

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

ASSESSMENT REPORT COVER PAGE

**CHEG 4101 CHEMICAL ENGINEERING
LABORATORY II**

FALL 2021 SEMESTER

NAME OF INSTRUCTOR: Dr. Jorge Gabitto

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 - 5.1 Assignments assessing students' ability to apply engineering design to produce solutions that meet specified needs with consideration of public health, safety, and welfare, as well as global, cultural, social, environmental, and economic factor. (outcome "2")
 - 5.2 Assignments assessing students' ability to identify, formulate, and solve complex engineering problems (CEP) by applying principles of engineering, science, and mathematics.
(Outcome 1)
 - 5.3 Assignments assessing students' ability to communicate effectively with a range of audiences (Oral & Written)

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

Course Syllabus Information

CHEG 4101-P01: Chemical Engineering Laboratory II Fall 2021 Syllabus

General Course Information

Information Item	Information
Instructor:	Dr. Jorge F. Gabitto, Ph. D.
Section # and CRN:	P01 CRN: 18036
Office Location:	Room 201J C. L. Wilson/Virtual
Office Phone:	936-261-9409
Email Address:	jfgabitto@pvamu.edu
Office Hours:	10 am. – 11 am., and 2-5 pm. Monday and Wednesday
Mode of Instruction:	Face to Face Instructional Method
Course Location:	Room 137 Gilchrist bldg.
Class Days & Times:	M 5:00 – 7:50 PM
Catalog Description:	(0-3) Credit 1 semester hours. Continuation of CHEG 3011, but directed to separation processes such as gas absorption, fractional distillation, extraction, and drying. Study of reaction rates and equilibria in simple chemical systems. Emphasis is placed upon experimental data required for the scale-up to commercial scale equipment.
Prerequisites:	CHEG 3023 and CHEG 3043
Co-requisites:	None
Required Text(s):	None
Recommended Text(s):	1. Holman, J. P., Experimental Methods for Engineers, 4 th Ed., McGraw-Hill, New York, 1986. 2. Fahien, R. W., Fundamentals of Transport Phenomena, McGraw-Hill, New York, 1993.

General Course Information Table

Student Learning Outcomes:

Upon successful completion of this course, students will be able to:	Program Learning Outcome Alignment	Core Curriculum Outcome Alignment
Demonstrate ability to perform quantitative physical measurements, operate, laboratory scale equipment.	D2	6
Demonstrate ability to plan, design, and evaluate experiments.	D2	6
Demonstrate ability to communicate effectively in oral and written formats.	D2	3
Demonstrate ability to work in teams. .	D2	5

Student Learning Outcomes Table

ABET OUTCOMES:

3. An ability to communicate effectively with a range of audiences
5. An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives
6. An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

The two performance criteria used to assess this outcome consist of

3. An ability to communicate effectively with a range of audiences

Students are able to:

- (i) Write an acceptable laboratory report from the technical and language point of view
- (ii) Present orally the results of their work with acceptable competence and knowledge.

5. Ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives

Students are able to:

- (i) Plan and distribute tasks.
- (ii) Make consistent contributions to the team under set deadlines.
- (iii) Make a positive, collegial contribution in their interactions with others.

3. Ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions

Student are able to:

- (i) Conduct experiments with appropriate competence and knowledge.
- (ii) Have enough to knowledge and skills to analyze and interpret experimental data appropriately.
- (iii) Are able to design a new experiment based on previous knowledge and skills.

Major Course Requirements

Method of Determining Final Course Grade

Course Grade Requirement	Value	Total
1. Quizzes (several)	variable	15% of course grade
2. Design of experiment report (1)	10% of course grade	5% of course grade
3. Lab. reports (4)	10% of course grade	40% of course grade
4. Final design of experiments oral presentation (1)	40% of course grade	40% of course grade
Total:		100%

Course Grade Requirement Table

Grading Criteria and Conversion:

A = 89 – 100 points

B = 79 – 88 points

C = 60 – 78 points

F = 59 or below

A signifies that the student has excellent understanding of all concepts covered and acquired excellent skills.

B signifies that the student has good understanding of all concepts covered and acquired good skills.

C signifies that the student has basic understanding of all concepts covered and acquired basic skills.

F signifies that the student has insufficient understanding of all concepts covered and failed to acquire basic skills.

Course Procedures or Additional Instructor Policies

Taskstream

Taskstream is a tool that Prairie View A&M University uses for assessment purposes. One of your assignments may be required to be submitted as an "artifact," an item of coursework that serves as evidence that course objectives are met. If applicable, more information will be provided during the semester by your department, but for general information, you can visit Taskstream via the link in eCourses.

Final Presentation Policy

All students in a group should participate in the final presentation. If a student cannot be present during the final presentation the student can share on the group's grade under the following circumstances: a). proper justification, b) adequate participation in the presentation preparation, and c) unanimous agreement of all group members. A) needs to be justified in writing. B) and C) will be certified by the testimony of all the members of the student's lab. group.

Reports Policy & Guidelines

Reports are group assignments and should be presented according to the agreed upon scheduled.

Extensions can be awarded after proof of honest effort to comply and proper justification. Students are encouraged to present reports in advance to get suggestions/recommendations about how to improve them. If a group of students disobeys the university's honor code and copies another group report instead of submitting the group's own independent work, ALL members will receive a grade of zero on the assignment and will be referred to the department head. Such meetings must take place within a week of the infraction.

Class Activities And Participation

Students are expected to attend scheduled classes on a regular basis and are expected to participate in classroom discussions. Required safety course can be made up only on justified excuses.

Class lab. activities are mandatory for this course. ***There is not possible to makeup a class activity.***

However, the student can share the grade of his/her group if the absence is properly justified and the other members agree.

Semester Calendar

Modules	Topic	Online Assignment/Activity (Due Date)	Assignment/ Activity (Face-to-Face[F2F])
August 23, 2021	Course Introduction. Review of Syllabus.	- Read the syllabus (August 23, 2021) - Complete the syllabus quiz (August 23, 2021)	Lecture
Module 1: August 30, 2021	Laboratory and Industrial Safety	- Watch AIChE Video (August 30, 2021) - Safety presentation - Complete quiz (August 30, 2021)	Lecture
Module 2: September 6, 2021 (Holiday; Sept. 6)	None	None	None
Module 2: September 13, 2021	Design of Experiments	- Design of experiments lecture - Complete online quiz (September 13, 2021)	Lecture
Module 3: September 20, 2021	Writing Lab. Reports	- Design of experiments lecture - Complete online quiz (September 20, 2021)	Lecture
Module 4: September 27-October 3, 2021	First Experiment	- Watch video on the lab. equipment for 1st EXP. - Prepare for 1st lab. exp.	None
Module 4: October 4-10, 2021	First Experiment	- Quiz (October 4) 1st report preparation	Conduct 1st Lab. Experiment
Module 5: October 11 – October 17, 2021	2 nd Experiment	- Turn in 1st lab. report (October 5, 2020) - Watch video for 2nd exp. - Prepare for 2nd lab. exp.	None

Modules	Topic	Online Assignment/Activity (Due Date)	Assignment/ Activity (Face-to-Face[F2F])
Module 5: October 18 –24, 2021	2 nd Lab. Experiment	• Quiz (October 18, 2021) • 2nd Lab. report preparation	• Conduct 2nd Lab. Experiment
Module 6: Module 7: October 25 – October 31, 2021	Design of Experiment Report 3 rd Lab. Experiment	• Turn in Design of experiment report (October 25, 2021) • Turn in 2nd lab. report (October 25, 2021) • Watch video on the lab. equipment for 3rd Lab. Exp.	• None
Module 7: November 1-7, 2021	3 rd Lab. Experiment	• Quiz (November 1, 2021) • 3rd Lab. exp. report preparation	• Conduct 3rd Lab. Experiment
Module 8: November 8 – November 14, 2021	4 th Lab. Experiment	• Turn in 3rd lab. report (November 8, 2021) • Watch video on the lab. equipment for 4th Lab. exp.	• None
Module 8: November 15 – November 21, 2021	4 th Lab. Experiment	• Quiz (November 15, 2021) • 4th lab. exp. report preparation	• Conduct 4th Lab. Experiment
Final Presentation: November 22, 2021	Final Presentation	• Turn in 4th report (November 22, 2021) • Tentative schedule (November 22, 2021)	• Final Presentation

Student Support and Success

John B. Coleman Library

The John B. Coleman Library's mission is to enhance the scholarly pursuit of knowledge, to foster intellectual curiosity, and to promote life-long learning and research through our innovative services, resources, and cultural programs, which support the Prairie View A&M University's global mission of teaching, service, and research. It maintains library collections and access both on campus, online, and through local agreements to further the educational goals of students and faculty. Website: <https://www.pvamu.edu/library/>; Phone: 936-261-1500

Academic Advising Services

Academic Advising Services offers students a variety of services that contributes to student success and leads towards graduation. We assist students with understanding university policies and procedures that affect academic progress. We support the early alert program to help students get connected to success early in the semester. We help refer students to the appropriate academic support services when they are unsure of the best resource for their needs. Faculty advisors support some students in their respective colleges. Your faculty advisor can be identified in PantherTracks. Advisors with Academic Advising Services are available to all students. We are located across campus. Find your advisor's location by academic major at www.pvamu.edu/advising. Phone: 936-261-5911

The University Tutoring Center

The University Tutoring Center (UTC) offers free tutoring and academic support to all registered PVAMU students. The mission of the UTC is to help provide a solid academic foundation that enables students to become confident, capable, independent learners. Competent and caring staff and peer tutors guide students in identifying, acquiring, and enhancing the knowledge, skills, and attitudes needed to reach their desired goals. Tutoring and academic support are offered face-to-face in the UTC, in virtual face-to-face sessions (<https://www.pvamu.edu/student-success/sass/university-tutoring-center/>), and through online sessions (<https://www.pvamu.edu/pvplace/>). Other support services available for students include Supplemental Instruction, Study Break, Academic Success Workshops, and Algebra Study Jam. Location: J. B. Coleman Library, Rm. 307; Phone: 936-261-1561; Email: pvtutoring@pvamu.edu; Website: <https://www.pvamu.edu/student-success/sass/university-tutoring-center/>

Writing Center

The Writing Center provides well-trained peer tutors to assist students with writing assignments at any stage of the writing process. Tutors help students with various writing tasks from understanding assignments, brainstorming, drafting, revising, editing, researching, and integrating sources. Students have free access to Grammarly online writing assistance. Grammarly is an automated proofreading and plagiarism detection tool. Students must register for Grammarly by using their student email address. In addition, students have access to face-to-face and virtual tutoring services either asynchronously via email or synchronously via Zoom. Location: J. B. Coleman Library, Rm. 209; Phone: 936-261-3724; Website: <https://www.pvamu.edu/student-success/writing-center/>; Grammarly Registration: <https://www.grammarly.com/enterprise/signup>

Academic Early Alert

Academic Early Alert is a proactive system of communication and collaboration between faculty, academic advisors, and PVAMU students that is designed to support student success by promptly identifying issues and allowing for intervention. Academic Early Alerts help students by providing a central location to schedule advising appointments, view advisor contact information, and request assistance. Students who recognize that they have a problem that is negatively affecting their academic performance or ability to continue school may self-refer an Academic Early Alert. To do so, students will log in to PV Place and click on Academic Early Alert on the left sidebar. Phone: 936-261-5902; Website: <https://www.pvamu.edu/student-success/early-alert/>

Student Counseling Services

The Student Counseling Services unit offers a range of services and programs to assist students in maximizing their potential for success: short-term individual, couples, and group counseling, as well as crisis intervention, outreach, consultation, and referral services. The staff is licensed by the State of Texas and assists students who are dealing with academic skills concerns, situational crises, adjustment problems, and emotional difficulties. Information shared with the staff is treated confidentially and in

accordance with Texas State Law. Location: Hobart Taylor, 2nd floor; Phone: 936-261-3564; Website: <https://www.pvamu.edu/healthservices/student-counseling-services/>

Office of Testing Services

Testing Services serves to create opportunities by offering a suite of exams that aid in the students' academic and professional success. Currently, we administer entrance (HESI A2), college readiness (TSI assessment), Prior Learning (CLEP, DSST), and proctored exams. Location: Wilhelmina Delco, 3rd Floor, Rm. 305; Phone: 936-261-3627; Email: aetesting@pvamu.edu; Website: www.pvamu.edu/testing

