

CHEN 3700 - CHEMICAL REACTION ENGINEERING

Required Core Course

- Catalog Data** **Lec (3).** Design of chemical reactors with homogeneous and heterogeneous reaction systems.
- Prerequisites** Pr: MATH 2650 and completion of CHEN 2610 and ENGR 2010 with a grade of C or higher, P/C CHEN 3620
- Schedule** Three one-hour class sessions per week
- Course Objectives** This course is designed to give chemical engineering students the ability to incorporate rate expressions into various energy and material balances for designing various types of chemical reactors with homogeneous and heterogeneous reaction systems.

Textbooks

1. Fogler, Elements of Chemical Reaction Engineering, 5e, **2016**, 978-0133887518, Pearson
2. Levenspiel, Chemical Reaction Engineering, 3e, **1998**, 9780471254249, Wiley

Topics Covered

1. Introduction (0.33 weeks)
2. Polymath exercise (0.67 weeks)
3. Mole Balance in Reactors (1.67 weeks)
4. Rate laws and stoichiometry (1.67 weeks)
5. Isothermal reactor design (3.33 weeks)
6. Nonisothermal reactor design (2 weeks)
7. Multiple reactions (1 week)
8. Bioreactions and bioreactors (1 week)
9. Catalysis and catalytic reactors (2 weeks)
10. Exams and Review (1.33 weeks, 2 exams given week 5, 10)

Course Outcomes: *Upon successful completion of this course, students should be able to:*

1. Define the reaction rates for homogeneous, heterogeneous, and catalytic reactions.
2. Explain comparative advantages and disadvantages of various industrial reactors.
3. Derive and solve mole balance equations for isothermal batch reactor, CSTR, and PFR.
4. Set up stoichiometric tables for chemical reactions occurring in steady-state flow reactors and in batch reactors. Use these tables to relate concentration to conversion.
5. Derive the reactor design equations using conversion as the main variable for batch reactors, CSTRs, and PFRs, and find analytical solutions where feasible.
6. Explain how temperature affects chemical reaction rate and determine the reaction rate constant and the equilibrium constant as function of temperature from the Arrhenius equation and experimental data.
7. Use the reactor design equations to calculate the reactor size and conversion for given rate laws and operational parameters.

8. Explain how the pressure variation affects the performance of the packed-bed reactor. Calculate the reactor size and conversion employing the Ergun equation to describe the pressure variation.
9. Analyze experimental rate data and determine rate laws by graphical, analytical, and numerical methods.
10. Explain how the multiple reactions are incorporated into reactor calculations, and optimize reactor design/operation with regard to yield and selectivity.
11. Derive energy balance equations for steady-state reactors and batch reactor, and couple them with mole balances, rate laws, and stoichiometric relationships in order to analyze and design non-isothermal reactors.
12. Explain the nature of catalytic reactions with regard to the multiple steps of mass transfer and surface reaction. Explain the concept of the rate limiting step.
13. Explain and apply the Levenspiel plot comparing the performance of multiple CSTRs and a PFR.
14. Explain the characteristics of enzymatic reactions and how they differ from general catalytic reactions.