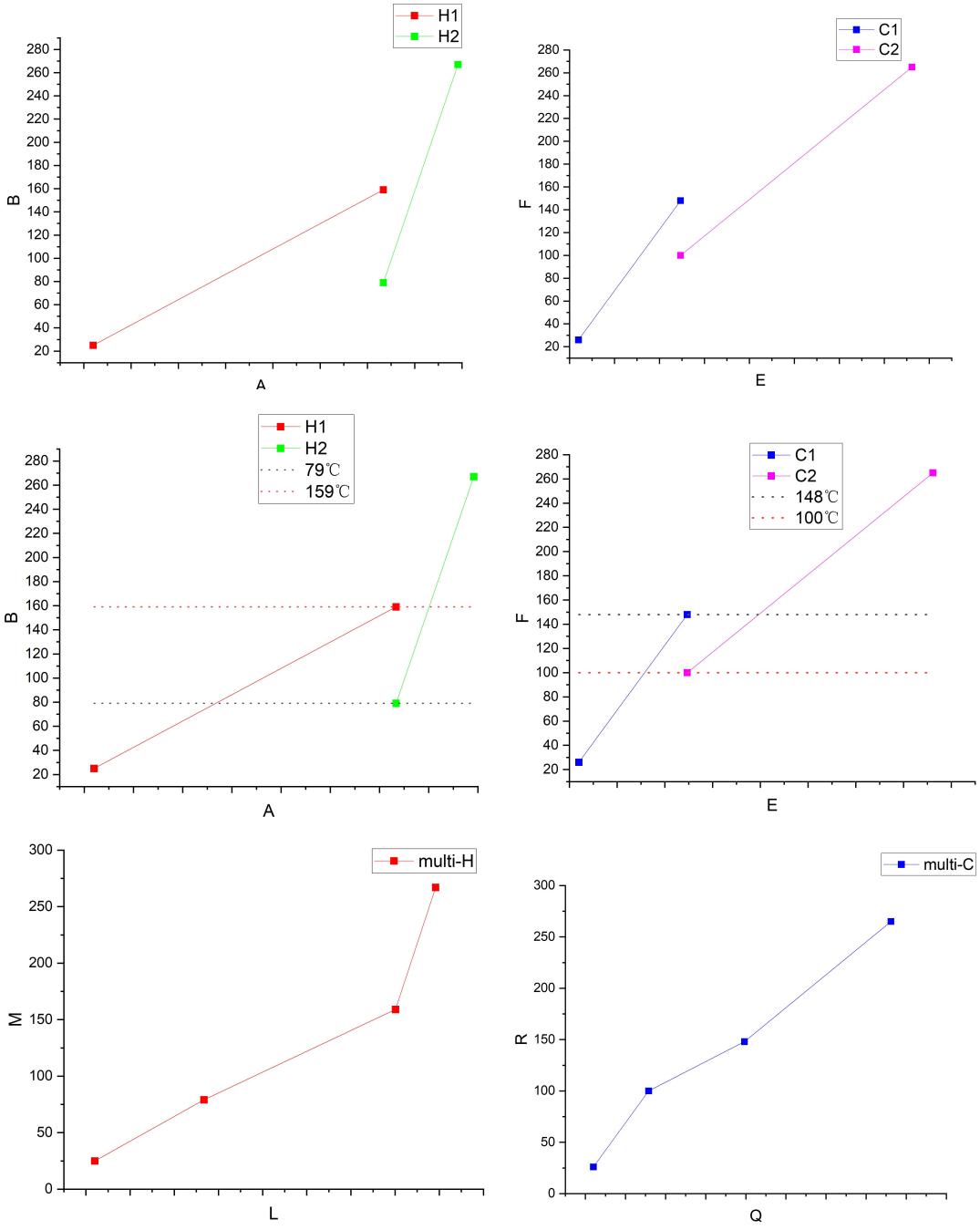
	H1	H2		C1	C2
Fcp[kW/C]	2.29	0.42	Fcp[kW/C]	0.93	1.56
Tin[℃]	159.00	267.00	Tin[℃]	26	100
Tout[℃]	25.00	79.00	Tout[℃]	148	265

1. Consider HRAT=10 ℃

a) Build the hot and cold composite curves. Show all the steps.