Office of Diagnostic Testing and Disability Services

The Americans with Disabilities Act (ADA) is a federal anti-discrimination statute that provides comprehensive civil rights protection for persons with disabilities. Among other things, this legislation requires that all students with disabilities be guaranteed a learning environment that provides for reasonable accommodation of their disabilities. If you believe you have a disability requiring an accommodation, contact the Office of Disability Services. As a federally-mandated educational support unit, the Office of Disability Services serves as the repository for confidential disability files for faculty, staff, and students. For persons with a disability, the Office develops individualized ADA letters of request for accommodations. Other services include learning style inventories, awareness workshops, accessibility pathways, webinars, computer laboratory with adapted hard and software, adapted furniture, proctoring non-standardized test administrations, ASL interpreters, ALDs, digital recorders, Livescribe, and a comprehensive referral network across campus and the broader community. Location: Hobart Taylor, Rm. 1D128; Phone: 936-261-3583; Website: <https://www.pvamu.edu/disabilityservices/>

Center for Instructional Innovation and Technology Services (CIITS)

Distance Learning, also referred to as Distance Education, is the employment of alternative instructional delivery methods to extend programs and services to persons unable to attend college in the traditional manner. The Center for Instructional Innovation and Technology Services (CIITS) supports student learning through online, hybrid, web-assist, and 2-way video course delivery. For more details and contact information, visit:

<https://www.pvamu.edu/dlearning/distance-learning-2-2/students-2/>; Phone: 936-261-3283

Veteran Affairs

Veterans Services works with student veterans, current military and military dependents to support their transition to the college environment and continued persistence to graduation. The Office coordinates and certifies benefits for both the G.I. Bill and the Texas Hazlewood Act. Location: Evans Hall, Rm. 102; Phone: 936-261-3563; Website: <https://www.pvamu.edu/sa/departments/veteranaffairs/>

Office for Student Engagement

The Office for Student Engagement delivers comprehensive programs and services designed to meet the co-curricular needs of students. The Office implements inclusive and accessible programs and services that enhance student development through exposure to and participation in diverse and relevant social, cultural, intellectual, recreational, community service, leadership development, and campus governance. Location: Memorial Student Center, Rm. 221; Phone: 936-261-1340; Website: <https://www.pvamu.edu/studentengagement/>

Career Services

Career Services supports students through professional development, career readiness, and placement and employment assistance. The Office provides one-on-one career coaching, interview preparation, resume and letter writing, and career exploration workshops and seminars. Services are provided for students at the Northwest Houston Center and College of Nursing in the Medical Center twice a month or on a requested basis. Distance Learning students are encouraged to visit the Career Services website for information regarding services provided. Location: Anderson Hall, 2nd floor; Phone: 936-261-3570; Website: <https://www.pvamu.edu/careerservices/>

University Rules and Procedures

Academic Misconduct

Academic dishonesty is defined as any form of cheating or dishonesty that has the effect or intent of interfering with any academic exercise or fair evaluation of a student's performance. The college faculty can provide additional information, particularly related to a specific course, laboratory, or assignment.

You are expected to practice academic honesty in every aspect of this course and all other courses. Make sure you are familiar with the *University Administrative Guidelines on Academic Integrity*, which can be found on the [Academic Integrity webpage](#). Students who engage in academic misconduct are subject to university disciplinary procedures. As listed in the *University Administrative Guidelines on Academic Integrity*, the University Online Catalog, and the Student Code of Conduct, the following are examples of prohibited conduct. This list is not designed to be all-inclusive or exhaustive. In addition to academic sanctions, any student found to have committed academic misconduct that is also a violation of criminal law may also be subject to disciplinary review and action by the Office of Student Conduct (as outlined in the Student Code of Conduct).

Forms of Academic Dishonesty:

1. Cheating: Deception in which a student misrepresents that he/she has mastered information on an academic exercise that he/she has not learned, giving or receiving aid unauthorized by the instructor on assignments or examinations. Examples: unauthorized use of notes for a test; using a "cheat sheet" on a quiz or exam; any alteration made on a graded test or exam which is then resubmitted to the teacher;
2. Plagiarism: Careless or deliberate use of the work or the ideas of another; representation of another's work, words, ideas, or data as your own without permission or appropriate acknowledgment. Examples: copying another's paper or answers, failure to identify information or essays from the internet and submitting or representing it as your own; submitting an assignment which has been partially or wholly done by another and claiming it as yours; not properly acknowledging a source which has been summarized or paraphrased in your work; failure to acknowledge the use of another's words with quotation marks;
3. Collusion: When more than one student or person contributes to a piece of work that is submitted as the work of an individual;
4. Conspiracy: Agreeing with one or more persons to commit an act of academic/scholastic dishonesty; and
5. Multiple Submission: Submission of work from one course to satisfy a requirement in another course without explicit permission. Example: using a paper prepared and graded for credit in one course to fulfill a requirement and receive credit in a different course.

Nonacademic Misconduct

The university respects the rights of instructors to teach and students to learn. Maintenance of these rights requires campus conditions that do not impede their exercise. Campus behavior that interferes with either (1) the instructor's ability to conduct the class, (2) the inability of other students to profit from the instructional program, or (3) campus behavior that interferes with the rights of others will not be tolerated. An individual engaging in such disruptive behavior may be subject to disciplinary action. The Office of Student Conduct will adjudicate such incidents under nonacademic procedures.

Sexual Misconduct

Sexual harassment of students and employees at Prairie View A&M University is unacceptable and will not be tolerated. Any member of the university community violating the university's sexual harassment policy will be subject to disciplinary action. In accordance with the Texas A&M University System guidelines, your instructor is obligated to report to the Office of Title IX Compliance (titleixteam@pvamu.edu) any instance of sexual misconduct involving a student, which includes sexual assault, stalking, dating violence, domestic violence, and sexual harassment, about which the instructor becomes aware during this course through writing, discussion, or personal disclosure. The faculty and staff of PVAMU actively strive to provide a learning, working, and living environment that promotes respect that is free from sexual misconduct, discrimination, and all forms of violence. If students, faculty, or staff would like assistance or have questions,

they may contact the Title IX Coordinator at 936-261-2144 or titleixteam@pvamu.edu. More information can be found at www.pvamu.edu/titleix, including confidential resources available on campus.

Pregnancy, Pregnancy-related, and Parenting Accommodations

Title IX of the Education Amendments of 1972 prohibits sex discrimination, which includes discrimination based on pregnancy, marital status, or parental status. Students seeking accommodations related to pregnancy, pregnancy-related conditions, or parenting (reasonably immediate postpartum period) are encouraged to contact Student Disability Services or the Dean of Students' Office for additional information and to request accommodations.

Non-Discrimination Statement

Prairie View A&M University does not discriminate on the basis of race, color, sex, religion, national origin, age, disability, genetic information, veteran status, sexual orientation, or gender identity in its programs and activities. The University is committed to supporting students and complying with The Texas A&M University System non-discrimination policy. It seeks to establish an environment that is free of bias, discrimination, and harassment. If you experience an incident of discrimination or harassment, we encourage you to report it. If you would like to speak with someone who may be able to afford you privacy or confidentiality, there are individuals who can meet with you. The Director of Equal Opportunity & Diversity has been designated to handle inquiries regarding the non-discrimination policies and can be reached at Harrington Science Building, Suite 109 or by phone at 936-261-1744 or 1792.

Class Attendance Policy (See the University Online Catalog for Full Attendance Policy)

Prairie View A&M University requires regular class attendance. Attending all classes supports the full academic development of each learner, whether classes are taught with the instructor physically present or via distance learning technologies such as interactive video and/or the internet. Excessive absenteeism, whether excused or unexcused, may result in a student's course grade being reduced or in the assignment of a grade of "F." Absences are accumulated beginning with the first day of class during regular semesters and summer terms. Each faculty member will include the University's attendance policy in each course syllabus.

Student Academic Appeals Process

Authority and responsibility for assigning grades to students rest with the faculty. However, in those instances where students believe that miscommunication, errors, or unfairness of any kind may have adversely affected the instructor's assessment of their academic performance, the student has a right to appeal by the procedure listed in the University Online Catalog and by doing so within thirty days of receiving the grade or experiencing any other problematic academic event that prompted the complaint.

Technical Considerations

Minimum Recommended Hardware and Software:

- Intel PC or Laptop with Windows 10 or later version; Mac with OS High Sierra*
- Smartphone or iPad/Tablet with Wi-Fi*
- High-speed Internet access
- 8 GB Memory
- Hard drive with 320 GB storage space
- 15" monitor, 800x600, color or 16 bit
- Sound card w/speakers
- Microphone and recording software
- Keyboard & mouse
- Most current version of Google Chrome, Safari, or Firefox

Note: Be sure to enable Java & pop-ups in the Web browser preferences

* Smartphones, Google Chrome books, and Android tablets may not be supported. iPads are the only tablets supported.

Participants should have a basic proficiency of the following computer skills:

- Sending and receiving email

- A working knowledge of the Internet
- Microsoft Word (or a program convertible to Word)
- Acrobat PDF Reader
- Windows or Mac OS
- Video conferencing software

Netiquette (online etiquette)

Students are expected to participate in all discussions and virtual classroom chats as directed. Students are to be respectful and courteous to others on discussion boards. Foul or abusive language will not be tolerated. Do not use ALL CAPS for communicating to others AS IT CAN BE INTERPRETED AS YELLING. Avoid slang terms such as "wassup?" and texting abbreviations such as "u" instead of "you." Limit and possibly avoid the use of emoticons. Be cautious when using humor or sarcasm as tone is sometimes lost in an email or discussion post, and the message might be taken seriously or sound offensive.

Video Conferencing Etiquette

When using Zoom, WebEx, or other video conferencing tools, confirm the visible area is tidy, clear of background clutter, inappropriate or offensive posters, and other distractions. Ensure you dress appropriately and avoid using high traffic or noisy areas. Stay muted when you are not speaking and avoid eating/drinking during the session. Before the class session begins, test audio, video, and lighting to alleviate technology issues.

Technical Support

Students should go to <https://mypassword.pvamu.edu/> if they have password issues. The page will provide instructions for resetting passwords and contact information if login issues persist. For other technical questions regarding eCourses, call the Center for Instructional Innovation and Technology Services at 936-261-3283 or email ciits@pvamu.edu.

Communication Expectations and Standards

Emails or discussion postings will receive a response from the instructor, usually in less than 48 hours. Urgent emails should be marked as such. Check regularly for responses.

Discussion Requirement

Online courses often require minimal to no face-to-face meetings. However, conversations about the readings, lectures, materials, and other aspects of the course can occur in a seminar fashion. The use of the discussion board will accomplish this. The instructor will determine the exact use of discussion boards.

It is strongly suggested that students type their discussion postings in a word processing application such as Word and save it to their PC or a removable drive before posting to the discussion board. This is important for two reasons: 1) If for some reason your discussion responses are lost in your online course, you will have another copy; 2) Grammatical errors can be greatly minimized by the use of the spell-and-grammar check functions in word processing applications. Once the post(s) have been typed and corrected in the word processing application, copy and paste to the discussion board.

COVID-19 Campus Safety Measures

To promote public safety and protect students, faculty, and staff during the coronavirus pandemic, PVAMU has adopted policies and practices to limit virus transmission.

- **Self-monitoring** - Students should follow CDC recommendations for self-monitoring. Students who have a fever or exhibit symptoms of COVID-19 should participate in class remotely and should not participate in face-to-face instruction.
- **Face Coverings** - Face coverings (cloth face covering, surgical mask, etc.) are recommended in classrooms, teaching laboratories, common spaces such as lobbies and hallways, public study spaces, libraries, academic resource, and support offices, and outdoor spaces where 6 feet of physical distancing is challenging to maintain reliably.

- **Physical Distancing** - Physical distancing should be maintained between students, instructors, and others in course and course-related activities where possible.
- **Personal Illness and Quarantine** - Students required to quarantine are to participate in courses and course-related activities remotely and must not attend face-to-face course activities. Students should notify their instructors of the quarantine requirement. Students under quarantine are expected to participate in courses and complete graded work unless they have symptoms that are too severe to participate in course activities. Students experiencing personal injury or illness that is too severe for the student to attend class qualify for an excused absence. To receive an excused absence, students must provide appropriate documentation to the Office for Student Conduct, studentconduct@pvamu.edu.

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 your Department. **You cannot use any number of your choice**
- 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

- Instructor's **critical evaluation** of perceived problems that affected students' performance. **Realistic problems should be identified throughout the semester and summarized in this section of the report.**

4. New Plans for Addressing Problems

- Instructor's plans for addressing the perceived problems the next time the class is taught. **These should be specific enough for another instructor to implement. Most of these should be things that, you, the instructor can implement to help students to improve. Be creative.**

5. Overall Trend over last three assessment periods

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

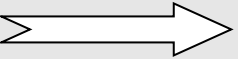
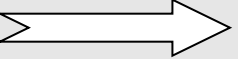
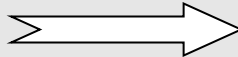
5. Were Expectations Met?

- 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.

