

## Chapter 4 – Material Balances

**Note:** Be sure to read carefully through all the examples in this chapter. The key concepts are best learned by problem solving.

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**Material balances:** material balances express the constraint of conservation of mass, as applied to a process.

**Batch process:** In a batch process, raw materials are fed into the process at the outset. The process then runs for some length of time, producing product, but no product is removed, and no additional raw materials are input (but energy may be input or withdrawn), while the process runs. At the end, the product is removed. The bottom line is that no mass enters or leaves while the process is running.

**Continuous process:** In this type of process, raw materials continuously enter and product continuously leaves the process.

**Semibatch process:** A semibatch process does not fall fully under either “batch” or “continuous” classification.

**Steady-state operation:** Under steady-state, the values of all variables associated with the process do not change with time. That is, at any given location in the process, the values of temperature, pressure, composition, flow rates, etc. are independent of time. Even though a process may be steady state, it is important to realize that temperature, flow rates, or other variables may, and typically do, change from one *location* to another (e.g. from one process stream to another).

**Transient or unsteady-state operation:** If some process variables change with time, then the process is transient. A process must be either steady-state or transient.

Batch and semibatch processes must be transient. Continuous processes may be transient or steady-state.

*Example:* How would you classify the following processes?

- i). a soda can is opened and goes flat with time.
- ii). hot and cold water flows come together and mix to deliver a continuous, constant temperature output water flow
- iii). A car engine burns fuel at a constant rate. What else must be true for the engine to be operating at steady-state?

# Chapter 4 Material Balances Note

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