Lecture 17.
Equipment for Crystallization

- Classification of Equipment for Solution Crystallization
- Circulating-Batch Crystallizers
- Continuous Cooling Crystallizers
- Continuous Vacuum Evaporating Crystallizers

Classification of Equipment (1)

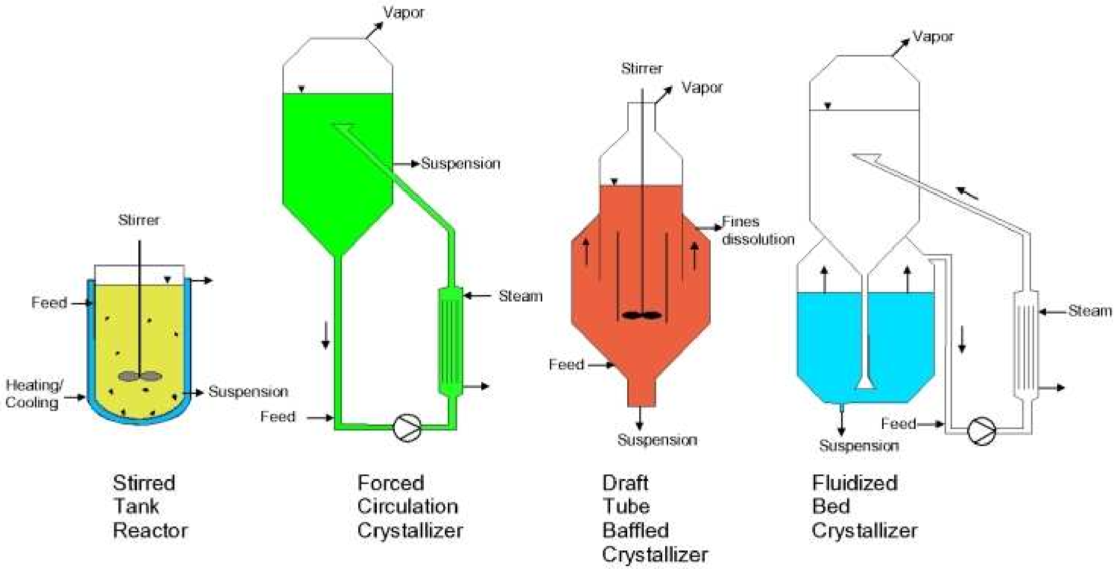
- Classification of equipment for solution crystallization

Operation modes	Methods for achieving supersaturation	Crystallizer features for achieving desired crystal growth
Batch Continuous	Cooling Evaporation	Agitated or nonagitated Baffled or unbaffled Circulating liquid or circulating magma Classifying or nonclassifying Controlled or uncontrolled Cooling jacket or cooling coils

- The choice of method for achieving supersaturation depends on the effect of temperature on solubility
  - For many inorganic compounds in the near-ambient temperature range (10–40^{o}C), the change in solubility is small and insufficient to utilize the cooling method
- The majority of industrial crystallizers use the evaporation method or a combination of cooling and evaporation

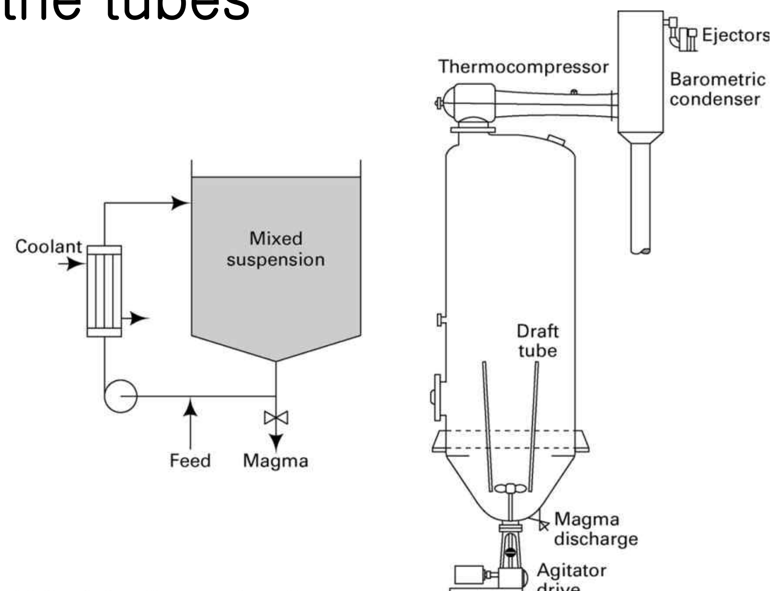
Classification of Equipment (2)