Table 2.1. END OF SEMESTER COURSE OUTCOME ASSESSMENT REPORT
CHEG4101-P01 Chemical Engineering Laboratory II
Fall 2021 SEMESTER

Report Prepared by: Dr. Jorge Gabitto

Report Date: December 18, 2021

Semester	Analysis Type	Number of Students	Outcome 5 Ability to design and conduct experiments.			Outcome 6 Ability to function on multi-disciplinary teams.			Outcome 3 Oral & Written Communication		
			Expected Average	Class Average	% Students Meeting Expected Average	Expected Average	Class Average	% Students Meeting Expected Average	Expected Average	Class Average	% Students Meeting Expected Average
Fall 2021	Direct	15	75	75.5	66.7	75	80.2	86.7	75	76.3	66.7
Fall 2020	Direct	20	75	80.0	85.0	75	75.0	70.0	75	82.1	100.0
Fall 2019	Direct	18	75	80.0	85.0	75	75.0	70.0	75	72.0	60.0
Implementation Summary			Practice sessions in laboratory describing procedures for data acquisition and analysis. Design of experiments lecture.			Evaluation of student participation in and out of the laboratory.			Lab report format distributed to students and discussed. A class on how to prepare reports/presentations added.		
Perceived Problems			Students perform well the data acquisition part of the experiment, but fail in data analysis. This issue leads to wrong conclusions.			Uneven participation in conducting the laboratory experiments and preparing the corresponding Lab. Report.			Students could not write logical conclusions and could not adequately comment on the results.		
Plans for Addressing Problems			The following is recommended for implementation next course offering: 1. Draft data analysis will be required during lab. class. 2. Quizzes will be administered to stress the need for proper data analysis. 3. Students will be encouraged to check their lab. Reports before turning them in.			The instructor proposes: 1. Assign every group a group leader. The leader is responsible for even student participation. The leader evaluates student participation in every report/presentation. 2. The instructor evaluates student participation by direct observation plus given individual quizzes when appropriate.			The instructor did: 1. Samples of conclusions on research report can be given to students. 2. Instructor discussed the reports with the students in class, and privately. 3. The students should be encouraged to discuss their reports/presentations with the instructor BEFORE turning them in. .		
Overall Trend over Periods			The class average has decreased significantly over last semester. More work is needed. Extra data are needed to figure it out if it is due to the pandemic or a trend.			The class average has decreased significantly over last semester. More work is needed. Extra data are needed to figure it out if it is due to the pandemic or a trend.			The class average has decreased significantly over last semester. More work is needed. Extra data are needed to figure it out if it is due to the pandemic or a trend.		

**Grade Sheet Showing
Student and Class Performance in Outcomes**

CHEG 4101-Y01
FALL 2021 SEMESTER

Outcome 3 Oral & Written Communication Report 4 & Final Pres		Outcome 5 Ability to function on multi-disciplinary teams. Report 2 + 3		Outcome 6 Ability to design and conduct experiments DOE Quiz + report 3	
	Total		Total		Total
8	1	7.75	1	8.75	1
7.1		7.1		7.5	1
7.8	1	7.8	1	8.9	1
8	1	7.75	1	8.75	1
8	1	7.75	1	7.75	1
7.1		7.1		8	1
7.1		7.1	0	5	
8	1	7.75	1	8.25	1
7.8	1	7.8	1	8.9	1
7.8	1	7.8	1	8.9	1
7.1		7.1		8	1
7.8	1	7.8	1	8.9	1
7.1		7.1		6.5	
7.8	1	7.8	1	8.4	1
8	1	7.75	1	7.75	1
114.5	10	113.25	10	120.25	13
7.633333333	66.67	7.55	66.67	8.016667	0.866667

	Design of Exp.	Report I	Report II	Report III	Report IV	Final Pres.
Student 1	10	5.5	6.8	7.5	7	8.5
Student 2	8	4.8	6	7	7	7.2
Student 3	10	4.8	5.5	7.8	7.8	7.8
Student 4	10	5.5	6.8	7.5	7	8.5
Student 5	8	5.5	6.8	7.5	7	8.5
Student 6	9	4.8	6	7	7	7.2
Student 7	3	4.8	6	7	7	7.2
Student 8	9	5.5	6.8	7.5	7	8.5
Student 9	10	4.8	5.5	7.8	7.8	7.8
Student 10	10	4.8	5.5	7.8	7.8	7.8
Student 11	9	4.8	6	7	7	7.2
Student 12	10	4.8	5.5	7.8	7.8	7.8
Student 13	6	4.8	6	7	7	7.2
Student 14	9	4.8	5.5	7.8	7.8	7.8
Student 15	8	5.5	6.8	7.5	7	8.5

**OUTCOME SPECIFIC ASSIGNMENTS
USED TO ASSESS OUTCOMES**

ASSIGNMENTS FOR OUTCOME 3

An ability to an ability to communicate effectively with a range of audiences.

**CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
Chemical Engineering Laboratory II
FALL 2021**

Instructor: Dr. Jorge F. Gabitto

Title of Assignment

Report 4

Outcome Measured Using this Assignment

Outcome 3

An ability to an ability to communicate effectively with a range of audiences.

Brief justification of why this assignment is suitable for this outcome

The rubric used for grading this assignment measures the students' ability to express themselves using written communication. Organization and professional language are also measured.

Roy G. Perry
College of Engineering



CHEG 4011 Chemical Engineering Lab II
Lab 3: Experiment 4 On Pumps in Parallel and Series

Group 2

Oluwatoyosi Idowu
Mohamed Akinotcho
Ike Anaghara
Utomwen Irabor
Laura Ukpede

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Abstract

Centrifugal pumps assembled in series or in parallel are used in a wide range of applications in the processing industry. The objective of this lab was to investigate the characteristic curves for a single centrifugal pump. Also, compare the behavior of 2 centrifugal pumps in parallel against two in series. The pump characteristics curves were developed for a single pump, two pumps in series, and two pumps in parallel by measuring flow rate, power, and head & pump efficiency using the experimental apparatus. The apparatus consists of a tank and pipework which delivers water to and from two identical centrifugal pumps. The assembly of the pumps was constructed in a way that the valves can be adjusted accordingly to activate an individual single pump, series pump, and parallel pump. For two identical pumps in a series, the head will be twice the head of a single pump, whereas pumps in parallel are expected to have twice the flow rate of a single pump for a given head. The mechanical power of the pump increases, and the flow rate increases which causes the total head to decrease. The pump efficiency peaks and decreases afterward.

Theory

According to Pumpwork.com, “the term pumping in series means that 1 pump acts as a booster to feed another pump” (1). They also added that the purpose of pumps operating in series is that, at the same flow rates, the differential pressure or head of both pumps is additive” (2). The three most used graphical representations of pump performance include the change in total head produced by the pump, the power input to the pump, and the pump efficiency. In this experiment, we also compared the behavior of two centrifugal pumps in parallel against two in series. To accomplish these, we are to utilize certain unit operation equations. Total Head is the addition of the suction head and the delivery head. The total head can also be calculated by adding the change in static head to the change in velocity head and change in elevation. That is, $H_t = H_s + H_v + H_e$. In this equation, the change in the static head (H_s) = $\frac{(P_{out} - P_{in})}{\rho g}$ where P_{in} is the fluid pressure at the inlet in pascal. While the change in velocity head (H_v) = $\frac{(V_{out} - V_{in})^2}{2g}$. Where V_{in} is the fluid velocity at the inlet stream and the V_{out} is the fluid velocity at the outlet. The change in elevation (H_e) = vertical distance between inlet and outlet. It is zero on the TQ H83 equipment. The power input (P_m) is the mechanical power input to the pump. $P_m = \text{rotational force} \times \text{angular distance}$. The efficiency of the pump is the division of the hydraulic power imparted to the fluid by the mechanical power absorbed by the pump.

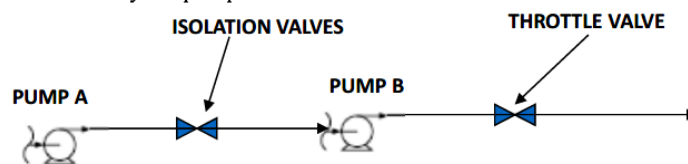


Figure 1: Schematic of two identical pumps connected in Series

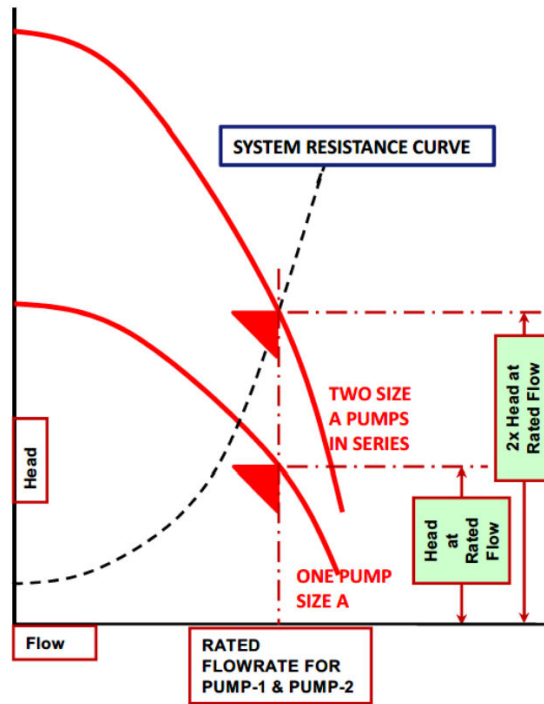


Figure 2: A Schematic showing the Head and Flow Curves plotted for pump A and the Series Curve which is plotted by totaling the Heads of Pump A and Pump B at the same flow rate.

Procedure

This experiment was carried out utilizing the TQ H83 series and parallel pump test set unit, the TecQuipment Versatile Data Acquisition System (VDAS), and venturi tubes to measure the head of the pump. The objective was to analyze and evaluate the efficiency, power, and total head; these steps were taken for a single centrifugal pump, pump in parallel, and pump in series respectively.

Single Pump:

- We started the pump motor and run it to maximum speed.
- Then used the bleed line to bleed all pressure gauges.
- Adjusted the motor speed for the pump by turning the black dial to the speed required for the experiment.
- Switched off both motor pump isolators.
- Closed pump 2 inlet valve and set the 2-way valve to direct flow straight to the delivery pipe.
- Fully open pump 1 inlet and the delivery valve.

- Step 5 - Record readings for pressure and flow for various dial settings.

Parallel Pumps:

- We started the pump motor and run it to maximum speed.
- Then used the bleed line to bleed all pressure gauges.
- Adjusted the motor speed for the pump by turning the black dial to the speed required
- Switched off both motor pump isolators.
- Open both inlet valves and set the two-way valve to direct flow straight to the delivery pipe
- Fully open the delivery valve. Switch on both motor drive isolators.
- Start the pump motors and run them to maximum speed. Bleed all pressure gauges.
- Adjust the motor speed both pumps by turning the black dial console to the speed required.

Series:

- We started the pump motor and run it to maximum speed.
- Then used the bleed line to bleed all pressure gauges.
- Adjusted the motor speed for the pump by turning the black dial to the speed required
- Switched off both motor pump isolators.
- Open Pump 1 inlet valves. Close Pump 2 inlet valve. Set the two-way valve to direct flow straight to the inlet of Pump 2. Fully open the delivery valve.
- Switch on both Motor Drive isolators. Start the pump motors and run them to maximum speed.
- Adjust the motor speed for pumps 1 and 2 by turning the black dial on each pump console to the speed required for the experiment.

Result & Discussion

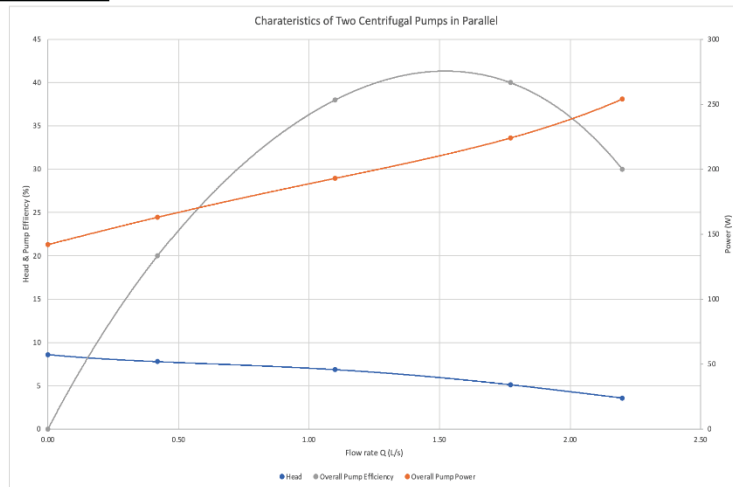


Figure 3: Graphical Representation of Characteristics of Two Centrifugal pumps in Parallel

When two or more pumps are arranged in parallel their resulting performance curve is obtained by adding the pump flow rates at the same head. Centrifugal pumps in parallel are used to overcome larger volume flows than one pump can handle alone. Figure 3 illustrates the flow rate of centrifugal pumps in parallel going from 0 L/s to 2.20 L/s.

