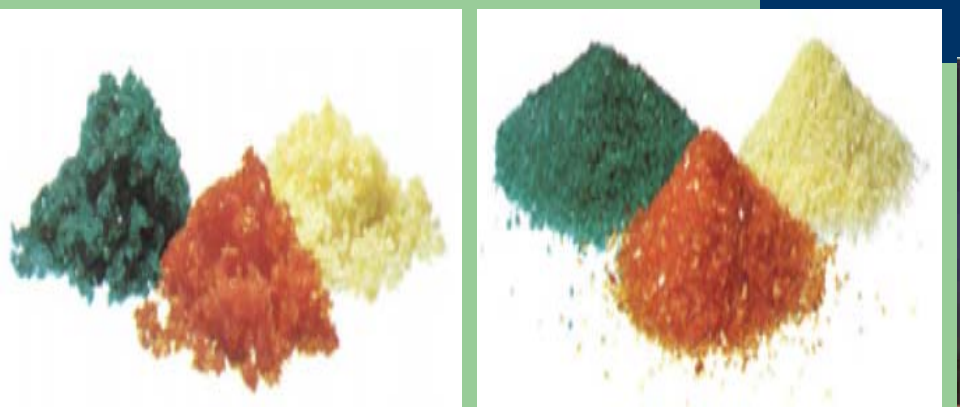
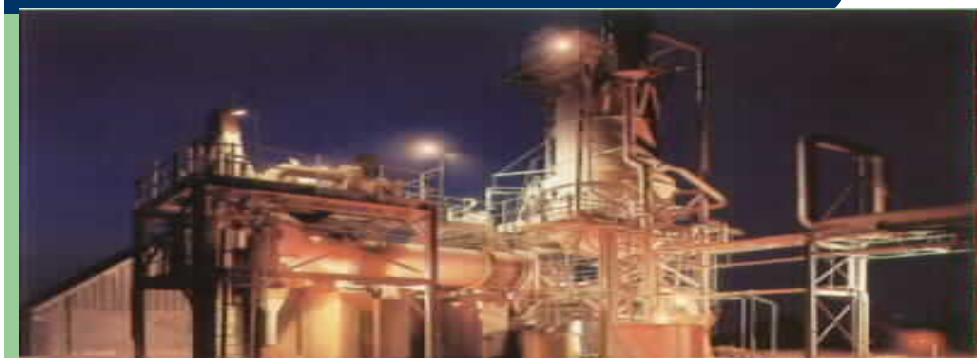
Mixed Suspension Mixed Product Removal Crystallization (MSMPR) cont……





Ashfaq M Ansery
Lecturer, ChE Deptt
BUET

Kinetic Coefficients

- Relation between nucleation rate B^o with the zero size particle density n^o

$$B^o = Gn^o$$

Number of Crystals per unit mass

- The number of crystals n_c in a unit volume of liquid (magma or product)

$$n_c = \int_0^\infty n dL = n^0 \tau G$$

- The total mass of product crystals in a unit volume of liquid

$$m_c = \int_0^\infty m n dL = 6 a \rho_c n^0 (G\tau)^4$$

Number of Crystals per unit mass

- Number of Crystals per unit mass is

$$\frac{n_c}{m_c} = \frac{n^0 G\tau}{6a\rho_c n^0 (G\tau)^4} = \frac{1}{6a\rho_c (G\tau)^3}$$

- If predominate size is used as a design parameter

$$\frac{n_c}{m_c} = \frac{9}{2a\rho_c L_{pr}^{\ 3}}$$

Nucleation Rate

Nucleation rate = no of crystals / time × volume of mother liquor

$$B^0 = \frac{Cn_c}{mV_c} = \frac{9C}{2a\rho_c V_c L_{pr}^{\ 3}}$$

Where C = mass production rate of the crystal

Problem

- A continuous vacuum crystallizer produces 5 tons of $MgSO_4.7H_2O$ per hour. The product is associated with magma. The volume ratio of crystal to magma is 0.15. The densities of crystal and mother liquor are 105 and 82.5 lb/ft^3. Growth rate , G=0.0018 ft/hr is anticipated and a predominant crystal size of 20 mesh is desired.

