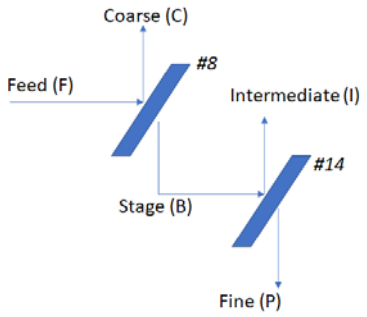
A blend of crystals is to be separated into three fractions: a coarse one retained on a 8-mesh sieve, an intermediate one retained on a 14-mesh sieve, and a fine one passing through the 14-mesh sieve. The results from the screen analyses are listed in Table 3. Calculate the efficiency for each sieve in the fractionation of the crystals.

Problem 3

	Differential Analysis (Fraction)			
Mesh	Feed	Coarse	Intermediate	Fine
3	0.035	0.14		
4	0.150	0.50	0.042	
6	0.275	0.24	0.358	
8	0.235	0.08	0.308	0.200
19	0.160	0.04	0.183	0.267
14	0.091		0.102	0.202
20	0.034		0.007	0.196
28	0.013			0.089
35	0.007			0.046
48	0.000			

Week 2 Problem 3



Basis: F = 100 kg/hr

OMB:

$$100 = C + I + P$$

A-component Balance:

$$X_F \cdot 100 = X_C \cdot C + X_I \cdot I + X_P \cdot P$$

Because the differential analysis constitute the real identity of the sample screened, we can use any of the X-values that **have all the streams** included, that is values for mesh 8 and mesh 10:

Mesh 8:

$$0.235 \cdot 100 = 0.08 \cdot C + 0.308 \cdot I + 0.200 \cdot P$$

Mesh 10:

$$0.160 \cdot 100 = 0.04 \cdot C + 0.183 \cdot I + 0.267 \cdot P$$

Including the OMB, we have 3 equations and 3 unknowns. Solving for the streams:

$$C := 24.905 \qquad I := 60.079 \qquad P := 15.016$$

Making an OMB for Mesh 8:

$$100 = C + B \qquad 100 = 24.905 + B \qquad B := 75.095$$

A-component balance around Mesh 8:

$$X_F \; 100 = X_C \; 24.905 + X_B \; 75.095$$

$$X_B = \frac{X_F \; 100 - X_C \; 24.905}{75.095}$$

Solving for XB for every XF and XC in the differential analysis:

Mesh	XF	XC	XB
3	0.035	0.14	0.000
4	0.15	0.5	0.034
6	0.275	0.24	0.287
8	0.235	0.08	0.286
10	0.16	0.04	0.200
14	0.091		0.121
20	0.034		0.045
28	0.013		0.017
35	0.007		0.009
48	0		0.000

Cumulative analysis of all the streams:

Cumulative Analysis

Mesh	XF	XC	XB	XI	XP
3	0.035	0.14	0	0	0
4	0.185	0.64	0.034	0.042	0
6	0.46	0.88	0.321	0.400	0
8	0.695	0.96	0.607	0.708	0.2
10	0.855	1	0.807	0.891	0.467
14	0.946	1	0.928	0.993	0.669
20	0.98	1	0.973	1	0.865
28	0.993	1	0.991	1	0.954
35	1	1	1	1	1
48	1	1	1	1	1

$F := 100$

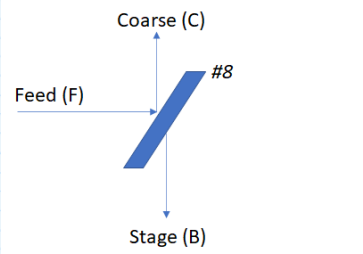
$C := 24.905$

$I := 60.079$

$P := 15.016$

$B := 75.095$

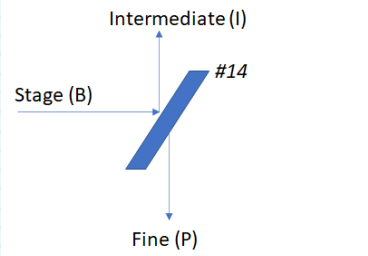
For Mesh 8:



$$E := \frac{C \cdot B \cdot 0.96 \cdot (1 - 0.607)}{F^2 \cdot 0.695 \cdot (1 - 0.695)}$$

$E = 0.333$ **$E = 33.3\%$**

For Mesh 14:



$$E := \frac{I \cdot P \cdot 0.993 \cdot (1 - 0.669)}{B^2 \cdot 0.928 \cdot (1 - 0.928)}$$

$E = 0.787$ **$E = 78.7\%$**