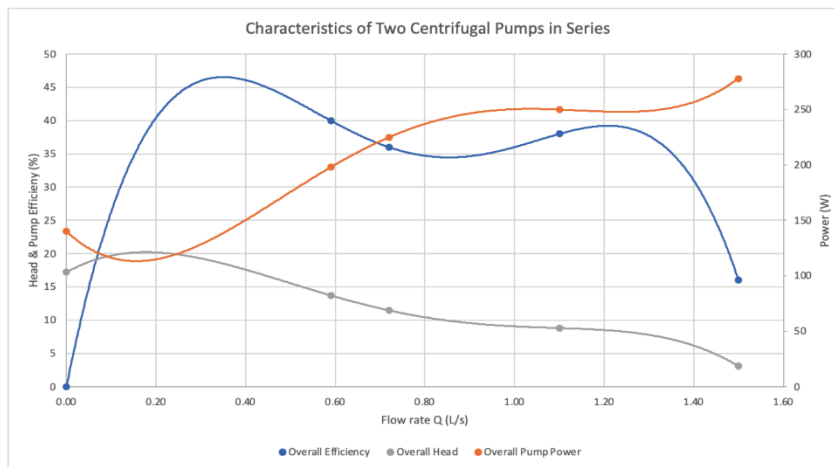


Figure 4: Graphical Representation of characteristics of Centrifugal Pumps in series

When two (or more) pumps are arranged in series their resulting pump performance curve is obtained by adding their heads at the same flow rate. Centrifugal pumps in series are used to overcome larger system head loss than one pump can handle alone. For two identical pumps in series, the head will be twice the head of a single pump at the same flow rate. Pumps in series will give higher head and pumps in parallel would give steady discharge.

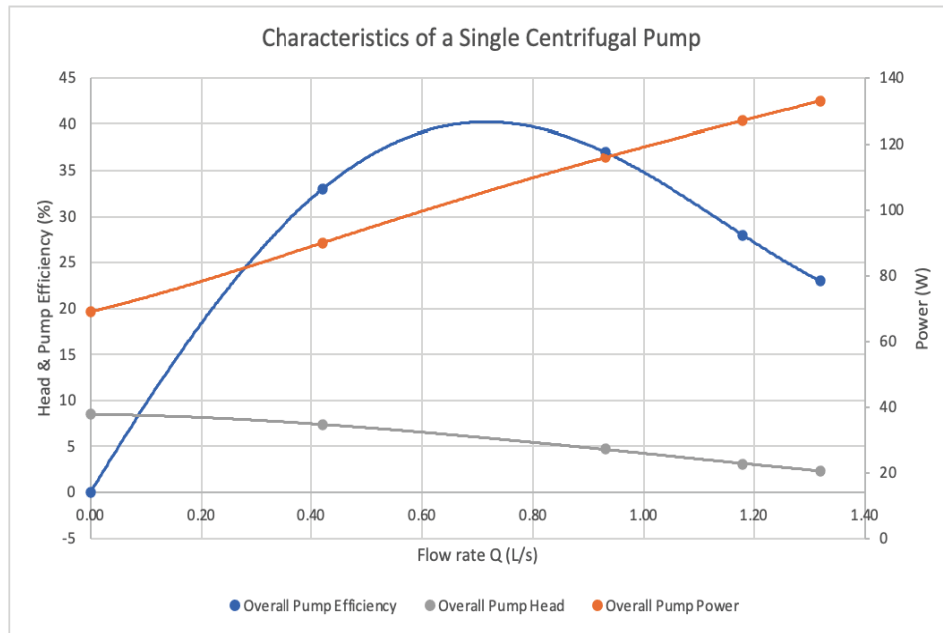


Figure 5. Graphical representation of characteristics a single centrifugal pump

For the pumps in parallel the head decreases while the pump efficiency increases and decreases, the power increases, and the volumetric flow rate increases which is different from the pump in series. In series the overall head increases as the efficiency and the overall pump increase, then start decreasing regardless of how the others are behaving. The overall head for a single pump is behaving the same as the overall head for pumps in parallel. Secondly, the overall power is increasing as the volumetric flow rate and the Pump efficiency increase or decrease in some cases for all the different pump arrangements, however, for a single pump and pumps in parallel, we have an ascending line while for pumps in series we have an oscillator graph. Lastly, the overall pump efficiency increases to a certain point as the overall pump power and the volumetric flow rate increase then starts decreasing as the others keep increasing for pumps in parallel and single pump, while for pumps in series it oscillates regardless of how the others are behaving. It increases to a certain point while the overall head and the overall pump increase, and decreases while the overall decreases and the overall pump power increases

Conclusion

When we compare the two or more parallel pumps versus the singular pump in parallel, we can see from the graph that the slope is steeper meaning that two or more parallel pumps are more efficient than one. In reference to the pumps arranged in series we can see that it is more efficient than pumps in parallel whether more than one or singular.

References

Roy G. Perry Department of Chemical Engineering. "TQ H83 - Understanding Series & Parallel Centrifugal Pumps."

Roy G. Perry Department of Chemical Engineering. "SOP H83."

<https://www.pumpworks.com/operating-two-pumps-series/>

**CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
Chemical Engineering Laboratory II
FALL 2021**

Instructor: Dr. Jorge F. Gabitto

Title of Assignment

Final Presentation

Outcome Measured Using this Assignment

Outcome 3

An ability to an ability to communicate effectively with a range of audiences.

Brief justification of why this assignment is suitable for this outcome

The rubric used for grading this assignment measures the students' ability to express themselves using oral communication. Presentation organization and professional language are also measured.

Centrifugal Pump Characteristics Lab

By: Group 1
Alessia Williams
Amiya Rogers
Chinenye Ihe
Taylon Owens
Franck Nangomoko



1

Outline



ABSTRACT



BACKGROUND



OBJECTIVE



THEORY



PROCEDURES



RESULTS



DISCUSSION



CONCLUSION

2

Abstract

- Characteristic curves show the performance & operating regions of a centrifugal pump which helps increase pump life
- The goals of this experiment were to:
 1. Investigate the characteristic curves for a single centrifugal pump
 2. Compare the behavior of pumps in parallel against pumps in series
- TecQuipment Two-Stage Series and Parallel Pumps – H83 was used to find the characteristics of centrifugal pumps working alone or in series or parallel
- As flowrate increased, total head decreased and as flowrate increased, power increased

Objectives

1

Obtain head, power, efficiency graphs

2

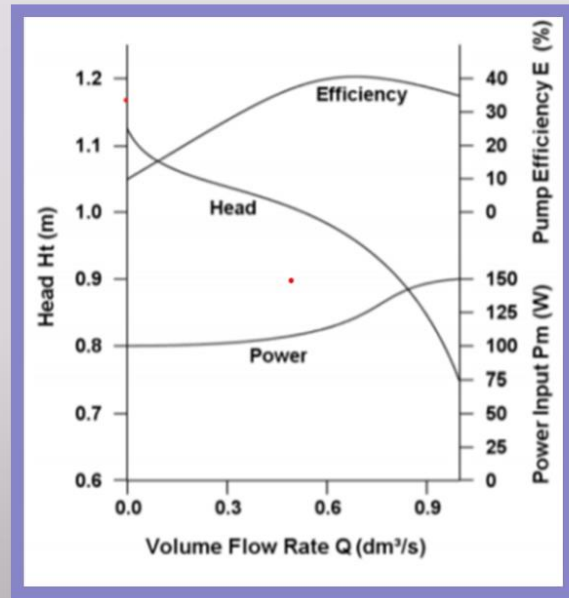
Determine maximum efficiency and flowrate at which it occurs

3

Compare with given curves

Background

- Efficiency is important when selecting pumping system
 - Ratio of hydraulic power (output) to mechanical power (input)
 - Energy and Cost savings
- No pump is 100% efficient



Reference Performance Curves

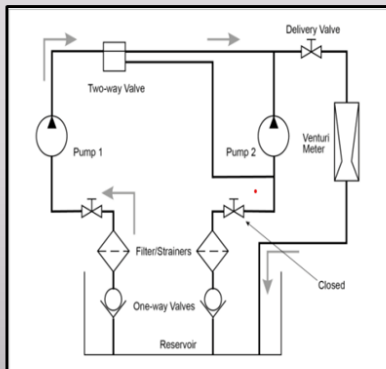
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Applications

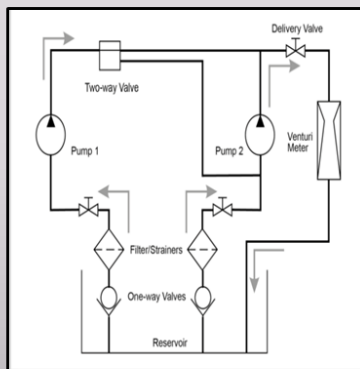
- Energy and oil industries
- Wastewater treatment systems
- Chemical and Petrochemical productions
- Industrial and fire protection



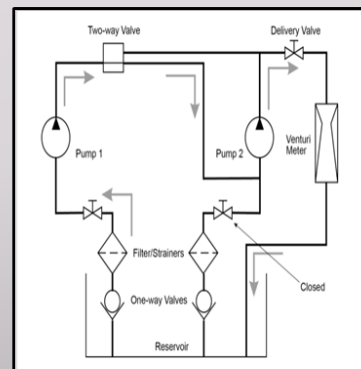
Theory



Single Stage Pump



Parallel Stage Pumps



Series Stage Pumps

7

Calculations

- Total Head:
 - $H_T = H_s + H_v + H_e$
 - $H_{Tseries} = H_1 + H_2$
 - $H_{Tparallel} = H_1 = H_2$
- Flow
 - $Q_{Tseries} = Q_1 = Q_2$
 - $Q_{Tparallel} = Q_1 + Q_2$
- Power (mechanical and hydraulic):
 - $P_m = 2\pi n t$
 - $P_h = H_T Q \rho g$
- Efficiency:
 - $E = 100 \left(\frac{P_h}{P_m} \right)$
- Parallel Pumps:
 - $Q \approx 2Q_{single} @ \text{constant Head}$
- Series Pumps:
 - $H_T \approx 2H_{Tsingle} @ \text{constant Flow}$



Lab Equipment



TecQuipment Two-Stage Series and Parallel Pumps – H83 is used to find the characteristics of centrifugal pumps working alone or in series or parallel



Procedure

Series Pump

1. Create a blank results table by clicking on the icon with the pencil
2. Use both pumps for series configuration. Switch off both motor drive isolators.
3. Open Pump 1 inlet valve. Close Pump 2 inlet valve. Set the two-way valve to direct flow straight to the inlet of Pump 2. Fully open the delivery valve.
4. Switch on both Motor Drive isolators. Start the pump motors and run them to below maximum speed
5. Adjust the motor speed for pumps 1 and 2 by turning the black dial on each pump console to the speed required for the experiment. Record readings for pressure and flow for various dial settings. Make sure to take 3 replicates for each pump dial setting by clicking on the acquire data button 3 times. Try to record data for the pumps having the same rpms.

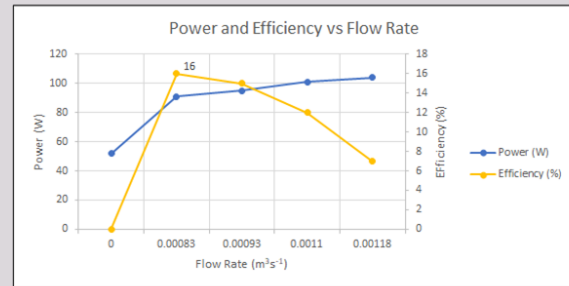
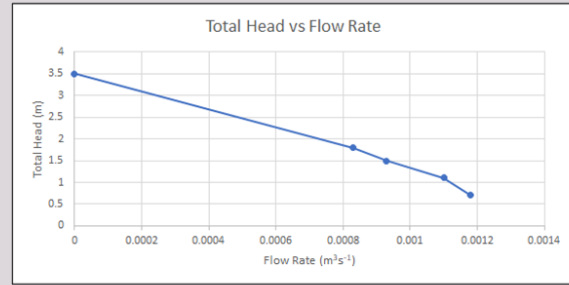
Parallel Pump

1. Create a blank results table
2. Use both pumps for parallel configuration. Switch off both motor drive isolators.
3. Open both inlet valves and set the two-way valve to direct flow straight to the delivery pipe. Fully open the delivery valve.
4. Switch on both motor drive isolators. Start the pump motors and run them to below maximum speed.
5. Adjust the motor speed for pumps 1 and 2 by turning the black dial on each pump console to the speed required for the experiment. Record readings for pressure and flow for various dial settings. Make sure to take 3 replicates for each pump dial setting by clicking on the acquire data button 3 times. Try to record data for the pumps having the same rpms.