Calculate

If this unit can be assumed **MSMPR** Crystallizer and the shape factor is assumed to be unity, then **calculate**

a) Volume of Magma in the crystallizer

b) Nucleation rate B^0

Calculate

c) The crystallizer has a free space above the magma level equal to 31% of the magma volume in the crystallizer. Length to diameter ratio of the crystallizer is 1.5. Determine its length and diameter

Calculate

d) Construct a table for different screen analysis for mesh no. 8 to 48 (i.e. 8,9,10.....42,48)

Population Density vs. Length

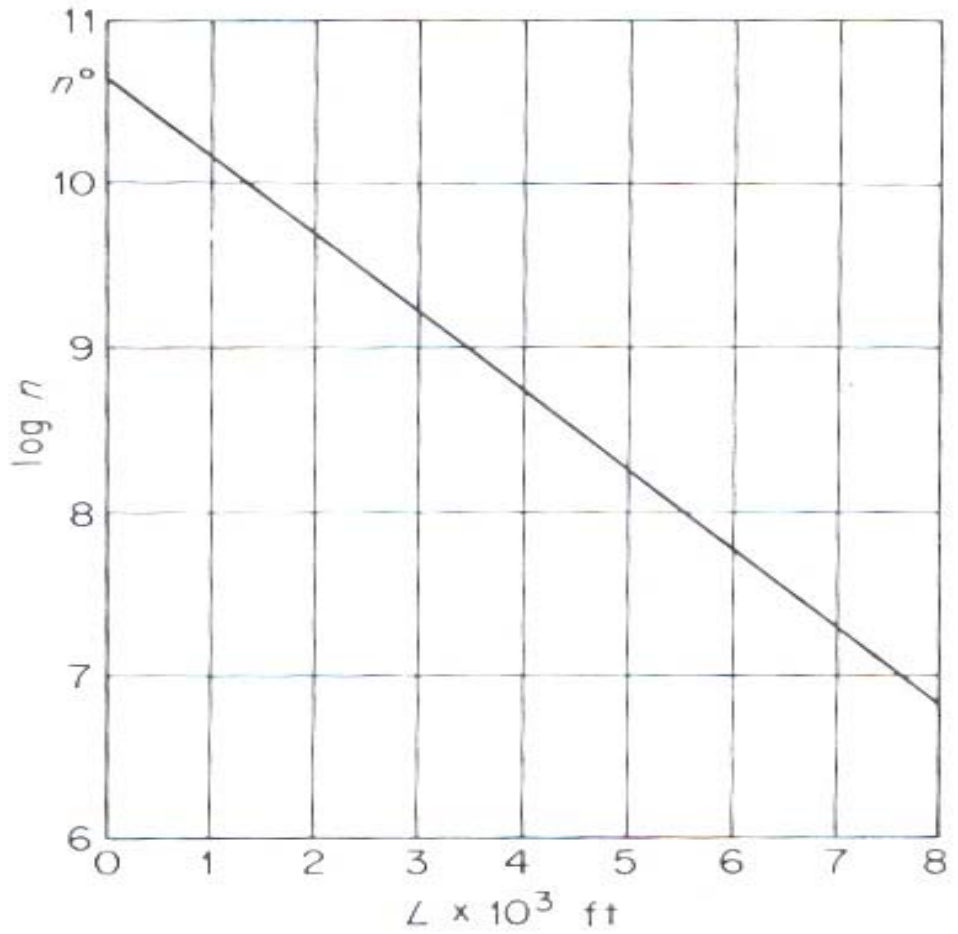
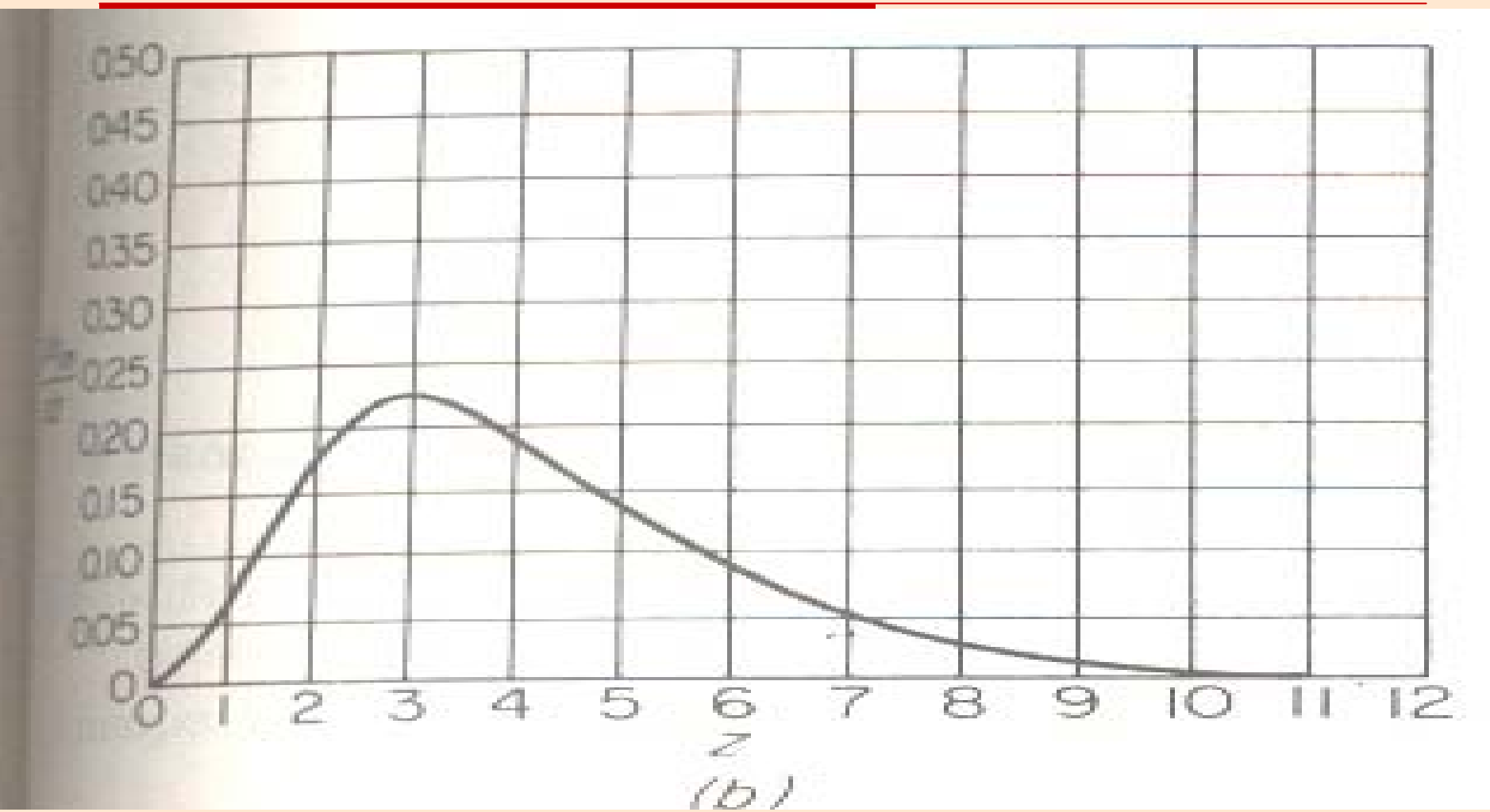