H1: $\Delta Q_{H1} = FcP\Delta T_1 = 306.86\ kW$; H2: $\Delta Q_{H2} = FcP\Delta T_2 = 78.96\ kW$

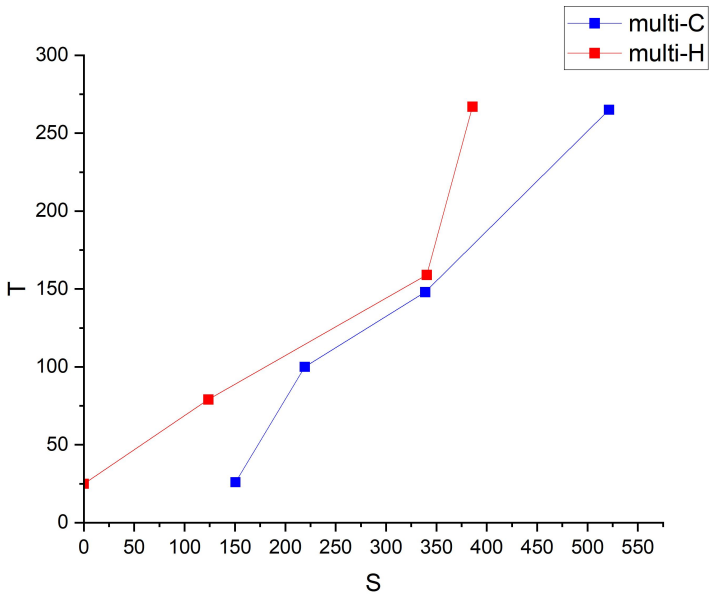
C1: $\Delta Q_{C1} = FcP\Delta T_3 = 113.46\ kW$; C2: $\Delta Q_{C2} = FcP\Delta T_4 = 257.4\ kW$



As to HRAT=10℃, try to find the minimum temperature difference at the turning points with moving the cold line to the ~~left or~~ right, then we can get the hot and cold composite curves diagram below.

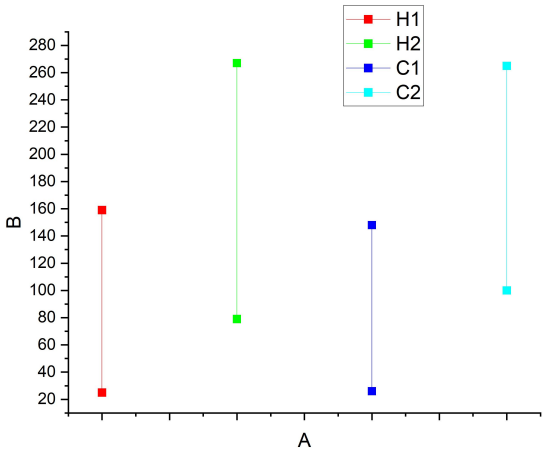
Turning points(kW) (starts from 0)	T	corresponding T of multi-C or multi-H curve	the dH if C or H starts from 0	calculate the moving distance (kW)
0 of H	25	\	\	\
123.66 of H	79	69∈(26,100) of C	39.99	83.67 e.t. 123.66-39.99
340.46 of H	159	149∈(148,265) of C	189.9	150.56
385.82 of H	267	257∈(148,265) of C	358.38	27.44
0 of C	26	36∈(25,79) of H	25.19	-25.19
68.82 of C	100	110∈(79,159) of H	207.67	-138.85
188.34 of C	148	158∈(79,159) of H	337.75	-149.41
370.86 of C	265	\	\	\

