

Problem 6-8

The purchased-equipment cost for a plant which produces pentaerythritol (solid-fluid processing plant) is \$300,000. The plant is to be an addition to an existing formaldehyde plant. The major part of the building cost will be for indoor construction. The contractor's fee will be 7% of the direct plant cost. All other costs are close to the average values found for typical chemical plants. On the basis of this information, estimate the total direct plant cost, the fixed capital investment, and the total capital investment.

Solution:

This solution is based on Example 6-1 and uses the "colorful worksheet." Solve the colorful worksheet first, using cost component factors for solid-fluid processing plants. Adjust the factors to account for indoor construction in an existing plant. Adjust the contractor's fee percentage until the contractors fee is 7% of the direct plant costs.

	A	B	C	D	E	F	G	H	I	J	K
1	ESTIMATION OF CAPITAL INVESTMENT BY PERCENTAGE OF DELIVERED EQUIPMENT METHOD										
2	(See Table 6-9)										
3	The fractions in the cells below are approximations applicable to typical chemical processing plants. These values may differ depending on many factors such as location, process type, etc.										
4											
5	Required user input		Default			Subtotal		Result			
6	Required, from a linked sheet or entered manually						Notes & comments				
7	Project Identifier: Illustration 101		Fraction of delivered equipment			User: copy from values at left or insert		Calculated values, million \$			
8			Solid-processing plant	Solid-fluid processing plant	Fluid processing plant						
11	Direct Costs										
12	Purchased equipment, E'							0.300			
13	Delivery, fraction of E'		0.10		0.10		0.10	0.030			
14	Subtotal: delivered equipment							0.330			
15	Purchased equipment installation		0.45	0.39	0.47		0.39	0.129			
16	Instrumentation&Controls(installed)		0.18	0.26	0.36		0.26	0.086			
17	Piping (installed)		0.16	0.31	0.68		0.31	0.102			
18	Electrical systems (installed)		0.10	0.10	0.11		0.10	0.033			
19	Buildings (including services)		0.25	0.29	0.18		0.32	0.106			Constraint: Increase building cost for indoor construction
20	Yard improvements		0.15	0.12	0.10		0.12	0.040			
21	Service facilities (installed)		0.40	0.55	0.70		0.55	0.162			
22	Total direct costs		1.69	2.02	2.60		2.05	1.007			←ANS
24	Indirect Costs										
25	Engineering and supervision		0.33	0.32	0.33		0.32	0.106			
26	Construction expenses		0.39	0.34	0.41		0.34	0.112			Constraint:
27	Legal expenses		0.04	0.04	0.04		0.04	0.013			Contractor's fee is 7% of FCI
28	Contractor's fee		0.17	0.19	0.22		0.2135	0.070			7.0000 =100*H28/H22
29	Contingency		0.35	0.37	0.44		0.37	0.122			Manipulate G28 until J21 is 7
30	Total indirect costs		1.28	1.26	1.44		1.28	0.424			
32	Fixed capital investment (FCI)										
33								1.430			ANS→ Sent to 'Evaluation' and Year-0 \$', there adjusted as described below
34	Working capital (WC)		0.70	0.75	0.89		0.75	0.248			
36	Total capital investment (TCI)										
								1.678			←ANS

Problem 6-9

Estimate by the turnover ratio method the fixed capital investment required in 2000 for a proposed sulfuric acid plant (battery-limit) which has an annual capacity of 1.3×10^8 kg/yr of 100 percent sulfuric acid (contact catalytic process), using the data from Table 6-11, when the selling price for the sulfuric acid is \$86 per metric ton. The plant will operate 325 days/year. Repeat the calculation, using the cost capacity exponent method with data from Table 6-11.

Solution:

Method 1 - Turnover Ratio

$$\text{Turnover Ratio} = \text{TOR} = \frac{\text{Gross Annual Sales}}{\text{Fixed Capital Investment}} = \frac{G_j}{\text{FCI}} = \text{constant}$$

From Table 6-11 contains data for the sulfuric acid plant.

$$\begin{aligned} \text{TOR}_1 &= \text{TOR}_2 \\ \left(\frac{G_j}{\text{FCI}} \right)_1 &= \left(\frac{G_j}{\text{FCI}} \right)_2 \\ \frac{9 \times 10^7 \frac{\text{kg}}{\text{y}} \cdot \frac{\$86}{1000\text{kg}}}{\$4,000,000} &= \frac{1.3 \times 10^8 \frac{\text{kg}}{\text{y}} \cdot \frac{\$86}{1000\text{kg}}}{\text{FCI}} \\ \text{FCI} &= \$5,778,000 \\ &\quad \underline{\underline{\text{ANS}}} \end{aligned}$$

Method 2 – Cost capacity exponent method (scaling):

$$\begin{aligned} \text{Cost of Plant A} &= \text{Cost of Plant B} \cdot \left(\frac{\text{Capacity of Plant A}}{\text{Capacity of Plant B}} \right)^n \\ \text{Cost of Plant A} &= \$4,000,000 \cdot \left(\frac{130,000,000 \text{ kg / yr}}{90,000,000 \text{ kg / yr}} \right)^{0.65} = \$5,080,000 \\ &\quad \underline{\underline{\text{ANS}}} \end{aligned}$$

PROBLEM SET 8

Problem 6-10

The total capital investment for a chemical plant is \$1 million, and the working capital is \$100,000. If the plant can produce 8000 kg of final product per day during a 365-day year, what selling price in dollars per kilogram of product would be necessary to give a turnover ratio of 1.0?

Solution:

$$\text{TCI} = \$1,000,000 \text{ and } \text{WC} = \$100,000$$

$$\therefore \text{FCI} = \text{TCI} - \text{WC} = \$1,000,000 - \$100,000 = \$900,000$$

$$\text{Turnover Ratio} = \text{TOR} = \frac{\text{Gross Annual Sales}}{\text{Fixed Capital Investment}} = \frac{G_j}{\text{FCI}} = 1.0$$

$$\frac{\frac{8000 \text{ kg}}{\text{day}} \cdot \frac{365 \text{ days}}{\text{yr}} \cdot \left(x \frac{\$}{\text{kg}} \right)}{\$900,000} = 1.0$$

Solving for x gives $x = \underline{\underline{\$0.308/\text{kg}}}$
ANS