Single Pump

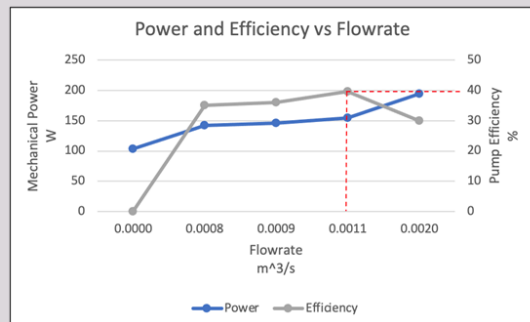
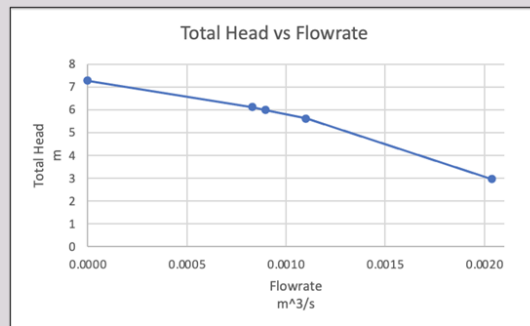
1. Create a blank results table
2. Take readings using the VDAS on Pump 1 only.
3. Switch off both motor pump isolators.
4. Close pump 2 inlet valve and set the 2-way valve to direct flow straight to the delivery pipe. Fully open pump 1 inlet and the delivery valve.
5. Start the pump motor and run it to below maximum speed.
6. Adjust the motor speed for pump 1 by turning the black dial to the speed required for the experiment. Record readings for pressure and flow for various dial settings. Make sure to take 3 replicates for each pump dial setting by clicking on the acquire data button 3 times.

Single Pump Results



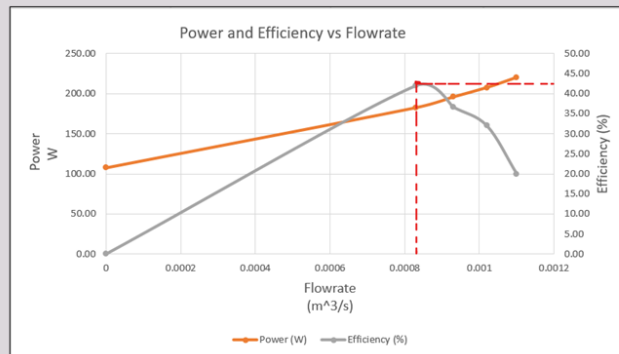
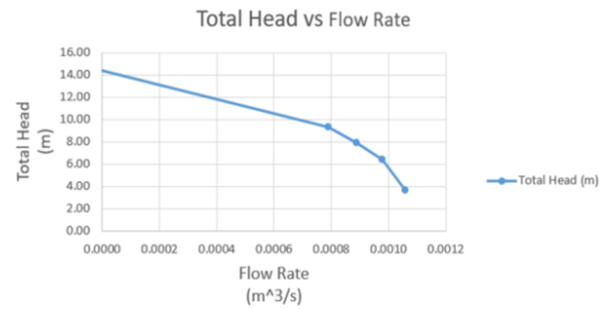
11

Parallel Pumps Results



12

Series Pumps Results



Discussion & Conclusion

Flowrate and Power are Directly Proportional

Flowrate and Total Head are Inversely Proportional

Greatest Efficiency is in Series

No Pump is 100% Efficient

- Single v Dual Pump Operation

Acknowledgements

**Dr. Gabitto
Dr. Antoine
Dr. Martin
Sachie Etherington
Roy G. Perry College of Engineering Faculty &
Staff**

15

QUESTIONS?

16

ASSIGNMENTS FOR OUTCOME 5

An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

**CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
Chemical Engineering Laboratory III
SPRING 2021**

Instructor: Dr. Jorge F. Gabitto

Title of Assignment

Report 2

Outcome Measured Using this Assignment

Outcome 5

An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Brief justification of why this assignment is suitable for this outcome

The rubric used to grade the report assesses the students planning, organization, and collaborative environment. Student participation is also assessed by private communication related to the activity.



Lab #2 Fluid Friction in Pipes

Shanelle Bryant

Willie Conner

Jevaun Christie

Ryan Livingston

Timothy Waugh

CHEG 4102 P02 Chemical Engineering Lab II

Group 2

September 29, 2021

Abstract

The goal of this experiment is to determine the relationship between pressure drop due to friction and velocity of the fluid in both smooth and rough pipes with different inner diameters. This experiment was done in a closed system. This enabled us to study the pressure drops in the pipes. We used an AFTC/AFT/AFT-B/AFT-B unit to run our experiment and utilized the first three pipes to conduct this experiment. Energy can be lost due to friction in straight pipes of different sizes and this can be studied on a certain range of Reynold's number. Calculating Reynold's number we can identify if the flow will be laminar or turbulent. After conducting twenty-seven trials, we were able to conclude that because of the roughness in the pipes, the flow of fluid from the beginning of the pipe to the end will be turbulent.

Theory

Osborne Reynolds was the first to demonstrate the distinction between the two types of flow in his classic experiment reported in 1883. A horizontal glass pipe was immersed into a glass-walled tank filled with water. Provisions were made to introduce a filament of dyed water into the stream from the entrance of the tube, and the flow was controlled by a regulating valve located at the outlet of the glass pipe. Reynolds observed and found that the jet of the colored water displayed *laminar flow* at low flow rates. When the flow rate was increased and reached its critical velocity, the water no longer flowed in a laminar motion. At this point, the thread of the colored water became wavy, *transitional*, and eventually spread uniformly throughout the glass tube. Otherwise known as *turbulent flow*.

Thus resulting in the formulation of the Reynolds number equation and the following conclusions on the types of flow:

$$Re = \frac{DV\rho}{\mu} = \frac{DV}{\nu} = \frac{\text{inertial forces}}{\text{viscous forces}}$$

- D : Diameter of pipe/tube
- V : Velocity of fluid
- ρ : Density of fluid
- μ : Dynamic viscosity

- ν : Kinematic viscosity

Laminar Flow

- Low velocities
- Small Length scales
- High kinematic viscosities
- $Re < \text{critical } Re (2000)$
- Viscous forces are dominant
- Pressure drop directly proportional to velocity
- $f = \frac{64}{Re}$

Turbulent Flow

- High velocities
- Large length scales
- Low kinematic viscosities
- $Re > \text{critical } Re (2000)$
- Inertial forces are dominant
- Pressure drop directly proportional to square of the velocity
- $f = \frac{.316}{Re^{1/4}}$

Once these values are determined we will be able to calculate our pressure drop due to friction using the *Darcy-Weisbach Law*.

Darcy-Weisbach Law...

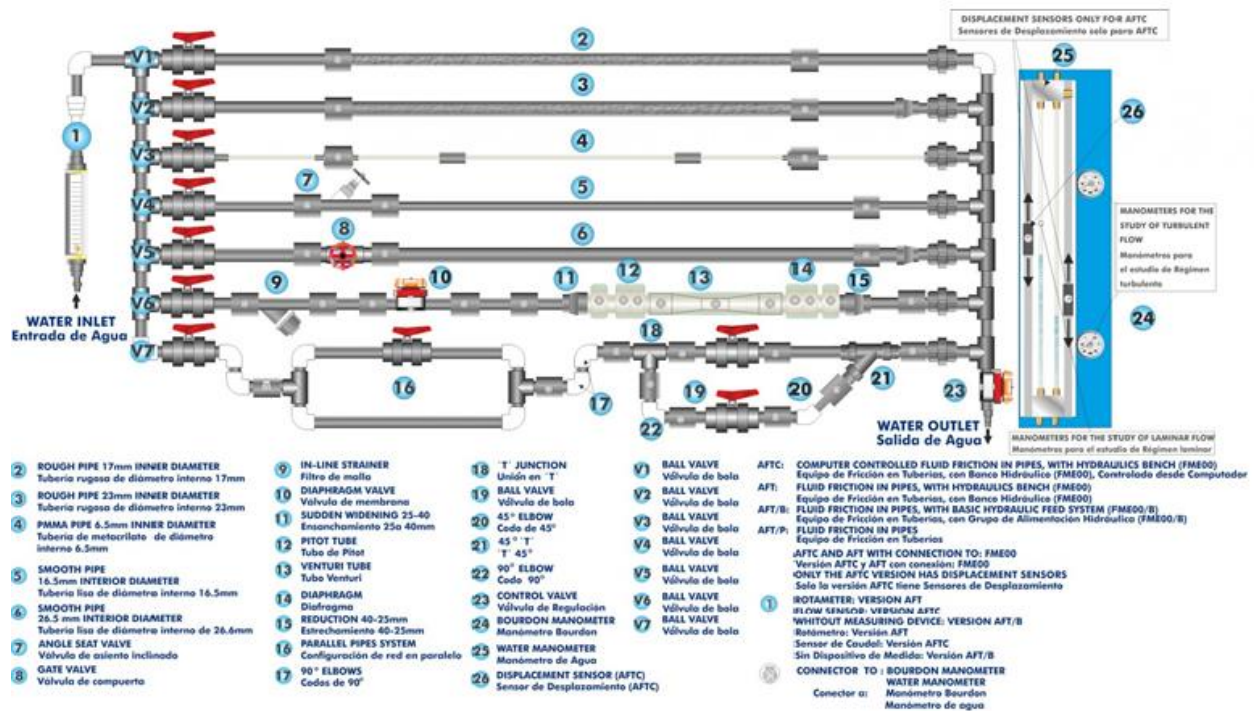
$$h_f / \Delta p = f \frac{L}{D} \times \frac{v^2}{2g} = \frac{8fLQ^2}{gD^5 \pi^2}$$

- f : Friction factor
- L : Length
- D : Diameter
- Q : Flow rate
- h_f : The Loss due to friction (head)
- Δp : Loss due to friction

The goal of this experiment is to determine the relationship between pressure drop due to friction and velocity of the fluid in both smooth and rough pipes with different inner diameters. By measuring the pressure drop across the pipes using the manometer and pressure gauge, as detailed in the Procedure, we will use these equations to derive our *Reynolds number*, *friction factor*, and *Darcy-Weisbach Law* (pressure drop). Thus, aiding in providing a quantitative explanation, with practical application, to sharpen our understanding of fluid flow.

Procedures

Step 1: Made sure everything was connected and turned the generator on.



Step 2: Open the valve for the pipe used (V1 for pipe 2, V2 for pipe 3, V3 for pipe 4).

Step 3: Open the valves for the low-pressure gauges.

Step 4: Connect the high-pressure taps to the used pipe.

Step 5: If high pressure couldn't be read, the low-pressure taps were connected.

Step 6: Rotate the flowmeter knob until the desired flow rate is achieved.

Step 7: Record the pressure drop.

Step 8: Record pressure drop for the other 2 flow rates chosen.

Step 9: Repeat for each pipe used.

The variables measured were pressure drop and the length of each pipe. Pressure drop was measured by either the difference of the two high-pressure gauges or low-pressure gauges. The length of each pipe was measured by an app called Measure.

The variable manipulated and measured was volumetric flow rate. The volumetric flow rate was measured by a flowmeter.

Results and Discussion

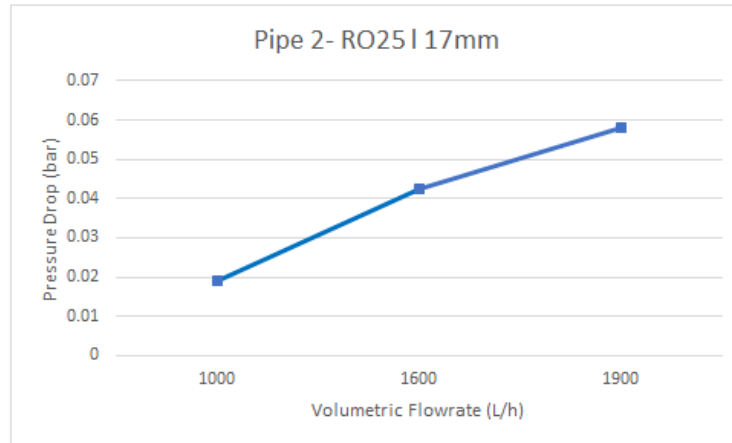


Figure 1: Pressure Drop vs. Volumetric Flow Rate in Pipe 2

Figure 1 depicts the increase in Pressure Drop rate as Volumetric Flow Rate increases in the rough 17mm piping. There is an exponential relationship between the two variables which displays a slight curve in line. The exponential function is on the verge of plateauing if the volumetric flow rate was to be increased.