- Use of mechanical agitation can result in smaller and more uniformly sized crystals of a higher purity that are produced in less time
- Supersaturation and uniformity can be controlled by circulation between a crystallizing zone and a supersaturation zone
- In a classifying crystallizer, the smaller crystals are separated from the larger and retained in the crystallizing zone for further growth or are removed from the zone and redissolved
- In a controlled design, one or more techniques are used to control the degree of supersaturation to avoid undesirable nucleation



Circulating–Batch Crystallizers

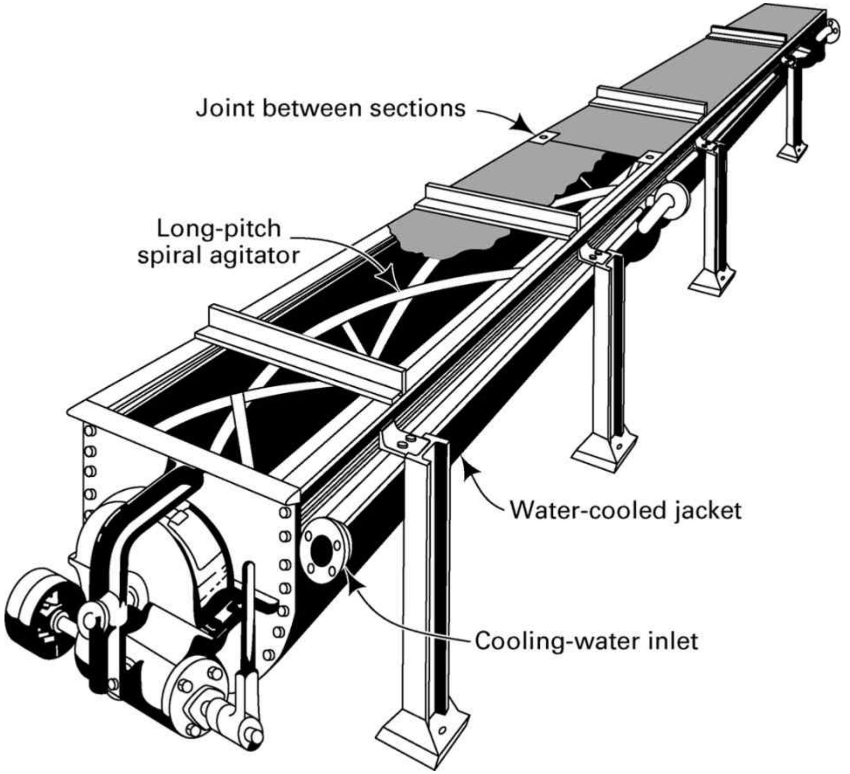
- Batch crystallizers without agitation or circulation may result in undesirably large, interlocked, impure crystals because of entrapment of mother liquor, and difficulty in removing crystals from the vessel
- In the design with external circulation, a high magma velocity is used through the tubes of the heat exchanger to obtain a reasonable heat-transfer rate with a small temperature-driving force and minimal crystal formation on the tubes
- In the design with internal circulation, the magma is circulated internally through a draft tube by a propeller. Energy for evaporation is supplied by the hot feed
- A typical cycle, including charging the feed, crystallization, and removal of the magma, is 2 to 8 h



(a) Circulation of magma through an external, cooling heat exchanger
(b) Internal circulation with a draft tube

Continuous Cooling Crystallizers

- A feed flows through a semicylindrical trough
- The trough has a water-cooled jacket and is provided with a low-speed (3–10 rpm), helical agitator-conveyor that scrapes the wall, prevents growth of crystals on the trough wall, and promotes crystal growth by gentle agitation
- The crystallization process is controlled by the rate of heat transfer, with the major resistance due to the magma on the inside
- The typical size of trough is 1 m wide × 3–12 m long. Standard-size units can be linked together



Continuous Vacuum Evaporating Crystallizers

- In the main body of the crystallizer, evaporation occurs, under vacuum, at the boiling surface
- Near the bottom and inside of the draft tube is a low-rpm propeller that directs the magma upward through the draft tube toward the boiling surface under conditions of a small degree of supercooling and in the absence of any violent flashing action

  → nucleation and buildup of crystals on the walls are minimized
- Surrounding the draft tube is an annular space where the magma flows back downward for re-entry into the draft tube