Course Number and Title: CPO 151 Chemical Process Tech I-System

Campus Location:
Stanton

Effective Date:
2018-51

Prerequisite:
CHM 110, CIS 107, CPO 135, SSC 100 or concurrent

Co-Requisites:
None

Course Credits and Hours:
4.00 credits
3.00 lecture hours/week
2.00 lab hours/week

Course Description:
This course provides an introduction to chemical stoichiometry, fluid flow, heat transfer, plant utilities, and reactor concepts. In addition, the unit operations of distillation, fermentation, crystallization, filtration, and drying are discussed, using a standardized format that emphasizes the operational knowledge and techniques important to chemical process technicians. In addition, renewable energy and biofuels technologies are highlighted.

Required Text(s):
Obtain current textbook information by viewing the campus bookstore - https://www.dtcc.edu/bookstores online or visit a campus bookstore. Check your course schedule for the course number and section.

Additional Materials:
None

Schedule Type:
Classroom Course

Disclaimer:
None

Core Course Performance Objectives (CCPOs):

1. Perform basic material and energy balance calculations. (CCC 6; PGC 7)
2. Define the principles of fluid flow and heat transfer in chemical process equipment. (CCC 6, PGC 3)
3. Describe the uses and production processes for the following plant utilities: air, cooling tower, nitrogen, steam, vacuum, and water. (CCC 6; PGC 3)
4. Identify the characteristics of batch and continuous chemical operations. (CCC 7; PGC 4)
5. Interpret process-related diagrams, including a process flow diagram (PFD), a block flow diagram (BFD), and a piping and instrumentation diagram (P&ID). (CCC 6; PGC 3, 4, 8)
6. Analyze the principles and major equipment used for distillation, fermentation, crystallization, filtration, and drying operations. (CCC 6; PGC 3, 6)
7. In a pilot plant and/or using computer simulation, start-up, operate, troubleshoot problems, and shutdown distillation, gas absorption, bioethanol production, and heat transfer units. (CCC 2, 3; PGC 2, 3, 4, 5)
8. Describe the importance of communications and teamwork in chemical process operations. (CCC 1, 3; PGC 9)
9. Define the characteristics of alternate biofuels and their production processes. (CCC 6; PGC 3, 4)

See Core Curriculum Competencies and Program Graduate Competencies at the end of the syllabus. CCPOs are linked to every competency they develop.

Measurable Performance Objectives (MPOs):
Upon completion of this course, the student will:

1. Perform basic material and energy balance calculations.
    1. Explain the concept of material balance, and use it in basic calculations.
    2. Describe the weight ratios in which substances combine in chemical reactions.
    3. Apply general rules for solving chemical process problems.
    4. Convert basic units of temperature, pressure, length, mass, energy, and force from English units to metric and SI units.
    5. Calculate changes in gas volume using the ideal gas law.
    6. Define the concept of energy balance.