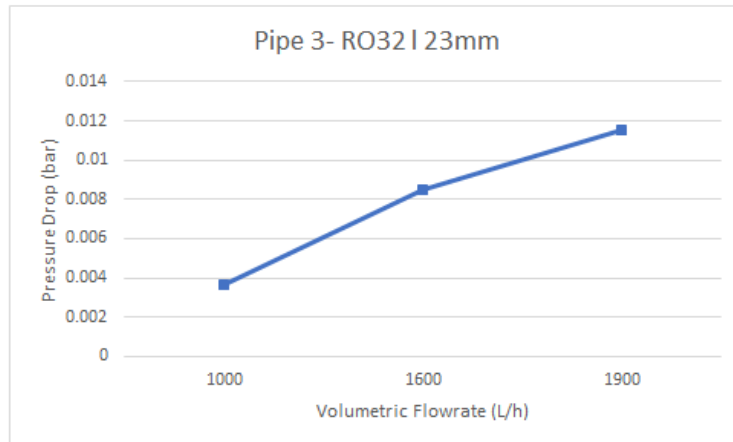


Figure 2: Pressure Drop vs. Volumetric Flow rate in Pipe 3

Figure 2 depicts the increase in Pressure Drop rate as the Volumetric Flow Rate increases in the 23 mm rough piping. There is an exponential relationship between the two variables which displays a slight curve in line. The exponential function is on the verge of plateauing if the volumetric flow rate was to be increased.

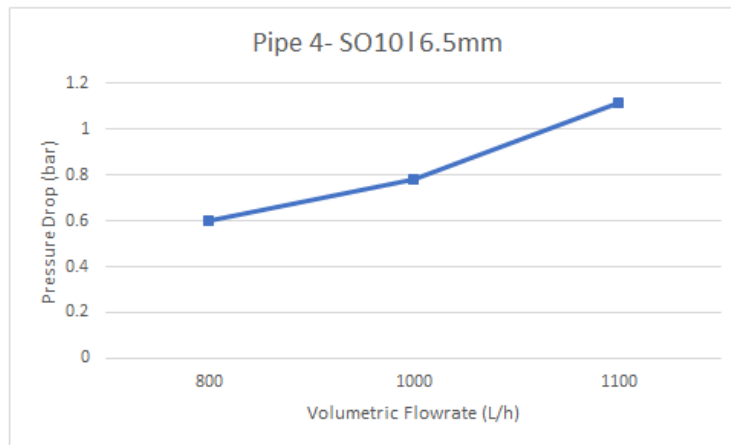


Figure 3: Pressure Drop vs. Volumetric Flow Rate in Pipe 4

Figure 3 depicts the increase in Pressure Drop rate as the Volumetric Flow Rate increases in the smooth narrow 6.5 mm piping. There is an exponential relationship between the two variables which displays a slight curve in the line.

Reynold's number: $Re = \frac{\rho v D}{\mu}$

Volumetric Flow Rate to fluid velocity

$Q = v \times A$

Volumetric Flow Rate

$800 \text{ L/h} = 0.00022 \frac{m^3}{s}$

$1000 \text{ L/h} = 0.000278 \frac{m^3}{s}$

$1100 \text{ L/h} = 0.0003056 \frac{m^3}{s}$

$$1600 \text{ L/h} = 0.000444 \frac{\text{m}^3}{\text{s}}$$

$$1900 \text{ L/h} = 0.000528 \frac{\text{m}^3}{\text{s}}$$

Pipe 2- RO25 | 17mm

For 1000 L/h

- $\text{Re} = \frac{1000 \text{ kg/cm}^3 \times 0.306 \text{ m/s} \times 0.017 \text{ m}}{1.002 \times 10^{(-3)} \text{ N s/m}^2} = 5190$
- $f = \frac{.316}{5190^{1/4}} = 0.037230$

For 1600 L/h

- $\text{Re} = \frac{1000 \text{ kg/cm}^3 \times 0.489 \text{ m/s} \times 0.017 \text{ m}}{1.002 \times 10^{(-3)} \text{ N s/m}^2} = 8300$
- $f = \frac{.316}{8300^{1/4}} = 0.033107$

For 1900 L/h

- $\text{Re} = \frac{1000 \text{ kg/m}^3 \times 0.5815 \text{ m/s} \times 0.017 \text{ m}}{1.002 \times 10^{(-3)} \text{ N s/m}^2} = 9870$
- $f = \frac{.316}{9870^{1/4}} = 0.0317035$

Pipe 3- RO32 | 23mm

For 1000 L/h

- $\text{Re} = \frac{1000 \text{ kg/cm}^3 \times 0.167 \text{ m/s} \times 0.023 \text{ m}}{1.002 \times 10^{(-3)} \text{ N s/m}^2} = 3830$
- $f = \frac{.316}{3830^{1/4}} = 0.040169$

For 1600 L/h

- $\text{Re} = \frac{1000 \text{ kg/cm}^3 \times 0.267 \text{ m/s} \times 0.023 \text{ m}}{1.002 \times 10^{(-3)} \text{ N s/m}^2} = 6130$

- $f = \frac{.316}{6130^{1/4}} = 0.0357126$

For 1900 L/h

- $Re = \frac{1000 \text{ kg/m}^3 \times 0.3177 \text{ m/s} \times 0.023 \text{ m}}{1.002 \times 10^{(-3)} \text{ Ns/m}^2} = 7290$
- $f = \frac{.316}{7290^{1/4}} = 0.034198$

Pipe 4- SO10 | 17mm

For 1000 L/h

- $Re = \frac{1000 \text{ kg/cm}^3 \times 1.66 \text{ m/s} \times 0.0065 \text{ m}}{1.002 \times 10^{(-3)} \text{ Ns/m}^2} = 10768$
- $f = \frac{.316}{10768^{1/4}} = 0.0310208$

For 1600 L/h

- $Re = \frac{1000 \text{ kg/cm}^3 \times 2.09 \text{ m/s} \times 0.0065 \text{ m}}{1.002 \times 10^{(-3)} \text{ Ns/m}^2} = 13558$
- $f = \frac{.316}{13558^{1/4}} = 0.0292845$

For 1900 L/h

- $Re = \frac{1000 \text{ kg/m}^3 \times 2.30 \text{ m/s} \times 0.0065 \text{ m}}{1.002 \times 10^{(-3)} \text{ Ns/m}^2} = 14920$
- $f = \frac{.316}{14920^{1/4}} = 0.2859$

The results show that the flow through all 3 pipes was turbulent. Pipes 2 and 3 consisted of sand, so turbulent flow was expected. The fourth pipe was smooth and there was the uncertainty of what the flow would be.

During the lab, pipe 2 seemed the roughest and hardest pipe to experiment with, so the fact that it's more turbulent than pipe 3 is unsurprising. The smooth pipe (pipe 4) being much more turbulent than pipes 1 and 2 wasn't expected.

Based on the graphs, all 3 pipes experienced proportional relationships between the volumetric flow rate and pressure drop.

Conclusion

Taking everything into account this experiment was to choose the association between pressure drop in view of grating and speed of the fluid in both smooth and rough pipelines with different estimations. In light of the diagrams, every one of the 3 pipes lines experienced corresponding connections between the volumetric stream rate and pressure drop. By estimating the pressure drop across the pipelines utilizing the manometer and tension check we had the option to decide the connection between pressure drop because of rubbing and speed of the liquid in both smooth and rough pipelines with various inward measurements. After carrying out twenty-seven trials, we were able to conclude that due to the roughness within the inside of the pipes, the flow of fluid from the start of the pipe to the end of the pipe may be turbulent.

**CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
Chemical Engineering Laboratory II
FALL 2021**

Instructor: Dr. Jorge F. Gabitto

Title of Assignment

Report 3

Outcome Measured Using this Assignment

Outcome 5

An ability to function effectively on a team whose members together provide leadership, create a collaborative and inclusive environment, establish goals, plan tasks, and meet objectives.

Brief justification of why this assignment is suitable for this outcome

The rubric used to grade the report assesses the students planning, organization, and collaborative environment. Student participation is also assessed by private communication related to the activity.

Prairie View A&M University
Chemical Engineering Department
Lab #3 Gas Absorption
CHEG 4104 - P01



Chiebuka Ejimadu
Katelyn Inman
Tyree Madison
Caleb Myers
Xavier Williamson

Date Conducted: 11/01/ 2021
Submission Date: 11/08/2021

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- Purpose
- Key Findings
- Major Conclusion Drawn

Theory

- Introduction
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- Background

Procedures

- Schematic Diagram

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- Treatment of Data
- Discussion

Conclusion

Abstract



Gas absorption is a separation process mostly used at chemical industries for chemical processes and/or sustainability control. Gas-liquid absorption is an extraction technique where one or more components from the gas mixture will be separated and dissolved into the liquid. This method is utilized in power generation and many chemical plants for CO₂ capturing, flue gas purification, off-gas waste treatment and so on. CAGC equipment from Edibon is a type of device used to conduct and simulate such experiments. CAGC stands for Computer Controlled Gas Absorption Column, which is used for examining and testing hydrodynamic and absorption experiments in packed columns. The objectives of this lab are to measure and record the pressure drops within the column as a function of air rate, but at various water flow rates. Also, we need to find the flooding point of the relationships under all the different conditions. The results showed a direct relationship in terms of as the liquid flow rate and gas flow rate increased, pressure drop increased as well.

Theory

In a gas-liquid absorption activity, the two reaching stages are a gas and water. The ideal result is to separate a solute or a few solutes from the gas stage into the fluid stage, to all the more effectively separate the ideal part from its unique combination. In this test arrangement notwithstanding, there is no solute stage. There are two masses, reaching stages, air and water. In this experiment, we have a countercurrent stream of air and water through a loaded section with air streaming vertically and water descending. The segment is loaded with Raschig Rings. There are four ways pressure drop can be calculated;

- In a packed bed, with one fluid phase
- In a packed bed, with gas/liquid counter-operation
- Random packing
- Flooding pressure drop in packed and structured packings

For pressure drop in a packed bed with a one fluid phase flow is caused by kinetic energy and viscous losses, which can be calculated from the Ergun's equation:

$$\left(\frac{-\Delta p}{L}\right)\left(\frac{D_p g_c}{\rho_v u^2}\right)\left(\frac{\varepsilon^3}{1-\varepsilon}\right) = 150\left(\frac{1-\varepsilon}{Re}\right) + 1.75$$

where,

$-\Delta p$ = pressure drop

ρ_v = fluid density

L = package length

u = average superficial velocity of fluid

g_c = conversion factor

D_p which is the effective particle of what Reynolds number is based off of.

$$Re = \frac{D_p G'}{\mu}$$

where,

G' = mass velocity of the fluid based on the tower cross section

μ = fluid viscosity

If the packing is not a spherical shape, the effective particle diameter is found by:

$$D_p = \frac{6V_p}{A_p} = \frac{6(1-\varepsilon)}{A_v}$$

Where,

ε = the fraction of total bed volume that is void

A_v = is the ratio of the total packing surface area in the bed to the total volume of the bed

Pressure drop in a packed bed with gas/liquid counter-current operation there is an upper limit to the flowrate of gas in a packed tower of a given size with a given packing and liquid flow. The column can't operate past this velocity. When gas flow velocities are low, the liquid will flow downward while the flow of the gas hinders the flow of the liquid by a countercurrent flow. The pressure drop is proportional to the increase of gas flow rate to the 1.8 power. At the loading point, a great amount of liquid appears in the packing. At this point the gas will start to rise to a faster rate. The accumulation of liquid increases as the gas flow rate increases. The liquid is no longer able to flow downward through the packing at the flooding point, which then will be solved by being blown out with the gas.

In the flooding pressure drop in a packed and structured packing proper designing is important to be able to infer the flooding pressure drop in columns, which limits the flow rate at flooding. To infer the limiting pressure drop at flooding Kister and Gill created an equation:

$$\Delta p_{flood} = 0.115 F_p^{0.7}$$

where,

Δp_{flood} = H₂O/ft height of packing

F_p the packing factor in ft⁻¹

For pressure drop in random packings is by Strigle. The empirical correlations for different random packings experimental data are used to infer the pressure drop in the gas flow.

Procedures

1. The atmospheric pressure (read in a barometer) and the operating temperature of the column (temperature of the water) are measured, in order to correct the gas flow measured in the Flowmeters.
2. Ensure that the air blower is connected (to check that the security valve is open).
3. Next, open the VR-1 valve and close the VR-2.
4. Check the air flow and ensure it is fixed by means of the VR-1 valve and after write down the pressure drop (read in the manometers of the panel) that the gas suffers when crossing the column.
5. Next, write down the load losses corresponding to each one of the 10 air flows. Of this form the points of the gas flow-fall of pressure graphic are obtained, corresponding to the dry filling.
6. Connect the water pump and check that the VR-3 valve is open, and fix the desired value for the water flow with the VR-3 valve.
7. For each liquid flow fixed (read directly in the flowmeter), to measure the load losses corresponding to 10 different gas flows.
8. Repeat the points 6 to 9 for other two liquid flows to obtain relationships between gas flow and pressure drop for the corresponding liquid flows.

