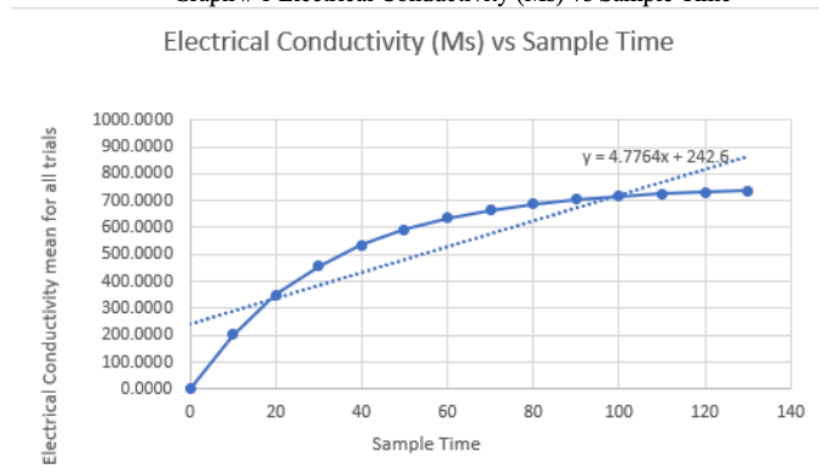
Table #2: Electrical Conductivity of the Vessel Mixture

Electrical Conductivity of the Vessel Mixture					
Set #	Sample Time (s)	Trial #1	Trial #2	Trial #3	Arithmetic Mean Value
1	0	0.01	-0.01	0.02	0.0067
2	10	203.6	203.7	203.9	203.7333
3	20	350.2	350.1	350.3	350.2000
4	30	457.4	457.3	457	457.2333
5	40	535.9	535.6	535.4	535.6333
6	50	592.9	593.1	593	593.0000
7	60	634.9	635	635	634.9667
8	70	665.4	665.6	665.8	665.6000
9	80	688.3	688.1	688	688.1333
10	90	704.5	704.4	704.6	704.5000
11	100	716.300	716.500	716.500000	716.4333
12	110	725.200	725.200	725.400000	725.2667
13	120	731.800	731.600	731.700000	731.7000
14	130	736.3	736.5	736.8	736.5333
	x				y

- b. By plotting the values from above, we can use obtain the graph on ~~Figure #1~~ which meets the next objective of establishing a model on which can be described EC-C calibration curve and develop the linearization by obtaining “” format from ~~Figure #1~~.

Graph # 1 Electrical Conductivity (Ms) vs Sample Time

Need to explain graph



- c. As displayed on ~~Figure #1~~, we have obtained the calibration model that allows to convert EC data into NaCl contraction data, the m, x and b for on which we can give x any time value while y would represent the concentration of mole NaCl per liter.
- d. Now that we have obtained an equation on which allows to determine the concentration of NaCl at any given time, we can use this to obtain the “characteristic mixing time, T_c ” which will determine if indeed the mixer is meeting the requirements. First, we start by linearizing the model that express the concentration of NaCl inside the small container as a function of time, .

$$C(t) = C_f(1 - e^{-\frac{t}{T_c}})$$

Figure # 1

- e. We start with the original equation $C(t) = C_f(1 - e^{-\frac{t}{T_c}})$ and it is transformed into a linear equation by linearizing the equation as showing on figure #2

$$C(t) = C_f(1 - e^{-\frac{t}{T_c}})$$

$$1 - (C(t) / C_f) = e^{-\frac{t}{T_c}}$$

$$\ln(e^{-\frac{t}{T_c}}) = \ln(1 - (C(t) / C_f))$$

$$\text{where } m = (-1/T_c) \quad x = t \quad y = \ln(1 - (C(t) / C_f))$$

- f. Now we substitute the following

i. T for time

ii. C(t) = molarity found on the slope from graph #1

- g. At this point, the same intervals of 10 seconds per sample is used while conducting the electrical conductivity of the vessel mixture (mS) table #2

Sample Time (s)	Trial #1	Trial #2	Trial #3	Arithmetic Mean Value
0	0.01	-0.01	0.02	0.0067
10	203.6	203.7	203.9	203.7333
20	350.2	350.1	350.3	350.2000
30	457.4	457.3	457	457.2333
40	535.9	535.6	535.4	535.6333
50	592.9	593.1	593	593.0000
60	634.9	635	635	634.9667
70	665.4	665.6	665.8	665.6000
80	688.3	688.1	688	688.1333
90	704.5	704.4	704.6	704.5000
100	716.300	716.500	716.500000	716.4333
110	725.200	725.200	725.400000	725.2667
120	731.800	731.600	731.700000	731.7000
130	736.3	736.5	736.8	736.5333

- h. Now we solve for T_c , as we see increasing the value, it will prove that our mixer from the small container is working properly with the use of our slope equation from graph #1

T_c
$m = 1/T_c$
$4.7764 = 1/T_c$
$T_c = 4.7764$

Figure #2

Discussion.

