ABE 55800

Homework 02

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Problem 6-1

Given:

100 ft^2 of heating surface is \$3000 in 1980

n = 0.60 between 100 ft^2 and 400 ft^2

n = 0.81 between 400 ft^2 and 2000 ft^2

Find:

Cost of 200 ft^2 in 1980 and the cost of 1000 ft^2 in 1985

Solution:

We can use the cost correlation equation to calculate the cost of the equipment:

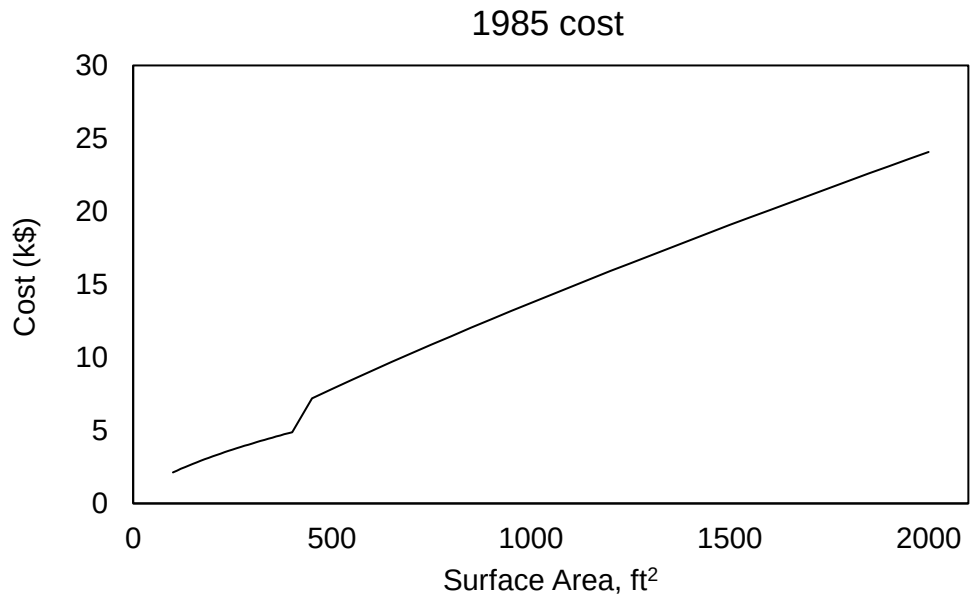
$$Cost\ Equip.\ A = Cost\ Equip.\ B\left(\frac{capacity\ equipment\ A}{capacity\ of\ equipment\ B}\right)^{n}$$

$$Cost\ 200\ ft^2\ in\ 1980 = \$3000\left(\frac{200\ ft^2}{100\ ft^2}\right)^{0.6} = \$4{,}547.15$$

$$Cost\ 1000\ ft^2\ in\ 1985 = \$4{,}547.15\left(\frac{790}{560}\right)\left(\frac{1000}{200}\right)^{0.81} = \$23{,}623.49$$

Problem 6-2

Plot purchased cost of a shell-and-tube heat exchanger using the data in the previous problem. Calculate the price for 1985. We will use the equation given in the proveious problem as well.



Problem 6-7

Using Table 17, we can get percentage ratios for the Total Capital Investment (TCI) and the Fixed Capital Investment (FCI). The land and contractor fees are given as percentages of the total capital investment and the fixed capital investment.

We know that the purchased cost of the equipment is $500,000. Thus, using the values in Table 17, we can calculate the total capital investment to be:

$$TCI = \frac{455}{100}(\$500{,}00) = \$2.28\ Million$$

Similarly, we can calculate the fixed capital investment with Table 17.

$$FCI = \frac{387}{100}(\$500{,}000) = \$1.94\ Million$$

We also know that land fees are approximately 5% of the fixed capital investment:

$$Land\ Fees = 0.05(FCI)$$

$$LandFees = 0.05(2.275\ million) = \$113{,}750$$

Contractor fees are 1.5% of the total capital investment:

$$Contractor\ Fees = 0.015(TCI)$$

$$ContractorFees = 0.015(2.275\ Million) = \$34{,}125$$

Problem 6-10

We know that the total capital investment for a chemical plant is $1 Million and the working capital is $100,000. The plant produces 8000 kg of final product per day during a 365 day cycle.

What selling price is necessary to get a turnover ratio of 1?

$$TR = 1 = \frac{Gross\ Annual\ Sales}{fixed\ capital}$$

Fixed Capital = $TCI - WC = \$1\ Million - \$100K = \$900{,}000$

Thus, the gross annual sales must equal $900,000. Gross annual sales is the production rate multiplied by the price:

Or,

$$P = \frac{\$900{,}000\ /\ yr}{8000\ kg/day * 365\ days/yr} = \$0.308/kg$$

Problem 6-11

A process plant was constructed in the Philly area (Middle Atlantic) at a labor cost of $200,000 in 1980. What would the average costs be in Miami, FL (South Atlantic) in late 1988.

Using Table 24, we can get percentage ratios to relate labor costs for different years and areas of the country.

