Crystallizer

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Crystallization

- Formation of solid particles within a homogeneous phase
 - Formation of solid particles in a vapor
 - Solidification of liquid melt
 - Crystallization from liquid solution

Importance

Its wide used has two fold basis

- A crystal formed from an impure solution is itself pure
- Affords a practical method of obtaining pure chemical substances in a satisfactory condition for packaging and storing

Magma

The two-phase mixture of mother liquor and crystals of all sizes

Nucleation

- In the formation of crystal two steps are required:
 - The birth of a new particle and
 - Its growth to macroscopic size

-the first step is called *nucleation*

Nucleation cont...

- The number of new particles formed per unit time per unit volume of magma or solids-free mother liquor
- This quantity is the first kinetic parameter controlling the *crystal* size distribution (CSD)

Importance of CSD

- Reasonable size and size uniformity are desirable for further processing
 - Filtering
 - Washing
 - Reacting with other chemicals
 - Transporting
 - Storing the crystals

CSD is the prime objective in the design and operation of crystallizers

Major Assumptions

- There is no nucleation
- Every particle grows through the same increase in linear dimension

If all crystals in magma grow in a uniform supersaturation field and at the same temperature and if all crystals grow from birth at a rate governed by the supersaturation, then all crystals are not only invariant but also have the same growth rate that is independent of size

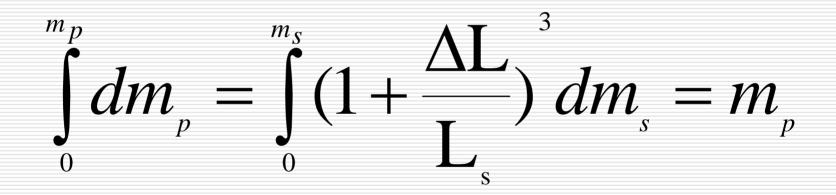
Equation:

$L_p = L_s + \Delta L$

$$m_{p} = \phi \rho L_{p}^{3} = \phi \rho (L_{s} + \Delta L)^{3}$$
$$m_{s} = \phi \rho L_{s}^{3}$$

Which combine to give $m_p = m_s (1 + \Delta L/L_s)^3$ (for the entire crystal mass)

For differential parts of the crystal masses



Problem

A solute that form crystals is to be precipitated from solution at a rate of 10,000Ib of solid (dry basis) per hour using 1,000Ib/hr of seed crystals. If no nucleation occurs and the seed crystal have the following size distribution, determine the product size distribution

Problem

Tyler Sieve Mesh	Weight Fraction Retained
-48+65	0.10
-65+100	0.30
-100+150	0.50
-150+200	0.05
-200+270	0.05

Reference

Foust *et al*: Principles of Unit Operations, second edition

McCabe & Smith: Unit Operations of Chemical Engineering, fifth edition