2. Define the principles of fluid flow and heat transfer in chemical process equipment.
    1. Explain the principles of fluid flow in process equipment.
    2. Define *density*, *specific gravity*, and *viscosity*.
    3. Differentiate between laminar and turbulent flow of a liquid in a pipeline.
    4. Describe the velocity profile of a liquid flowing through a pipe.
    5. Explain the four variables used to calculate Reynolds Number.
    6. Name the six principles of liquid pressure.
    7. Explain the relationship between gauge pressure and absolute pressure.
    8. Define *static pressure*, *impact pressure*, *velocity pressure*, and *fluid head*.
    9. Describe the factors that affect the friction loss in a liquid piping system.
    10. Explain the Bernoulli principle and how it applies to various flow measurement devices.
    11. Differentiate among temperature, heat energy, and heat transfer.
    12. Name the types of sensible and latent heats.
    13. Describe the three methods of heat transfer: conduction, convection, and radiation.
    14. Define *specific heat*, *thermal coefficient of expansion*, *thermal conductivity,* and *overall heat transfer coefficient*.
    15. Explain the major components of a shell and tube heat exchanger.
    16. Contrast parallel and counter flow through a heat exchanger.
    17. Explain the impact of fouling on the heat transfer efficiency of a heat exchanger.
    18. Describe the start-up and shutdown procedures for a heat exchanger.
3. Describe the uses and production processes for the following plant utilities: air, cooling tower, nitrogen, steam, vacuum, and water.
    1. Explain the uses for the following plant utilities: air, cooling tower, nitrogen, steam, vacuum, and water.
    2. State the typical range of properties for following plant utilities: air, cooling tower, nitrogen, steam, vacuum, and water.
    3. Describe the processes for following plant utilities: air, cooling tower, nitrogen, steam, vacuum, and water.
4. Identify the characteristics of batch and continuous chemical operations.
    1. Describe the purpose of a stirred-tank reactor system.
    2. Explain the major components of a stirred-tank reactor system and their functions.
    3. State the purpose of agitation equipment in a stirred-tank reactor system.
    4. Define the key operating parameters in a stirred-tank reactor system.
    5. Explain alternate process control schemes in a stirred-tank reactor system.
    6. Describe methods for determining endpoint of the chemical reaction.
5. Interpret process-related diagrams, including a process flow diagram (PFD), a block flow diagram (BFD), and a piping and instrumentation diagram (P&ID).
    1. Determine the type of information that is shown on a PFD.
    2. Describe the purpose of a BFD.
    3. Interpret the symbols on a P&ID.
    4. Use a P&ID to solve a process problem.
    5. Prepare basic qualitative and quantitative process flow diagrams.
6. Analyze the principles and major equipment used for distillation, fermentation, crystallization, filtration, and drying operations.
    1. State the purpose of distillation.
        1. Describe the vapor-liquid equilibrium relationship for a methanol-water mixture.
        2. Explain the major components of a distillation system.
        3. Name the equipment types used to obtain liquid-vapor contact.
        4. Describe flow sheets for batch and continuous distillation systems.
        5. State the qualitative effects of changes in distillation column conditions.
        6. Explain reflux ratio and its impact on distillation column performance.
        7. Define the major factors governing the performance and efficiency of distillation operations.
        8. Describe the purpose of azeotropic distillation.
    2. Describe the purpose of the crystallization operation.
        1. Explain the basic mechanisms of crystal formation and crystal growth.
        2. State the factors that control the rate of production of the desired crystal.
        3. Explain the major components of the crystallization system and their functions.
        4. Define the key operating parameters of the crystallization system.
    3. State the purpose of the filtration operation.
        1. Explain the concept of microfiltration through a semipermeable ceramic membrane.
        2. Describe the construction of a microfiltration membrane.
        3. Differentiate between pressure and vacuum filtration.
        4. Explain the procedure for determining filtrate rate for a typical solid material.
        5. Describe alternate methods for washing impurities from a filter cake and for determining the endpoint of the washing cycle.
        6. Explain the major components of a microfilter, a plate-and-frame filter, a rotary filter, and a centrifuge.
        7. Define the key operating parameters for a microfilter, a plate-and-frame filter, a rotary filter, and a centrifuge.
    4. Describe the purpose of the drying operation.
        1. Explain the simultaneous heat and mass transfer occurring in the drying operation.
        2. Define *equilibrium moisture content, dry-weight basis*, and *free moisture content*.
        3. Describe the typical drying rate curve.
        4. State three alternate methods for drying solid materials.
        5. Explain the major components and operation of a dust collector.
        6. Describe the major components of a batch rotary vacuum dryer, a continuous rotary kiln dryer, and a spray dryer.

