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.

ESTIMATION OF CAPITAL INVESTMENT BY PERCENTAGE OF DELIVERED EQUIPMENT METHOD

(See Table 6-9)

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.

Required user input | Default | Subtotal | Result

Required, from a linked sheet or entered manually | Notes & comments

Project Identifier: Illustration 101

	Fraction of delivered equipment			User: copy from values at left or insert	Calculated values, million $	
	Solid-processing plant	Solid-fluid processing plant	Fluid processing plant			
Direct Costs						
Purchased equipment, E'					0.300	
Delivery, fraction of E'	0.10	0.10	0.10	0.10	0.030	
Subtotal: delivered equipment					0.330	
Purchased equipment installation	0.45	0.39	0.47	0.39	0.129	
Instrumentation&Controls(installed)	0.18	0.26	0.36	0.26	0.086	
Piping (installed)	0.16	0.31	0.68	0.31	0.102	
Electrical systems (installed)	0.10	0.10	0.11	0.10	0.033	
Buildings (including services)	0.25	0.29	0.18	0.32	0.106	**Constraint:** Increase building
Yard improvements	0.15	0.12	0.10	0.12	0.040	cost for indoor construction
Service facilities (installed)	0.40	0.55	0.70	0.55	0.162	
Total direct costs	1.69	2.02	2.60	2.05	1.007	←ANS
Indirect Costs						
Engineering and supervision	0.33	0.32	0.33	0.32	0.106	
Construction expenses	0.39	0.34	0.41	0.34	0.112	**Constraint:**
Legal expenses	0.04	0.04	0.04	0.04	0.013	Contractor's fee is 7% of FCI
Contractor's fee	0.17	0.19	0.22	0.2135	0.070	7.0000 =100*H28/H22
Contingency	0.35	0.37	0.44	0.37	0.122	Manipulate G28 until J21 is 7
Total indirect costs	1.28	1.26	1.44	1.28	0.424	
Fixed capital investment (FCI)				ANS→	1.430	Sent to 'Evaluation' and 'Year-0 $', there adjusted as described below
Working capital (WC)	0.70	0.75	0.89	0.75	0.248	
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 form 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

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

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

$$\text{TOR}_1 = \text{TOR}_2$$

$$\left(\frac{G_j}{FCI}\right)_1 = \left(\frac{G_j}{FCI}\right)_2$$

$$\frac{9\times10^7 \frac{kg}{y}\cdot\frac{\$86}{1000kg}}{\$4,000,000} = \frac{1.3\times10^8 \frac{kg}{y}\cdot\frac{\$86}{1000kg}}{FCI}$$

$$FCI = \$5,778,000$$

ANS

Method 2 – Cost capacity exponent method (scaling):

$$\text{Cost of Plant A} = \text{Cost of Plant B}\cdot\left(\frac{\text{Capacity of Plant A}}{\text{Capacity of Plant B}}\right)^n$$

$$\text{Cost of Plant A} = \$4,000,000\cdot\left(\frac{130,000,000 \text{ kg/yr}}{90,000,000 \text{ kg/yr}}\right)^{0.65} = \$5,080,000$$

ANS

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=$0.308/kg

ANS