Results & Discussion

The objective of this lab, as previously stated, was to measure pressure drops as functions of inlet air volumetric flow rate for three different liquid volumetric flow rates of 1.5, 2.0, & 2.5 L/min. Pressure values at SP3 and SP4 were recorded for the various liquid and gas flow rates and tabulated below:

Table 1: Pressure readings for several liquid and gas flow rates into the absorption column

Valve openness	Liquid flow rate [L/min]	Gas flow rate [L/min]	SP3 [in H ₂ O/ft]	SP4 [in H ₂ O/ft]
40%	1.5	34.4	5.5	3.0
60%	1.5	51.1	14.1	10.0
80%	1.5	67.1	26.0	19.1
40%	2.0	33.3	5.2	3.9
60%	2.0	50.1	16.8	14.1
80%	2.0	67.5	40.2	33.9
40%	2.5	33.8	10.1	8.5
60%	2.5	50.7	39.6	36.8
80%	2.5	67.1	55.9	50.4

Pressure drop values were derived from this data by the use of SP3 - SP4 calculations to find the change in liquid pressure between the two points. In order to discover the relationship between gas flow rates and the resulting pressure drops, the two parameters were plotted against each other and the trends analyzed. The graph below displays this information; each line represents data for a particular controlled liquid flow rate:

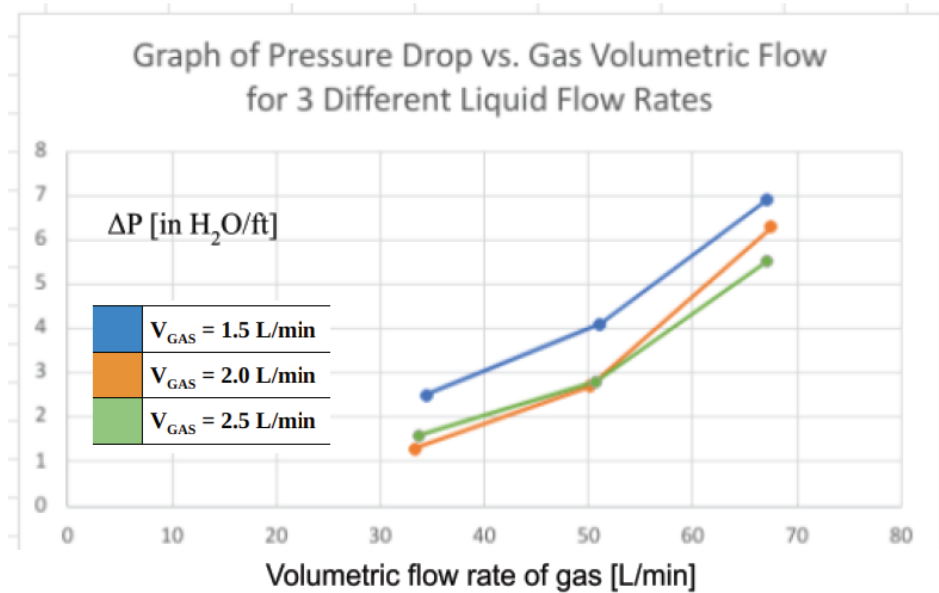


Figure 1: Graph of Pressure Drop vs. Gas Volumetric Flow for 3 Different Liquid Flow Rates

Looking at the trend, it is clear that the liquid flow rate has an effect on the pressure drop along with the gas flow rate. By keeping the liquid flow rates and three different controlled values, this was more easily observed. As the liquid flow rate increased, the pressure drops increased as well. This was also true as the gas flow rate increased, as shown by the increase in y-values as the gas flow rate on the x-axis increased. The pressure drop is shown to be proportional to the flow rate of the gas to the 1.8 power.

Conclusion

In this experiment, the pressure drop, as a function of air rate and three water rates, was measured for several conditions of a 2-phase flow. The results show that as the valve opens more, at a constant liquid flow rate, the pressure increases along with the pressure drop. When comparing the pressure drop of each 3 liquid flow rates at the same valve opening percentage, the pressure drop was highest at the 1.5 L/min liquid flow rate and decreases as the flow rate increases. When collecting the data for SP3 and SP4, an average range was taken due to the large fluctuation of numbers.

ASSIGNMENTS FOR OUTCOME 6

An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

**CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
Chemical Engineering Laboratory III
SPRING 2021**

Instructor: Dr. Jorge F. Gabitto

Title of Assignment

Report 1

Outcome Measured Using this Assignment

Outcome 6

An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Brief justification of why this assignment is suitable for this outcome

The rubric used to grade the report assesses the students' data gathering, data processing, and interpretation of the experimental results. Student understanding of the experiment goals and drawing of appropriate conclusions is also measured.

Prairie View A&M University
Roy G Perry College of Engineering
Distillation Efficiency Lab 1



Submitted by group 1:

Alexus Lovelace , Ebonie Henderson , Cherish Vaughn, Irene A, and Duaa Al badri

To: Dr. Jorge Gabitto

Chem lab 2 4101

10/06/2021

ABSTRACT

Distillation is the process whereby the components of a solution are separated into its respective liquid and gas phases via vaporization or condensation. Heat was applied to the ethanol-water mixture creating the gas and liquid phases. Rotameter readings were taken to measure the flow rates of the feed, the gas top, the liquid bottom, and the reflux. These readings were used to determine the theoretical number of trays. Various samples had to be taken off of each tray of the distillation column to determine the experimental number of trays. These liquid and gas samples, when measured under a refractometer, enabled the determination of the liquid and gas mole fractions. The main focus of the experiment was to compare the number of trays determined experimentally and theoretically, to the actual number of trays of the distillation column. Both procedures gave results of 6 trays and a reboiler, which was the correct number of trays. However, from the graph of the experimental results, the lines connecting the points of the liquid and gas mole fractions protruded the equilibrium line. An error also occurred in the exhausting section, where the points fell below the proposed operating line.

THEORY

Distillation separates liquid components and vapor components into desired purities. The feed is separated into distills enriched in light components which have high volatility and bottoms enriched in heavy components with a lower volatility. The final vapor product coming above is condensed and the liquid product is removed. Which is called distilled which contains high concentration A. The reflux is the only liquid that is not removed from the condenser. The liquid leaving the bottom tray enters the reboiler, where it is partially vaporized and the remaining liquid which (A is lean and B is rich), is withdrawn as liquid product. The vapor from the reboiler is sent back to the bottom tray. The primary equipment used in the process of distillation are distillation towers, which are designed to achieve separation efficiently. The overall experiment was calculating the overall efficiency for an equimolar ethanol- water mixture. Ethanol and water achieve equilibrium. In the lab we measure the reflux by measuring the top tray with a beaker and using a device called a rotameter. The refluxes that are measured are X_b, X_f, X_d which are used to design the McCabe-Thiele diagram. We use the McCabe-Theory to calculate the number of theoretical stages ethanol and water achieves.

The first step when designing an equilibrium diagram is plotting the rectifying line, the feed line (q-line), and stripping line.

Rectifying line shows the total condenser and the reflux at the bubble point.

The overall balance

$$V_{n+1} = L_n + D$$

Component Balance

$$V_{n+1} y_{n+1} = L_n x_n + D x_D$$

$$(L+D) y_{n+1} = L x_n + D x_d$$

Rectifying lines represent the concentration between vapor phase(Y) and liquid phase (x).

Rectifying line:

$$y_{n+1} = \frac{R}{(R+1)} x_n + \frac{1}{(R+1)} x_D \quad (R \text{ represents reflux ratio } R = L/D).$$

In this experiment, we are given the feed line. Your feed can go in different directions, due to different feed conditions:

Feed saturated vapor $q=0$,

Feed superheat vapour $q<0$

Feed partially vapour $0<q<1$

Feed at bubble point $q=1$

Cold feed (below bubble point) $q>1$

Stripping section shows reboiled vapour in equilibrium with bottoms leaving liquid columns.

The overall balance

$$L = V + B$$

Component Balance:

$$L x_m = V y_{m+1} + B x_B$$

Stripping line equation:

$$Y = \frac{L}{(L-B)} x - \frac{B}{(L-B)} x_b$$

Once stripping line, q line, and rectifying line is plot we are to find the number of theoretical stages. The actual number of trays are given. Now calculate the overall stage efficiency;

$$\text{Overall stage efficiency} = \frac{\text{Number of theoretical stages}}{\text{Number of actual trays for same separation}}$$



PROCEDURE

The main equipment used in this lab experiment is the UOP3CC Distillation Column. There are 8 plates in this column, the feed is introduced between plates 4 and 5. Our feed mixture is a mix of ethanol and water. The source of energy is coming from the reboiler through the trays to the condenser. In this process we are able to control the reflux ratio from the program. Once the distillation column is in equilibrium the experiment is able to be carried out. We collected samples from the reboiler and the condenser and tested them using a Refractometer.



(UOP3CC Distillation Column)



(Refractometer)

Once samples were collected we used a pipet to place the samples from the reboiler and condenser on the refractometer. The data collected was completed in 3 trials to get an average of the numbers. After the 3 trials on each specimen, we went back to the program to get the reflux ratio. Also located on the program were our temperatures, trays, reboiler, and condenser.

RESULTS AND DISCUSSION

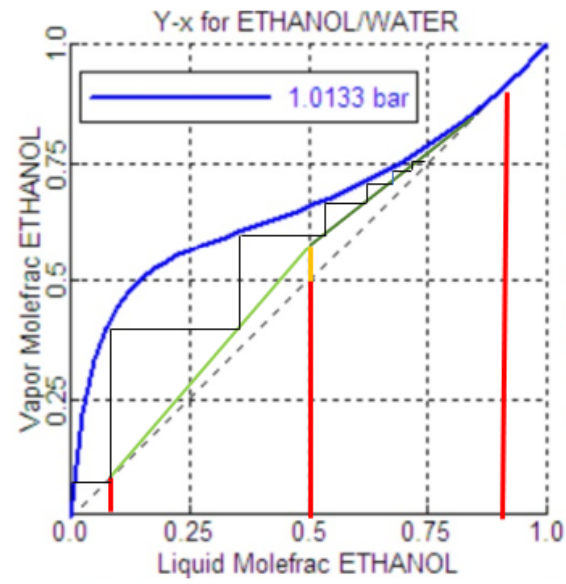
Table 1
Refractometer Readings

Location of Sample	Trial Number	Refractive Index
Bottoms	1	1.363
		1.362
		1.362
	2	1.366
		1.365
		1.365
Distillate	1	1.366
		1.366
		1.366
	2	1.365
		1.356
		1.365

Table 2
Given Distillation Data

Parameter	Value
Feed Composition (X_F) (Ethanol mole fraction)	.5
Reflux Ratio (R)	4.8
Number of Actual Trays	8

Graph 1
Txy Diagram



Viewing the document above there are 6 theoretical steps/trays within our



CONCLUSION

In conclusion, the purpose of this lab was to determine the column operation efficiency of distillation using the McCabe-Thiele method. Distillation is commonly used for separation processes within the chemical industry. When doing this experiment, an insulator was provided in an attempt to prevent heat transfer from happening so we could have a closer count of theoretical equilibrium. When taking the number of theoretical stages found in the column and dividing that by the number of trays, the overall efficiency our group achieved was .75 efficiency. After 6 steps the equilibrium composition of X_b was .05 and X_d was .95. When constructing our McCabe-Thiele diagram from the two components of the liquid and vapor composition, our temperature was constant. We were able to determine that at equilibrium our overall stage of ethanol and water was systematically achieved which increased the energy required to complete the separation.



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Industrial Distillation Systems: Distillation Column Design & Build. EPIC Modular Process.

(2020, May 6). Retrieved October 6, 2021, from

[https://www.epicmodularprocess.com/systems/distillation-systems/distillation-column-design?clid=CjwKCAjwkvWKBhB4EiwA-GHjFtaf-BQCx4U1gO7ZBfkqwSPAWPal69wYvzxOB5B2v](https://www.epicmodularprocess.com/systems/distillation-systems/distillation-column-design?clid=CjwKCAjwkvWKBhB4EiwA-GHjFtaf-BQCx4U1gO7ZBfkqwSPAWPal69wYvzxOB5B2vMyg-P1D5G0aoBoCEIUQAvD_BwE)

[Myg-P1D5G0aoBoCEIUQAvD_BwE](https://www.epicmodularprocess.com/systems/distillation-systems/distillation-column-design?clid=CjwKCAjwkvWKBhB4EiwA-GHjFtaf-BQCx4U1gO7ZBfkqwSPAWPal69wYvzxOB5B2vMyg-P1D5G0aoBoCEIUQAvD_BwE).

**CHEMICAL ENGINEERING DEPARTMENT
OUTCOMES SPECIFIC ASSIGNMENT COVER SHEET
Chemical Engineering Laboratory II
FALL 2021**

Instructor: Dr. Jorge F. Gabitto

Title of Assignment

Final Presentation

Outcome Measured Using this Assignment

Outcome 6

An ability to develop and conduct appropriate experimentation, analyze and interpret data, and use engineering judgment to draw conclusions.

