

CH4010 Assignment-1: Targetting

Given stream data:

Stream No.	Type	Heat Capacity* Flow Rate kW / K	Supply Temperature °C	Target Temperature °C
1	Hot	2.1	180	40
2	Hot	4	150	40
3	Cold	3	60	180
4	Cold	2.6	30	130

Since $(\Delta T)_{\min} = 9$ degrees C (even roll number), we can shift the hot stream below by $9/2 = 4.5$ degrees and the cold stream above by 4.5 degrees. This results in:

Modified stream data:

Stream No.	Type	Heat Capacity* Flow Rate kW / K	Supply Temperature °C	Target Temperature °C
1	Hot	2.1	175.5	35.5
2	Hot	4	145.5	35.5
3	Cold	3	64.5	184.5
4	Cold	2.6	34.5	134.5

Part-1: Pinch-point, Q_c , Q_H and composite curves

Using the problem table algorithm, one can arrive at the following table:

	2.1	4	3	2.6	$\Sigma (FC_{p, hot})$ (in kW/C)	$\Sigma (FC_{p, cold})$ (in kW/C)	ΔT (in C)	ΔH (in kW)	$q_{transfer}$ (in kW)
184.5	0	0	1	0	0	3	9	27	0
175.5	1	0	1	0	2.1	3	30	27	-27
145.5	1	1	1	0	6.1	3	11	-34.1	-54
134.5	1	1	1	1	6.1	5.6	70	-35	-19.9
64.5	1	1	0	1	6.1	2.6	29	-101.5	15.1

35.5	0	0	0	1	0	2.6	1	2.6	116.6
34.5	0	0	0	0	0	0			114

We can see the lowest q_{transfer} is -54 kW. So if we provide a heating of 54 kW, all heat transfers will be non-negative (and hence heat won't flow from lower temperature to higher temperature).

	2.1	4	3	2.6	$\Sigma (FC_{p, \text{hot}})$ (in kW/C)	$\Sigma (FC_{p, \text{cold}})$ (in kW/C)	ΔT (in C)	ΔH (in kW)	q_{transfer} (in kW)
184.5	0	0	1	0	0	3	9	27	54
175.5	1	0	1	0	2.1	3	30	27	27
145.5	1	1	1	0	6.1	3	11	-34.1	0
134.5	1	1	1	1	6.1	5.6	70	-35	34.1
64.5	1	1	0	1	6.1	2.6	29	-101.5	69.1
35.5	0	0	0	1	0	2.6	1	2.6	170.6
34.5	0	0	0	0	0	0			168

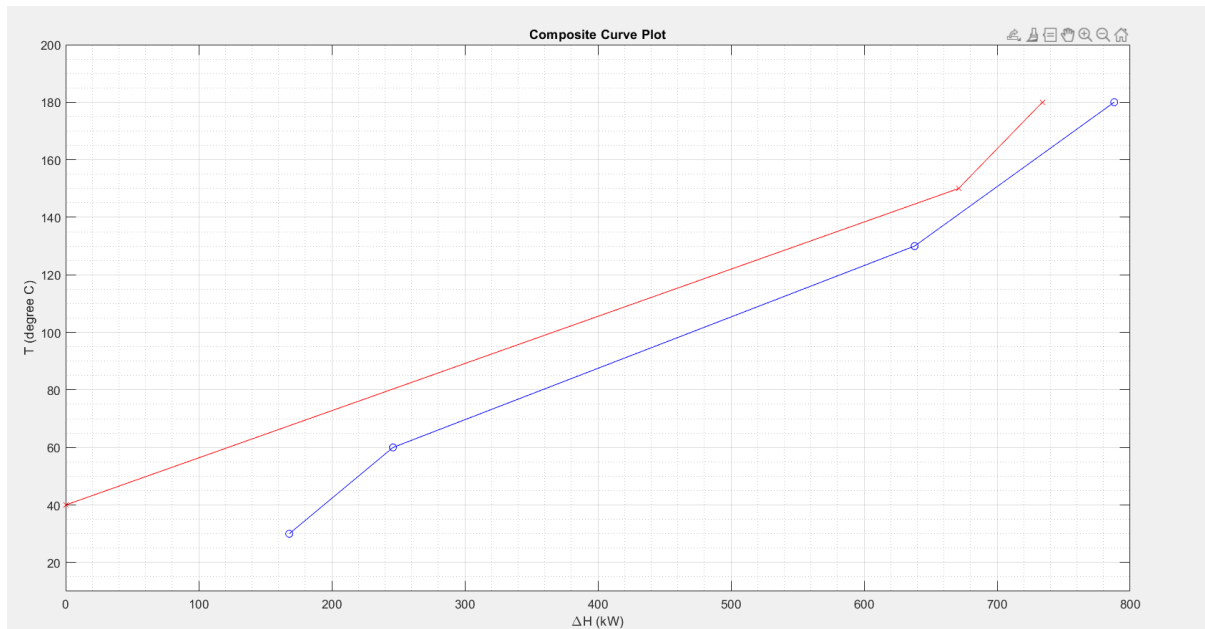
Hence from the above Problem Table we obtain the following:

Pinch point: i) cold stream pinch = $145.5^\circ\text{C} - 4.5^\circ\text{C} = 141^\circ\text{C}$

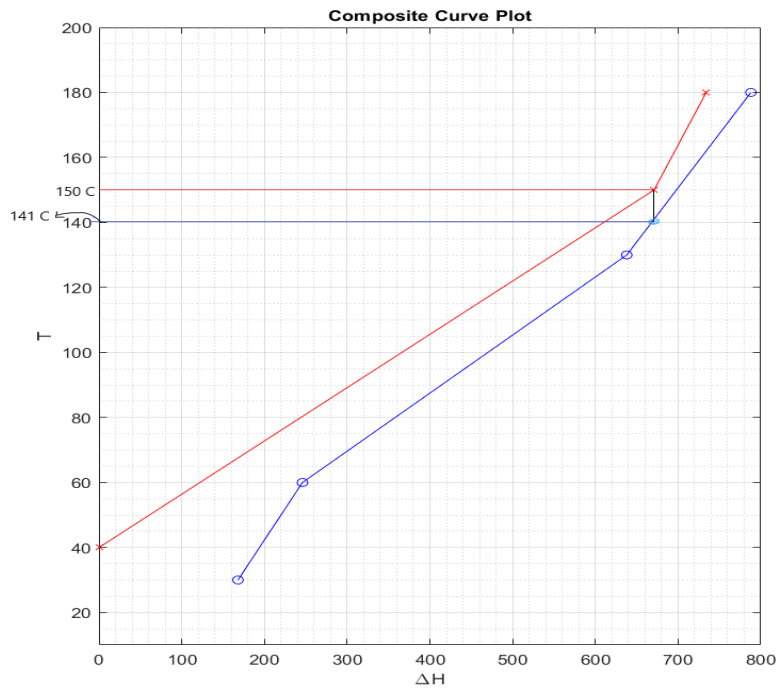
ii) hot stream pinch = $145.5^\circ\text{C} + 4.5^\circ\text{C} = 150^\circ\text{C}$

Heating utility required, $Q_h = 54 \text{ kW}$

Cooling utility required, $Q_c = 168 \text{ kW}$

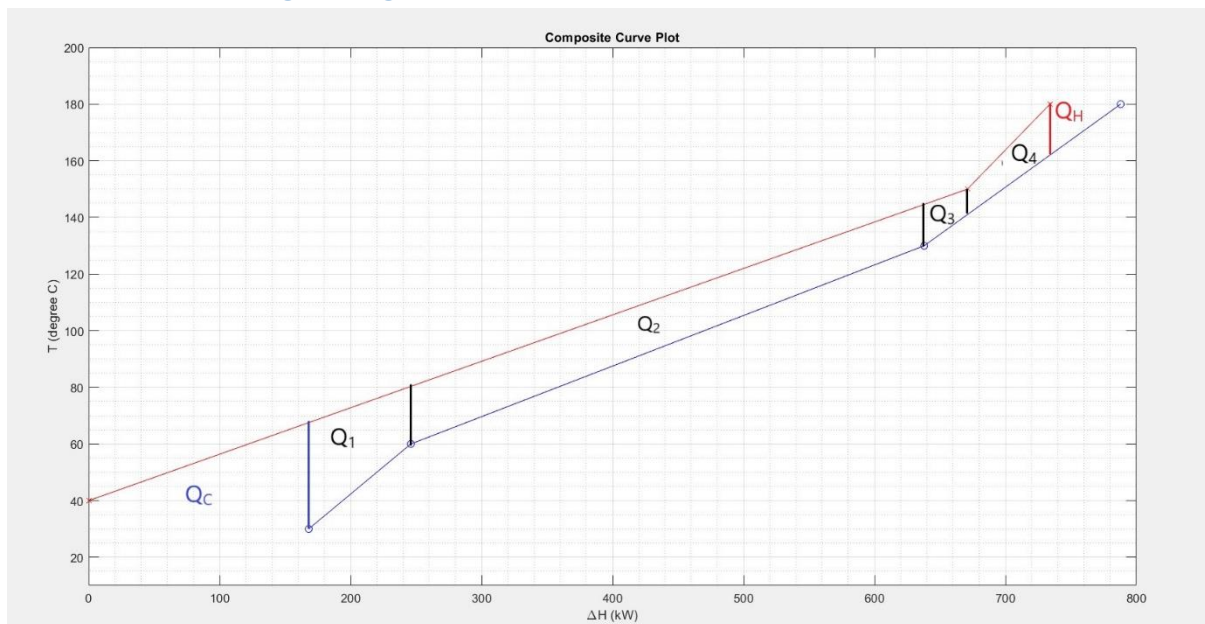


Plot 1a): Composite curves. Red: hot curve; blue: cold curve



Plot 1b): Composite curves with the pinch point marked. Red: hot curve; blue: cold curve

Part-2: Area Targeting



Plot 2: Showing different parts of the system where heat exchangers have to be used.