To determine if the mixer was working properly, it is needed a way to measure how well the solution is being mixed. One way to do it is by comparing the electrical conductivity of two substances which have different resistance as they are being release from the container that has the mixer and letting the solutions passed through a EC “electrical conductivity meter”. On this case, pure water (H_2O) and sodium chloride ($NaCl$). By Nature, $NaCl$ is a better conductor than water due to the ionic bond of the two atoms that makes up this molecule. By letting the solution that is being release passed through the EC, we obtain a value on which we can later compare to the given standard value table #1 “Calibration curve”. It is intuitive that as we are recording a higher number of mS from the solution that passes through the EC, we are getting a stronger concentration for $NaCl$ per liter, this indicates that the mixer inside the small container is working properly, however; to determine the instantaneous value of concentration at any given time, we can obtain the mean value from our standard values from table #1 and later use to determine the characteristic mixing time value that would quantify the performance of the mixer. This can be obtain once we have got our linear equation and determine the m, x and b value from the values and graph from table #1 and solving for c from the equation $c = c_0 e^{-t/T_c}$ which after a period of T, the limit for the concentration on the small container for $NaCl$ mole per liter would be the same as the concentration of $NaCl$ mole per liter that was given for the storage container.

Conclusion and Recommendations

Unfortunate my results could not prove that the mixer indeed works properly due to making a mistake while plotting my data. I accidently made the mistake of plotting the date from table #1 and using that graph to obtain the linear equation that later was used to find the concentration at any given time thus making my value for c incorrectly by making the result of c super bigger instead of getting a small number. I should instead have plotted using the equation of linearization instead of just using the slop equation that I obtained from the first table.

BELOW AVERAGE

Memorandum

Date: December 2nd, 2021

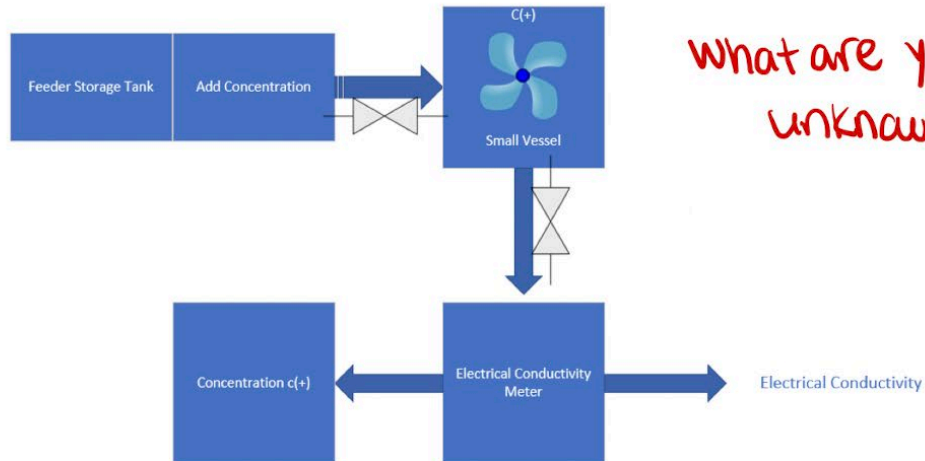
To: Dr. Lealon L. Martin

From: Mohamad Alwan

Re: Final Exam - Finding the mixing time and the unknown NaCl concentration

Introduction

A sodium chloride (NaCl) solution is held in a feed storage tank, which is fed to a smaller vessel with pure liquid water which dilutes it. The concentration of NaCl solution is unknown. The fluid leaving the smaller vessel is then passed through an electrical conductivity meter to find the efficiency of the system. I am looking for the concentration of NaCl and the mixing time, the experiment is shown in figure 1 below.



