CH0401 Process Engineering Economics

Lecture 4

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1 **Economic Analysis**

2 Economic Balance in Cyclic Operation

1. **Economic Analysis**
2. Economic Balance in Cyclic Operation

Economic balance is the design of equipment or the selection of operating conditions whereby the increasing costs are balanced by decreasing cost to give the greatest economic return. There are numerous type of economic balance in design, in operation (cyclic operation or continuous operations) as well.

In many cases the individual cost items may be expressed as mathematical relation, all such equations can be added, and the sum (or total cost) can be differentiated with respect to the common variable. When the differential equation is set to zero and solved, the optimum value for common variable may be obtained.

Steps involved in solving economic balance problems

- Add all the costs involved
- Set the first derivative equal to zero
- Solve for common variable to obtain optimum value

Problem 1. The annual fixed cost for insulating a certain pipe line carrying steam in sugar industry is given as

$$C_F = 30x + 40 \quad , ₹/\text{year},$$

Where x is the insulation thickness in mm, and the cost of energy lost (annual direct cost C_D) from the installation in terms of insulation thickness is given as follows

$$C_D = \frac{100}{x} \; , ₹/\text{year}$$

a) Determine algebraically, the annual thickness of insulation

b) Determine graphically, the annual thickness of insulation

Solution

Step 1 Add all the cost involved to get total cost for the processes or operations

C_T = Annual fixed cost (C_F) + Annual direct cost (C_D)

$C_T = 30x + 40 + 100^{-1}$, ₹/year

Step II Set the first derivative equal to zero

$$\frac{dC_T}{dx} = 30 - 100x^{-2}$$

Step III Solve for optimum thickness

$$30 - 100x^{-2} = 0$$

$$30 - \frac{100}{x^2} = 0$$

$$30 = \frac{100}{x^2}$$

$$30 \times x^2 = 100$$

$$x^2 = \frac{100}{30}$$

$$x = \sqrt{\frac{100}{30}} \quad \text{(or)} \quad x = \left(\frac{100}{30}\right)^{1/2}$$

$$x = 1.83 \text{ mm}$$

$$\text{i.e. } x^* = 1.825 \text{ mm}$$

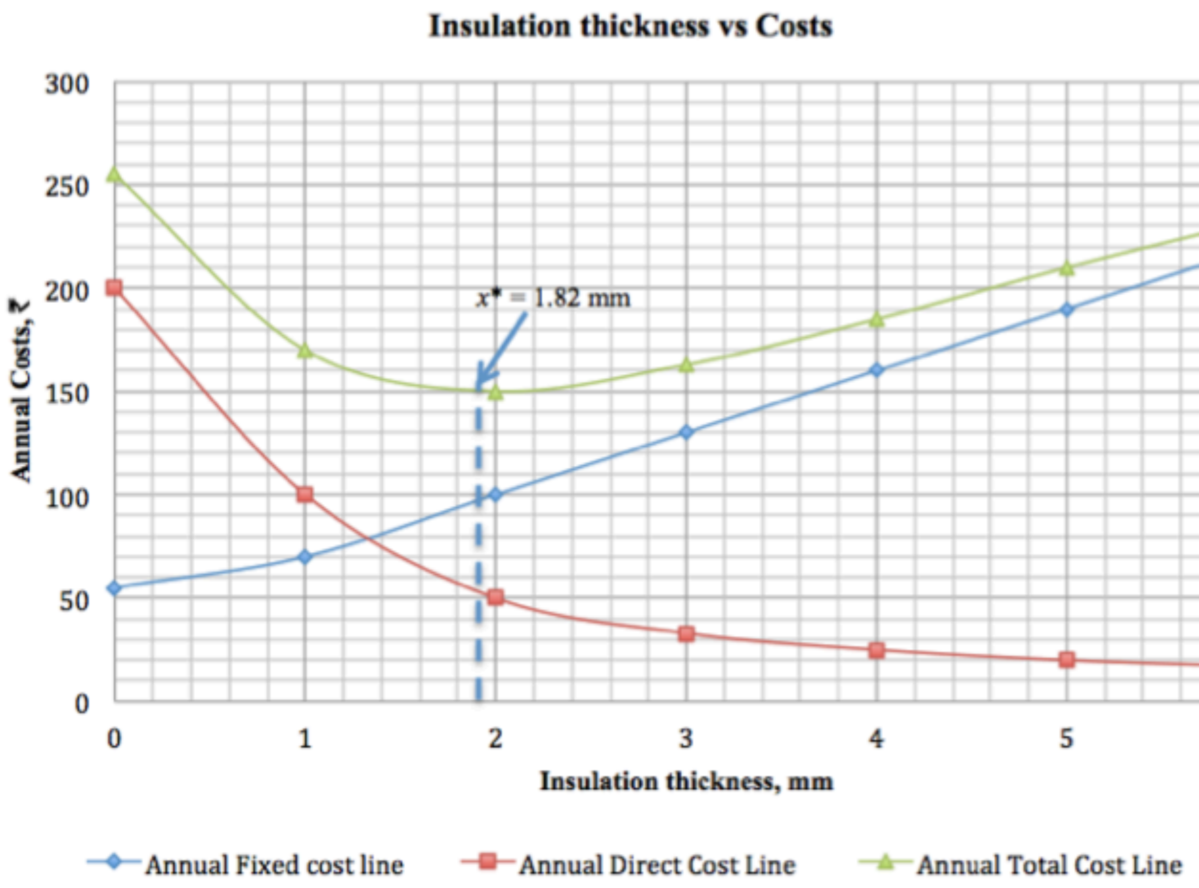
Therefore, it is found that the optimum thickness of insulation for the given data is 1.825 mm

Process Engineering Economics – *Economic Balance*

Graphical Procedure

Insulation Thickness	Annual fixed Cost	Annual Direct Cost	Total Annual Costs
mm	₹	₹	₹
1	70	100	170
2	100	50	150
3	130	33	163
4	160	25	185
5	190	20	210
6	220	17	233

Graphical Procedure



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