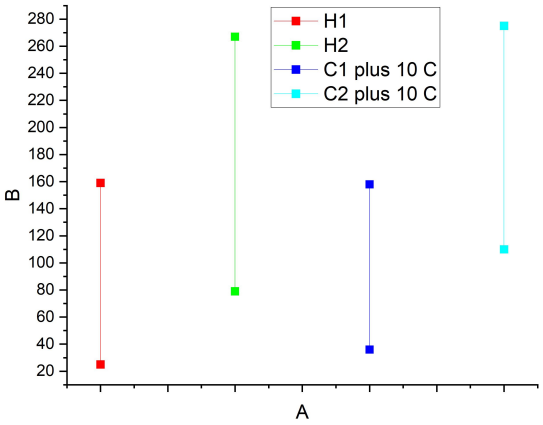
Result is that the pinch of hot temperature is 159℃

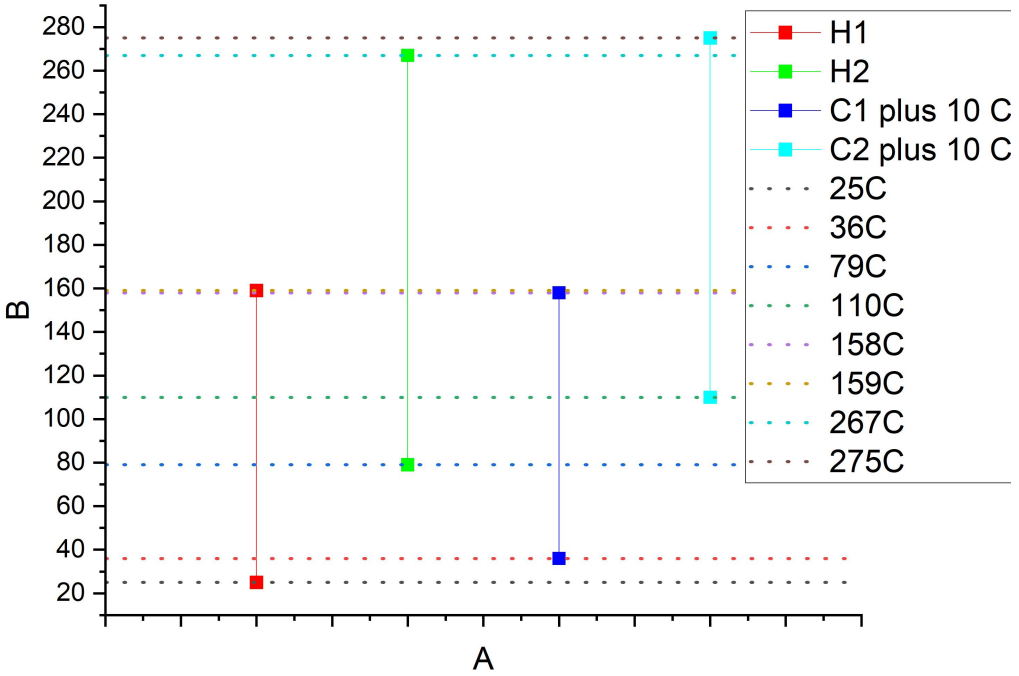


b) Build a Pinch Tableau and identify the minimum utility (hot and cold) and the pinch temperature.

According to the hot and cold composite curves diagram, divide the temperature range into intervals as the table below and shift the cold temperature scale(plus 10 ℃).







