ChE 200 - Material Balances
Course Outcomes

The Law of Conservation of Matter states that matter is neither created nor destroyed in the normal physical and chemical transformations that are part of a typical chemical process. However, its state and composition can change when a substance changes temperature, pressure, location, or phase, or when it reacts or forms a solution. All of the material involved in a process can be accounted for, just like balancing a bank account. This allows a chemical engineer to answer economic, safety, and environmental questions about the amount of raw materials consumed, product produced, and waste generated.

After you successfully complete this course, you will be able to:

I. Analyze the steady state operation of a chemical process, using the Law of Conservation of Matter, in conjunction with process specifications, physical properties and laws, and physical constraints.
   - A. Sketch a chemical process from a description, or describe a chemical process from a sketch.
   - B. Explain the terms “steady state” and “accumulation”, and explain the difference between “steady state” and “equilibrium”.
   - C. Identify parts of a chemical process that involve transformations in composition and/or state.
   - D. Label process streams and define process variables to describe them.
   - E. Write mathematical equations for overall and component balances based on the Law of Conservation of Matter
   - F. Write mathematical expressions equivalent to verbal process specifications (e.g., “40 % of the feed is condensed”).
   - G. Write mathematical expressions based on physical properties (e.g., density, molecular weight) to describe relationships among process variables.
   - H. Write mathematical expressions based on simple equilibrium relationships (Raoult’s Law, Henry’s Law) and equations of state (Ideal Gas Law, General Compressibility Factor) to describe relationships among process variables.
   - I. Write mathematical expressions for physical constraints (e.g., “the sum of the mole fractions is 1”).
   - J. Convert between mass flow rate, molar flow rate, and volumetric flow rate; and between mass and mole fraction.
   - K. State the relationship between volumetric fluid flow rate, pipe diameter, and average fluid velocity.
   - L. Use the Ideal Gas Law appropriately to calculate gas properties.
   - M. Use the Antoine Equation to calculate the vapor pressure of a substance given the temperature, or the temperature given the vapor pressure.
   - N. Identify situations when vapor-liquid equilibrium (VLE) is likely to play an important role.
   - O. Define saturated and superheated vapor, dew point, bubble point, relative humidity, and relative saturation, and use these concepts to determine the composition and phase of streams containing volatile and condensable components.
   - P. Use ideal VLE behavior to determine the likely phase of a single- or multi-component stream with volatile and condensable component(s) from its temperature, pressure, and composition.

Q. Use ideal VLE behavior to predict condensation and vaporization in streams with condensable and non-condensable components.

R. Use a T-xy diagram to find the dew point, bubble point, and amount and composition of each phase in problems involving two-phase, two-component systems.

S. Complete the analysis of steady state chemical processes including multiple components with chemical reactions and phase changes.

1. Specify a control volume.
2. Make appropriate assumptions and justify them.
3. Write equations and identify the data required.
4. Complete a degree-of-freedom analysis
5. Gather the data (given, look up, estimate).
6. Solve equations (linear, non-linear, simultaneous, integral).

T. Evaluate calculations using engineering judgment and fundamental principles of science.

During this course, you will improve your ability to:

II. Think, act, and communicate like a successful chemical engineer.

A. Demonstrate professional behavior in work performance and interpersonal interactions.

B. Consider and discuss ethical, economic, safety, and environmental concerns.

C. Communicate technical information effectively and confidently.

1. Present written and oral information concisely, in a logical order, in an orderly format.
2. Follow rules of standard English and technical writing.
3. Use an engineer's vocabulary.
4. Consistently provide appropriate units, significant figures, and references with information.

D. Use the computer as a tool to solve problems.

E. Explain the purpose of flash tanks, reactors, pumps, evaporators, distillation columns, liquid-liquid extraction columns, and crystallizers.

(Last modified on 01/04/07)