Philadelphia's ratio in 1980 → 267

Atlanta's (South Atlantic) ratio in 1988 → 348

We can then calculate the new predicted labor cost:

$$\$200{,}000\frac{348}{267} = \$260{,}674$$

Problem 6-13

A conventional chemical plant has a total capital investment of $1,500,000 and it produces 3 million kg of product per year. The current selling price is $0.82/kg. We want to calculate the total product costs. Before, we need to know the total capital investment, the fixed capital investment, and the working capital.

$$\text{WC} = 15\% \text{ of TCI}$$

$$\text{WC} = 0.15(\$1.5\text{ M}) = \$225{,}00$$

$$\text{FCI} = \text{TCI - WC} = \text{TCI - 0.15TCI} = 0.85\text{TCI} = 0.85(\$1.5\text{ M}) = \$1{,}275{,}000$$

$$\text{Product Costs} = \text{Direct Product Costs} + \text{Indirect Product Costs} \quad \text{or} \quad \text{PC} = (\text{DP} + \text{IPC})$$

$$\text{DP} = \text{Fixed Cost} + \text{VC}$$

$$\text{VC} = \text{Raw material} + \text{misc. material} + \text{utilities} + \text{packaging}$$

$$\text{misc. material} = 10\% \text{ maintenance}$$

$$\text{maintenance} = 7\% \text{ FCI} = 0.07(1.275\text{M}) = \$89{,}250$$

Thus,

$$\text{misc. material} = 0.10(\$89{,}250) = \$8{,}925/3\text{ M kg} = \$0.02975/\text{kg}$$

$$\text{VC} = 0.09 + 0.02975 + 0.05 + 0.008 = \$0.17775/\text{kg}$$

$$\text{Fixed Costs} = \text{labor} + \text{supervision} + \text{maintenence} + \text{P. O.} + \text{Rent} + \text{Royalty} + \text{depreciation}$$

Supervision = 0.2*labor = 0.2*0.08 = $0.016/kg

P.O. = 0.6(0.08 + 0.016 + 0.02975) = $0.07545/kg

Insurance = 1%FCI = $0.00425/kg

Depreciation = 15% FCI = $0.06375/kg

Thus, Fixed Cost = $0.2692/kg

Now, DPC = $0.44695/kg

Take IPC as 25% DPC = $0.11738/kg

Thus, our manufacturing costs are:

$0.559/kg

Problem 6-14

We need to estimate the cost per 100lb or product under the following conditions:

FCI: $2 million
Annual Production Output: 10 million lb of product
Raw Materials Cost: $0.12/lb
Utilities:
100 psig steam = 50lb/lb product
Power = 0.4kWh/lb product
Filtered and soft water = 10 gal/lb product
Operating Labor = 20 men per shift @ $12/employee/hr
Plant operates 300 24-hr days per year
Corrosive liquids are involved
Shipments are in bulk
A large amount of direct superivision is required.
There are no royalty charges
Plant overhead costs amount to 50% of the cost for labor, supervision, and maintenance

The total raw material cost is:

$$(\$0.12/\text{lb})(10\text{M lb}) = \$1.2\text{ M}$$

Operating labor amounts to:

$$(20\text{ persons/shift})(\$12/\text{employee hr})(3\text{ shifts/day})(8\text{hr/shift})(300\text{ day/yr}) = \$\,1.728\text{ M}$$

$$\text{P.O. cost} = 50\%(\text{labor}) = 0.5(\$1.728\text{ M}) = \$864{,}0000$$

Total cost:

$$1.2 + 0.864 + 1.728 + 4 = \$7.792$$

So, cost per 100 pounds:

$$\$7.792/10\text{ million lb} = \$\,77.92/\text{lb}$$

Problem 6-16

We need to calculate the fixed cost per pound of a product at the breakeven point:

Plant Stats:

2000 tonnes/yr = 4,000,000 pounds/yr

Sells for $0.8/lb

DPC of $2 million @ 100 % capacity

Fixed Cost = $700,000

Let X be the capacity of production as a percentage from total.

We know profit is the following:

$$\text{Profit} = \text{Sales - Fixed Costs - Variable Costs}$$

At the breakeven point, we will get:

$$0.8 * 2{,}000\ \text{tonne}/yr * X - 2{,}000{,}000 * X - 700{,}000 = 0$$

Thus, X is:

58.3%

Fixed cost per pound at BEP = (700,000) / (0.583*400,000) = $3/lb product

Profit at full capacity:

The profit will be equal to the following:

$$\text{product creation rate} * \text{selling price - VC} - \text{FC}$$

$$(4{,}000{,}000)*0.8 - (2{,}000{,}000) - (700{,}000) = \$500{,}000$$

$$\text{Net profit} = \text{profit - income tax} = 500{,}000 - 100{,}000 = \$400{,}000$$

What about profit at full capacity and the selling price of the product is increased by 10%?

New selling price = $0.8 * 1.1 = $0.88/lb

Profit = (0.88)*(4,000,000) – (2,000,000) – (700,000) = $820,000

Net profit = 820,000 – 164,000 = $656,000

The dollar increase in net profit = 656,000 – 400,000 = $256,000