T cut	T start	T end	Fcp		dH		cascade	cascade updated
275	275	267	-1.56	C2	-12.48	d	-12.48	123.12
267	267	159	-1.14	C2+H2	-123.12	d	-135.6	0
159	159	158	1.15	C2+H2+H1	1.15	s	-134.45	1.15
158	158	110	0.22	C1+C2+H1 +H2	10.56	s	-123.89	11.71
110	110	79	1.78	C1+H1+H2	55.18	s	-68.71	66.89
79	79	36	1.36	C1+H1	58.48	s	-10.23	125.37
36	36	25	2.29	H1	25.19	s	14.96	150.56
25								

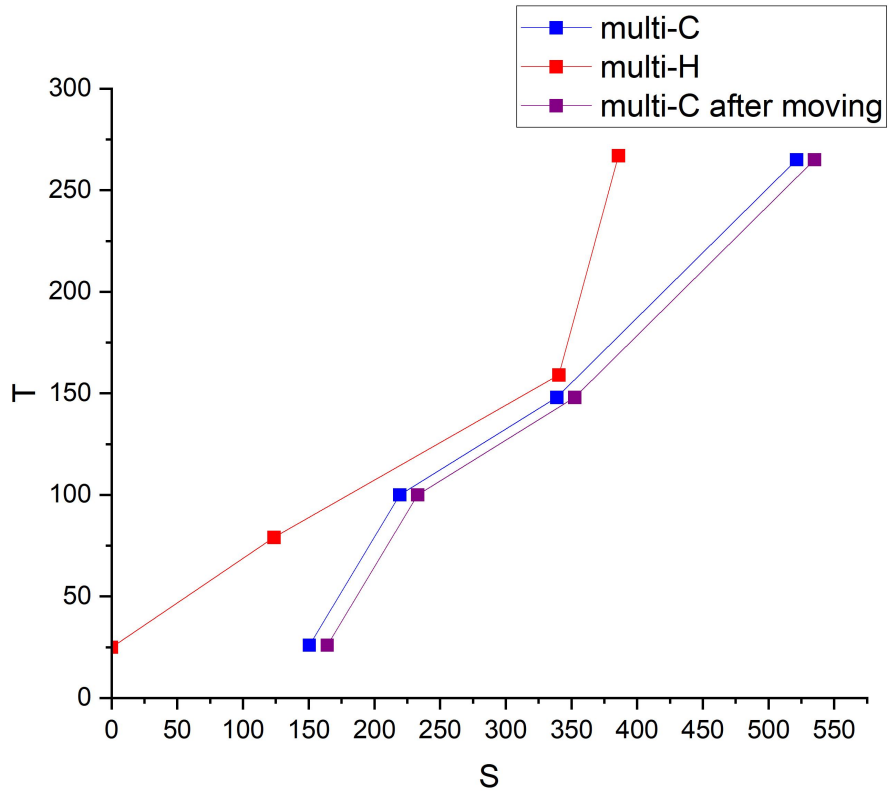
d:deficit ; s:surplus

So the pinch temperature: The hot temperature is 159 C, the cold temperature is 149 C, the average is 154 C.

The minimum utility: the min hot utility is 135.6 kW, the min cold utility is 150.56 kW.

c) Show how much the cold utility changes when you add 10% to the hot utility.

As to the min hot utility 135.6 kW, when adding 10% to the hot utility, the difference(increment) is 135.6*0.1 kW=13.56 kW. It can be obtained through shifting the multi-cold line which is drawn below.



It's obvious that the cold utility also have a increment of 13.56kW.

d) Assume your cold ustility uses water at 15 oC. Will the pinch temperature change if you use water at 10 oC.

I think the cooling water in different temperature can not influence the Fcp of multi-H curve, so I think the pinch temperature will not change.