[Figure 1: The Impeller Mixture] Center

Objectives

There were five main objectives for this experiment:

- To develop a model that shows the mean of the electrical conductivity curve
- To convert the electrical conductivity, mean data to NaCl concentration

- To linearization the model
- To find the change of NaCl concentration using the new model
- To find the efficiency of the mixer

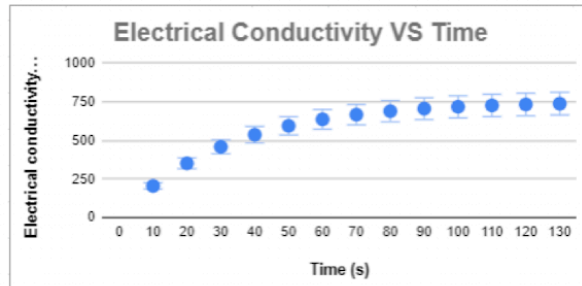
Results

I first got all the data that was given and found the geometric mean to create a model that shows the electrical conductivity vs time curve. In Table 1, the given information is shown as well as the geometric mean.

[Table 1: Sample times, trials, and geometric mean] center

Sample Time(s)	Trial 1	Trial 2	Trial 3	Geometric mean
x				y
0	0.01	-0.01	0.02	#NUM!
10	203.6	203.7	203.9	203.7
20	350.2	350.1	350.3	350.2
30	457.4	457.3	457.0	457.2
40	535.9	535.6	535.4	535.6
50	592.9	593.1	593.0	593.0
60	634.9	635.0	635.0	635.0
70	665.4	665.6	665.8	665.6
80	688.3	688.1	688.0	688.1
90	704.5	704.4	704.6	704.5
100	716.3	716.5	716.5	716.4
110	725.2	725.2	725.4	725.3
120	731.8	731.6	731.7	731.7
130	736.3	736.5	736.8	736.5

Figure 2 shows the geometric mean of the electrical conductivity vs the sample times that was given, as well as error bars.



Trendline ?
Equation ?

Figure 2: Average electrical conductivity (mS) Vs. time (s)

Then I converted the electrical conductivity data into NaCl concentration, where the data is shown in Table 2.

Table 2: Electrical conductivity data to NaCl concentration

n	C(moles NaCl/L)-x	Mean EC (mS)-y	x*y	x*x	y*y	Fitting Parameters	Value	c model
1	0	0	0	0	0	m	1491.4	3.60
2	0.05	80	4	0.0025	6400	b	3.6	78.17
3	0.1	155	15.5	0.01	24025	r	1.0	152.74
4	0.15	230	34.5	0.0225	52900			227.31
5	0.2	300	60	0.04	90000			301.88
6	0.25	375	93.75	0.0625	140625			376.45
Sum	0.75	1140	207.75	0.1375	313950			
Sum^2	0.5625	1299600						

The average electrical conductivity vs concentration of NaCl, trend line, error bars ~~are~~ *are* shown in Figure 3.

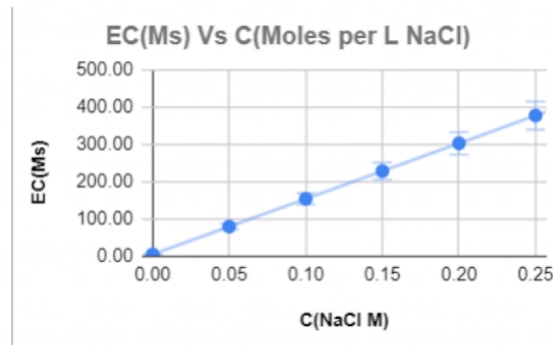


Figure description ?

Figure 3: Electrical conductivity converted to NaCl concentration

I got a model of $y=1491.4x+3.6$ from my data and I use that data to get the equation $C_t = \frac{EC_t - 3.6}{1491.4}$.

Then I had to linearize the model, I was given $C_t = C_f \left(1 - e^{-\frac{1}{t_c}}\right)$ and was told that the concentration of NaCl was unknown. To linearize the model, I had to use $\ln\left(\frac{dC_t}{dt}\right) = -\frac{1}{t_c} t + \ln\left(\frac{C_f}{t_c}\right)$, I also know to linearize any equation you must use $y=mx+b$.

I used the equation I found above with the electrical conductivity vs NaCl concentration which is in Figure 3 to change the NaCl concentration to find the new model. This is shown in Table 3.

