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

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- 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°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.
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