Brief justification of why this assignment is suitable for this outcome

The rubric used to grade the final presentation assesses how the students analyze, process, interpret data, and draw appropriate engineering conclusions. Understanding of proper experimental procedures is also assessed.



FRACTIONATION: DISTILLATION COLUMN EFFICIENCY

Prairie View A&M University - Chemical Engineering
Department
Dr. Jorge Gabitto - Team 2

Chiebuka Ejimadu
Katelynn Inman
Tyree Madison
Caleb Myers
Xavier Williamson



Presentation Outline

- Introduction
 - Background
 - Objectives&Purpose
- Procedures
- Data Analysis
 - McCabe-Thiele Method
 - Results
- Conclusion





Background

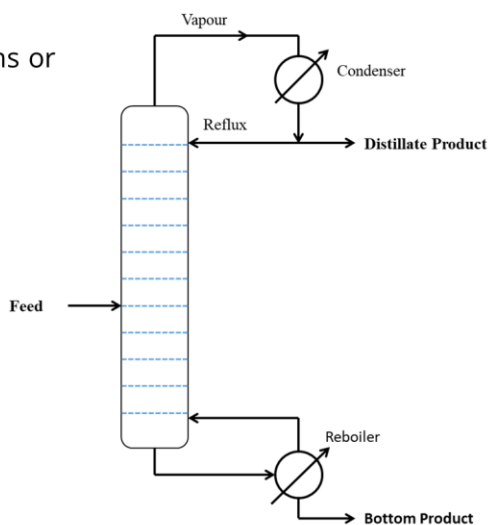
Fractional distillation is a separation of multicomponent mixtures into individual fractions or components based on their volatilities.

Refractive Index is the ratio of the velocity of light in a vacuum against its velocity in a specific mixture

$$n = \frac{c}{v}$$

Column Design Considerations

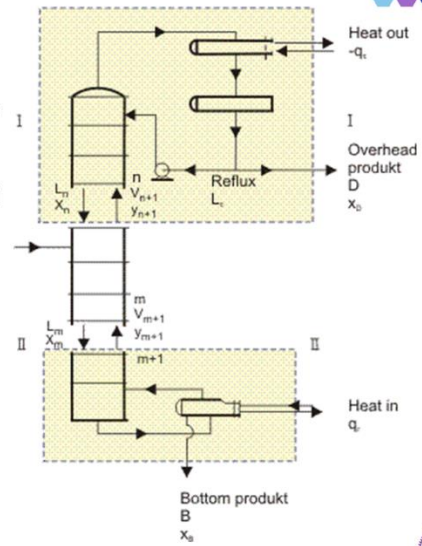
- Flow rates of distillate and bottoms streams
- Reflux rate
- Heat duties of Condenser and Reboiler
- Number of theoretical stages required



Objectives & Purpose

To separate the equimolar component mixture...

- Use refractive index vs. mol. % Ethanol graph
- Calculate the mass balance of the system
- Determine the column efficiency using the McCabe-Thiele method
- Calculate the global energy balance required for the equipment.
- Suggest efficiency improvement ways



Procedures

Column Preparation

- Add a mixture of a desired chemical solution in reboiler can be heated up
- Turn off the Reflux Ratio Timer on the timer so the column can operate at total reflux
- Set the heat controller temperature high then reduce it so the reflux feed can bubble over the column trays at a steady rate
- Allow the column to heat through reboiler for 30 minutes minimum before collecting data



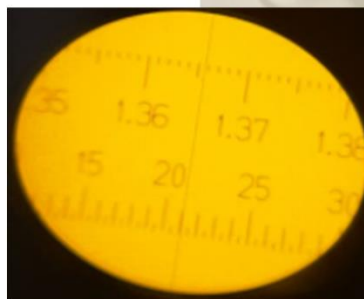
Data Collection (Feed Rates)

- Begin the experiment by calculating the volumetric flow rate of distillate and bottoms streams
- To measure, open the appropriate valve for either stream and set up a volumetric cylinder under the tubing
- Once set up, record the time it takes to fill at desired volume and repeat 3 times for accuracy
- Calculate volumetric flow rate using the times and repeat steps for the next stream (depending on where you began measurement)
- Save small amount of solution from each stream to calculate mole percentage

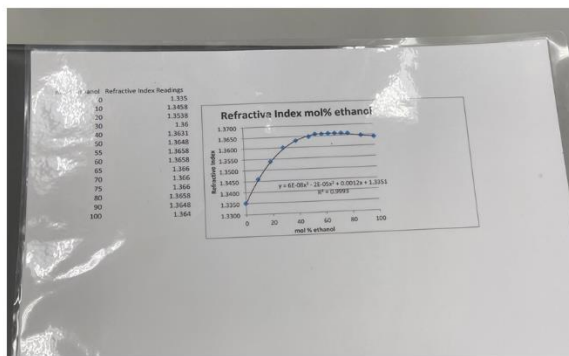
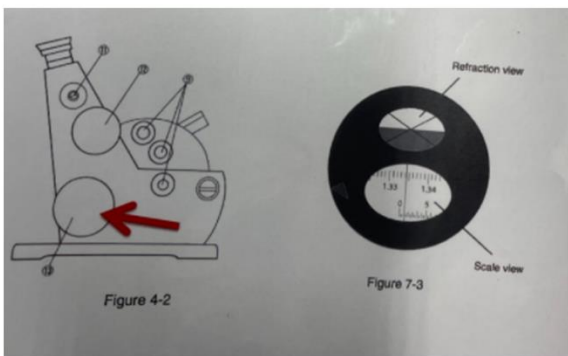


Data Collection (Refractometer)

- Take Solution from sample and place under refactor prism
- Close/tighten the prism and adjust measurement knob until boundary line appears
- When seen adjust the color compensator knob until the line is free of red or blue tint
- Once clear set boundary line to the intersection
- Once this is set, record the number and compare it to the refractive index to get mole percentage of Ethanol in the desired stream (Distillate or Bottoms)



Data Collection (Molar Percentage)





Data Analysis

McCabe-Thiele Method

Enriching Section

Reflux Ratio, $R = 5$

$$y[n+1] = (Rx[n] / R+1) + (x[D] / R+1)$$

$$y[n+1] = 5/6 x[n] + 1/6 x[D]$$

Stripping Section

$$y[m+1] = (L[m]x[m] / V[m+1]) + (Bx[B] / V[m+1])$$

$$y[m+1] = 0.91x[m] + 0.089x[B]$$

Feed Section (q-line)

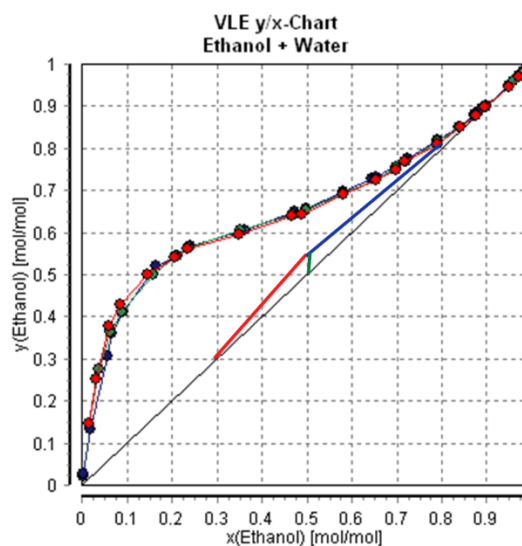
$q > 1$ for subcooled mixtures

$$q = (\lambda + c[p](T[b] - T[F])) / \lambda$$

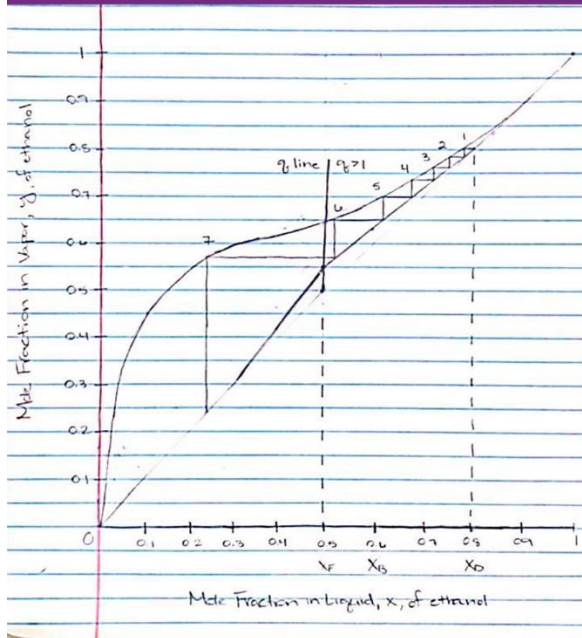
$$q =$$

$$y = (qx / q-1) - (x[F] / q-1)$$

$$y = 49.25x - 48.25x[F]$$



Results



Overall Mole Balance:

$$F = D + B$$

Ethanol Mole Balance:

$$F x[F] = D x[D] + B x[B]$$

Overall Energy Balance:

$$\Delta H = Q$$

$$Q = Q[C] + Q[R]$$

$E[O] = 7$ theoretical trays / 8 actual trays

Column Efficiency = $E[O] = 0.875$

McCabe-Thiele Method

Enriching Section

Reflux Ratio, $R = 5$

$$y[n+1] = (R x[n] / R + 1) + (x[D] / R + 1)$$

$$y[n+1] = 5/6 x[n] + 1/6 x[D]$$

Stripping Section

$$y[m+1] = (L[m] x[m] / V[m+1]) + (B x[B] / V[m+1])$$

$$y[m+1] = 0.91 x[m] + 0.089 x[B]$$

Feed Section (q-line)

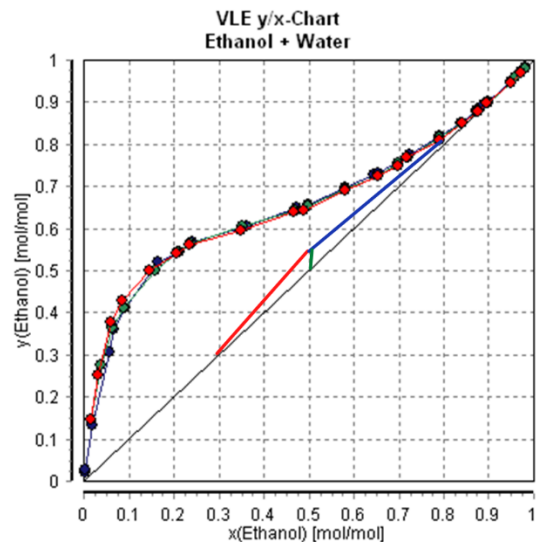
$q > 1$ for subcooled mixtures

$$q = (\lambda + c[p](T[b] - T[F])) / \lambda$$

$$q =$$

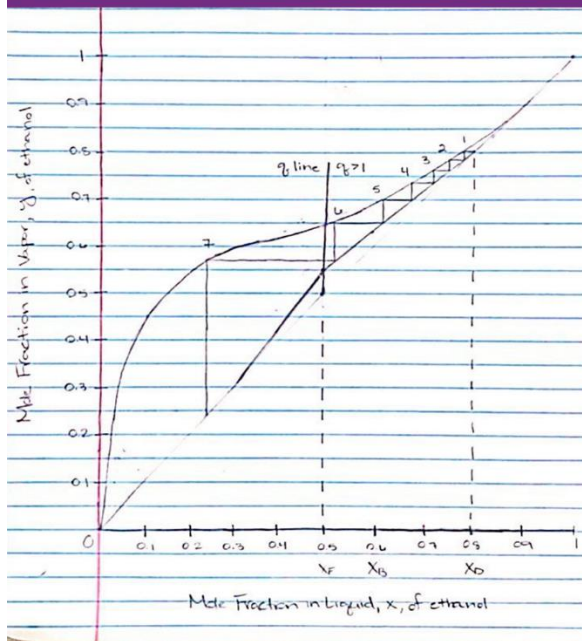
$$y = (q x / q - 1) - (x[F] / q - 1) \quad 1.021$$

$$y = 49.25 x - 48.25 x[F]$$



Conclusion

Results



Overall Mole Balance:

$$F = D + B$$

Ethanol Mole Balance:

$$F x_F = D x_D + B x_B$$

Overall Energy Balance:

$$\Delta H = Q$$

$$Q = Q_C + Q_R$$

$E[O] = 7 \text{ theoretical trays} / 8 \text{ actual trays}$

Column Efficiency = $E[O] = 0.875$

Conclusion

The efficiency of a distillation column that separates an equimolar mixture of water and ethanol was analyzed by graphing data generated using a refractor prism.

Results

Column Efficiency : 87.5%
Distillate Composition: 80%
Actual Column Trays: 8
Theoretical Column Trays: 7



Areas of Improvement

- Heat reboiler prior starting the experiment
- Heat reboiler temperature to desired temperature
- Decrease amount of trays in distillation column for better efficiency

