TUTORIAL-05: COST TARGETING

Based on **Lecture-21: Cost targeting**

Problem 1: Compute the cost targeted for stream data shown in Table 1, where two hot streams exchange heat against a single cold stream assuming ΔT_{min} as 10°C. The overall heat transfer coefficient, U, is constant and is equal to 0.123 $kW.m^{-2}K^{-1}$ for all exchangers.

Table 1: Stream data for Problem 1

stream	Supply temperature, Ts (˚C)	Target temperature, Tt (˚C)	Heat capacity flow rate, CP ($kW.^{o}C^{-1}$)
HOT (H1)	180	140	1.4
HOT (H2)	150	90	2.5
COLD (C1)	70	150	4

Given:

(a) The capital cost of the individual heat exchangers is according to following relationship:

Heat exchanger capital cost ($) = $30,000 + 400\ (A)^{0.9}$

Where, A is the heat transfer area of exchanger in m^2.

(b) The utility costs are:

Steam cost = 120,000 ($\$.kW^{-1}.y^{-1}$)

Cooling water cost = 10,000 ($\$.kW^{-1}.y^{-1}$)

(c) Plant life and rate of interest are assumed as 5 years and 10%, respectively.

Solution 1: To target the cost for stream data shown in Table 1 first area is targeted as shown for Problem 1 of Tutorial-03, which comes out to be 68.866 m^2.

Now cost targeting can be described as -

a) Capital cost targeting
Capital cost = $30,000 + 400\ (A)^{0.9} = 30,000 + 400\ (68.866)^{\mathbf{0.9}} = 48041.156$
Conversion of the capital cost into annual capital cost :

Conversion factor : $\frac{i(1+i)^n}{(1+i)^n - 1}$

where n and i are 5 and 10, respectively.

So the annual capital cost is computed as:

Annual capital cost = Capital cost * Conversion factor

$$= 48041.156 * \frac{0.1 * (1+0.1)^5}{(1+0.1)^5 - 1}$$

$$= 12673.1359 \ \$yr^{-1}$$

b) Operating cost targeting

For the present problem hot and cold utility are found as 114 kW and 0 kW, respectively, as computed for Problem 1 of Tutorial-03. Thus,

Hot utility cost = 114 ***** 120,000 = 13680.00 $.yr^{-1}

Similarly,

Cold utility cost = 0 ***** 10,000 = 0 $.yr^{-1}

Thus, total annual operating cost is 13680$.yr^{-1}.

c) Total Annual Cost (TAC) Targeting

TAC = Annual capital cost + Annual operating cost

=13680 +12673.1359 = 26353.1359

So, Total annual cost is targeted as $ 26353.1359/yr.

Problem 2: For a process the stream data, together with utility data and heat transfer coefficients are shown in Table 2, where ΔT_{min} is selected as 10 °C. Steam from 250°C to 249°C is used as hot utility whereas cold water from 25°C to 35°C is used as cold utility. Target the cost for this process.

Table 2: Complete stream and utility data for the process

Stream	Supply temperature T_s (°C)	Target temperature T_T (°C)	ΔH (MW)	Heating capacity flow rate, CP ($MW.^oC^{-1}$)	Film heat transfer coefficient, h ($MW.m^{-2}.^oC^{-1}$)
Cold (C1)	25	185	32.0	0.25	0.0008
Hot (H1)	260	50	-31.5	0.16	0.0009
Cold (C2)	145	235	27.0	0.32	0.0009
Hot (H2)	190	70	-30.0	0.26	0.0010
Steam (HU)	250	249			0.0040
Cold water (CU)	25	35			0.0010

Given:

Cost of hot utility = 150 ($\$.kW^{-1}.y^{-1}$)

Cost of cold utility = 15 ($\$.kW^{-1}.y^{-1}$)

Installed capital cost = $40000*A^{0.83}$

Rate of interest = 12%

Plant life = 6 year

Solution 2: To calculate the cost for stream data shown in Table 2, total area is targeted first, which is 6520.636 m^2 as shown for Problem 2 of Tutorial-03.

Now the total cost targeting is described below:

a) Capital cost targeting

Capital cost targets ($) = $40000*\ (A)^{0.83} = 40000*(6520.636)^{0.83} = 58603108$

Conversion of the capital cost into annual capital cost:

$$\text{Conversion factor} = \frac{i(1+i)^n}{(1+i)^n - 1}$$

where n and i are 6 and 0.12, respectively.
Thus, the annual capital cost is computed as:

Annual capital cost = Capital cost * Conversion factor

$$= 58603108 * \frac{0.12 * (1+0.12)^6}{(1+0.12)^6 - 1}$$

$$= 14253783.05 \ \$yr^{-1}$$

b) Operating cost targeting
For the present problem hot and cold utility are found as 12.9 MW and 8.90 MW, respectively, as computed for Problem 1 of Tutorial-03. Thus,

Hot utility cost = 12900 ***** 150 = 1935000 $.yr^{-1}

Similarly,

Cold utility cost = 8900 ***** 15 = 133500 $.yr^{-1}

Thus the total annual operating cost is 2068500 $.yr^{-1}

c) Total Annual Cost (TAC) Targeting

TAC = Annual capital cost + Annual operating cost
= 14253783.05 + 2068500 = 16322283.05$.yr^{-1}

So, Total annual cost is targeted as $ 16322283.05/yr.