7. Explain the operating parameters controlling the performance of the above drying systems.

7. In a pilot plant and/or using computer simulation, start-up, operate, troubleshoot problems and shutdown distillation, gas absorption, bioethanol production, and heat transfer units.
    1. Prepare laboratory reports for the following computer process simulation modules:
        1. Intro to Process Simulation System
        2. SPM 100: Tank System
        3. SPM 200: Pumping System
        4. SPM 300: Mix Tank
        5. SPM 400: Heat Exchanger
        6. SPM 500: Flash Tank
        7. SPM 600: Unit Operations
    2. Prepare laboratory reports to document operation of the following units in the Unit Operations Laboratory:
        1. Distillation Unit
        2. Gas Absorption Unit
        3. Heat Transfer Unit
        4. Bioethanol Production Unit
8. Describe the importance of communications and teamwork in chemical process operations.
    1. Define the different types of teams encountered in the process industries.
    2. Explain the difference between work groups and teams.
    3. Identify the characteristics of a high performance or effective team.
    4. Define the terms *synergy* and *team dynamics*.
    5. Describe the steps or stages through which a team evolves.
    6. Identify factors that contribute to the failure of a team.
    7. Define *workforce diversity*, and explain its impact on workplace relationships.
9. Describe the characteristics of alternate biofuels and their production processes.
    1. Explain how biofuels and petroleum affect the global carbon cycle.
    2. Describe the attributes that make biofuels suitable as fuel for specific applications.
    3. Outline the process steps for producing ethanol from crops.
    4. Describe the role enzymes and yeast play in the ethanol conversion process.
    5. Discuss the importance of cellulosic ethanol, and explain how the process differs from the traditional fermentation process.
    6. Explain why biobutanol may be a major fuel in the future.

Evaluation Criteria/Policies:
Students must demonstrate proficiency on all CCPOs at a minimal 75 percent level to successfully complete the course. The grade will be determined using the Delaware Tech grading system:

92	**–**	**100**	**=**	**A**
83	**–**	**91**	**=**	**B**
75	**–**	**82**	**=**	**C**
0	**–**	**74**	**=**	**F**

Students should refer to the Student Handbook - https://www.dtcc.edu/handbook for information on the Academic Standing Policy, the Academic Integrity Policy, Student Rights and Responsibilities, and other policies relevant to their academic progress.

Final Course Grade:
Calculated using the following weighted average

Evaluation Measure	Percentage of final grade
Summative: Tests (5) (equally weighted)	60%
Summative: Final Exam	15%
Formative: Laboratory Work	25%
TOTAL	100%

Core Curriculum Competencies (CCCs are the competencies every graduate will develop):

1. Apply clear and effective communication skills.
2. Use critical thinking to solve problems.
3. Collaborate to achieve a common goal.
4. Demonstrate professional and ethical conduct.
5. Use information literacy for effective vocational and/or academic research.
6. Apply quantitative reasoning and/or scientific inquiry to solve practical problems.

Program Graduate Competencies (PGCs are the competencies every graduate will develop specific to his or her major):

1. Maintain safety, health, and environmental standards in a chemical plant.
2. Handle, store, and transport chemical materials according to all applicable federal, state, and local regulations.
3. Apply chemical process and quality systems safely and efficiently.
4. Operate, monitor, control, and troubleshoot batch and continuous chemical processes.
5. Analyze samples of raw materials, intermediates, and finished products in a chemical plant.
6. Perform routine, predictive, and preventive maintenance and service to process equipment and instrumentation.
7. Apply mathematical and statistical concepts and principles to analyze and solve chemical process problems.
8. Use computers and computerized equipment for communications and chemical process control.
9. Communicate effectively orally and in writing.
10. Function collaboratively in teams and independently.

Disabilities Support Statement:
The College is committed to providing reasonable accommodations for students with disabilities. Students are encouraged to schedule an appointment with the campus Disabilities Support Counselor to request an accommodation needed due to a disability. A listing of campus Disabilities Support Counselors and contact information can be found at the disabilities services - https://www.dtcc.edu/disabilitysupport web page or visit the campus Advising Center.