Table 3: Conversion of NaCl concentration to new model

sample time(s)	Geometric mean	concentration of NaCl	$dc(t)/dt$	$\ln[dc(t)/dt]$
t		$C(t)=[EC(t)-3.6]/1491.4$	$c'(t)$	$y=\ln[dc(t)/dt]$
0	0.0	-0.0024		
10	203.7	0.1342	0.01174	-4.44470
20	350.2	0.2324	0.00850	-4.76784
30	457.2	0.3041	0.00622	-5.08069
40	535.6	0.3567	0.00455	-5.39202
50	593.0	0.3952	0.00333	-5.70405
60	635.0	0.4234	0.00243	-6.01824
70	665.6	0.4439	0.00178	-6.33103
80	688.1	0.4590	0.00130	-6.64221
90	704.5	0.4700	0.00095	-6.96034
100	716.4	0.4779	0.00070	-7.26825
110	725.3	0.4839	0.00051	-7.57535
120	731.7	0.4882	0.00038	-7.88729
130	736.5	0.4914		

Figure 4 shows the new model of the change of NaCl Vs the time that was found using the data from Table 3.

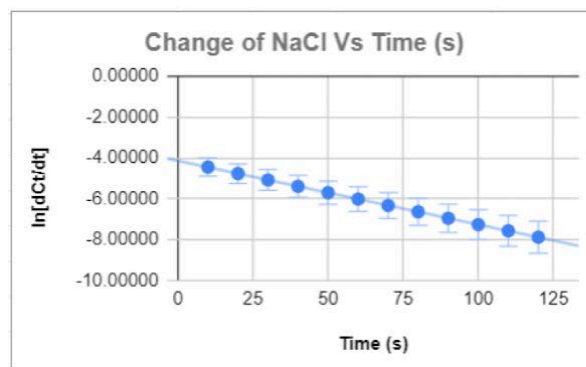


Figure needs a description

Figure 4: Graph of change of NaCl Vs time

Lastly, I need to find the efficiency of the mixer, from our previous equations we know that $m = -\frac{1}{t_c}$. And by our new data we know that $m = -0.0313$ and by plugging that in we get $t_c = 32$ s. We also know $b = \ln\left(\frac{C_f}{t_c}\right) = -4.1$, and by plugging in the numbers we have we get an answer of 0.51 M.

Discussion

Need more explanation

From the given data in Table 1, the sample times that were given shows an exponential growth, which helps me choose the best method to find the mean which is the geometric mean. I used Figure 2 to help show the relationship between electrical conductivity and time, and as shown in the graph they have a nonlinear relationship because the points do not line up in a linear fashion and are curved. I also included error bars for this graph. Table 2 is the electrical conductivity data that was used to help convert to the NaCl concentration in moles. The relationship between these two were linear and is shown in Figure 3. I also included a trend line and error bars for this graph. Then, I found the parameters which are shown in Table 2 and used those numbers to plug into the equation $y = mx + b$ and got $y = 1491.4x + 3.6$. By looking at this equation we can see that 1491.4 is my slope and that 3.6 is my y intercept, and also had a r greater than 0.99. Then I used the equation that was provided, $C_t = C_f \left(1 - e^{\frac{1}{t_c}t}\right)$ and is nonlinear. I linearized the equation and got use

$\ln\left(\frac{dC_t}{dt}\right) = -\frac{1}{t_c}t + \ln\left(\frac{C_f}{t_c}\right)$ and used $y = mx + b$ to help separate the equation to help me understand it better. Then I had to use the electrical conductivity data I have found to help transform into NaCl concentration. I used the most accurate method to help me convert this data and I choose the central derivative; this is shown in Table 3. After computing this data, I used linear regression to find my parameters and I got $m = -0.0313$ and $b = -4.1$. Which gives us a new equation of $y = -0.0313x - 4.1$, and this is a good equation because r is less than -0.99. In my Figure 4 it shows the change of NaCl Vs time, which is linear and I added a trend line as well as error bars. With all my data I can calculate t_c and I got 32 s, and shows the vessel is efficient. Then I used $b = \ln\left(\frac{C_f}{t_c}\right)$ to find the concentration of NaCl. I plugged in all the values I found and got $C_f = 0.51$ M.

Restate parameters

r value significance?

Conclusion and recommendation

The results I got show that the impeller mixer was efficient in diluting the NaCl because of the low t_c I got of 32 s. The vessel could have been better if the time was shortened when controlling the valves. Another way it could have been better if the impeller moved faster to help dilute the solution quicker. We could also miss with the valves by closing the valve to the small vessel and keeping the vessel to the electrical conductivity meter on or vice versa to help see what can help us get the lowest t_c possible.