FIGURE 27.16
Population density vs. length (Example 27.6).

Tyler Standard Screen Scale

Tyler	US	mm	Inches
8	8	2.36	0.094
10	12	1.65	0.065
12	14	1.40	0.056
14	16	1.17	0.047
16	18	0.991	0.039
20	20	0.833	0.033
24	25	0.701	0.028
28	30	0.589	0.023
32	35	0.495	0.020
35	40	0.417	0.016
42	45	0.351	0.014
48	50	0.295	0.012

Size Distribution Relations



Screen Analysis of the Product

	Size			Screen analysis, %	
Mesh	ft	mm	z	Cumulative	Differential
8	0.0078	2.37	8.5	97	3
9	0.0065	1.98	7.1	93	4
10	0.0054	1.65	5.9	84	9
12	0.0046	1.40	5.0	74	10
14	0.0038	1.16	4.2	61	13
16	0.0033	1.01	3.6	48	13
20	0.0027	0.82	3.0	35	13
24	0.0023	0.70	2.5	25	10
28	0.0019	0.58	2.1	17	8
32	0.0016	0.49	1.8	11	6
35	0.0014	0.43	1.5	6	5
42	0.0011	0.34	1.2	4	2

Reference

- McCabe & Smith: **Unit Operations of Chemical Engineering,** fifth edition, pages 909-916