	H1	H2	H3		C1	C2	C3
Fcp[kW/C]	2.29	0.42	0.54	Fcp[kW/C]	0.93	1.56	0.45
Tin[℃]	159	267	340	Tin[℃]	26	100	60
Tout[℃]	25	79	90	Tout[℃]	148	265	178

2. Use the IChemE spreadsheet to obtain the minimum utility for HRAT=10 ℃, 20 ℃, 30 ℃, and 40 ℃. For each case.

0) One of screenshots of input interface of IChemE spreadsheet(when HRAT=10 ℃)

Input Data

1. Select Input Method from the Dropdown list: Heat Capacity Flowrate
2. Input Global dTmin & select input temperature units: 10 °C
3. Select appropriate units for the input data from the drop down lists below (E15/F15).
4. Input data: Stream Name, Temperatures & Heat/Flow Data (max 50 streams).
5. Select desired output unit set: SI-based (kW/K)

Requires Input -
Optional Input -
Calculation cell -

Stream Name	Supply Temperature	Target Temperatur	dT Min Contrib	Heat Capacity Flowrate		Heat Flow	Stream Type	Supply Shift	Target Shift
	°C	°C	°C	kW/K		kW		°C	°C
C1	26	148		0.930		113.46	COLD	31.0	153.0
H1	159	25		2.290		306.86	HOT	154.0	20.0
C2	100	265		1.560		257.4	COLD	105.0	270.0
H2	267	79		0.420		78.96	HOT	262.0	74.0
C3	60	178		0.450		53.1	COLD	65.0	183.0
H3	340	90		0.540		135.0	HOT	335.0	85.0

a) Show the composite curves.

b) Report the hot and cold utility.

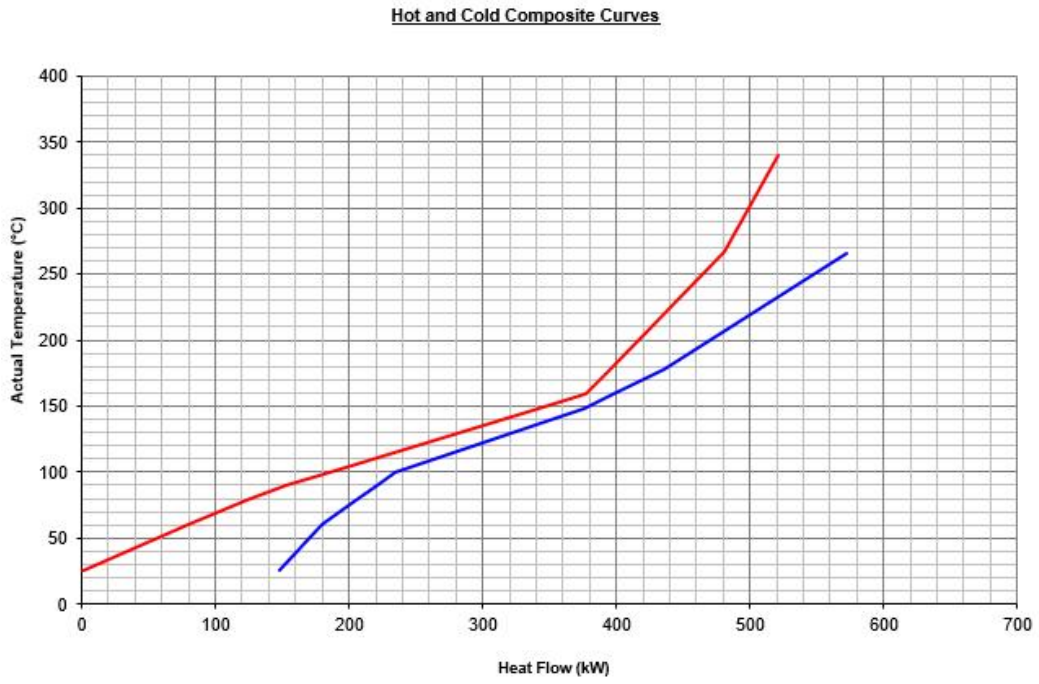
c) Identify the pinch.

d) A summary of the result of b) and c)

	pinch(C)			utility(kW)	
HRAT(C)	hot	cold	average	hot	cold
10	159	149	154	50.91	147.77
20	159	139	149	79.38	176.24
30	159	129	144	108.78	205.64
40	159	119	139	138.18	235.04

For HRAT=10 ℃

a)

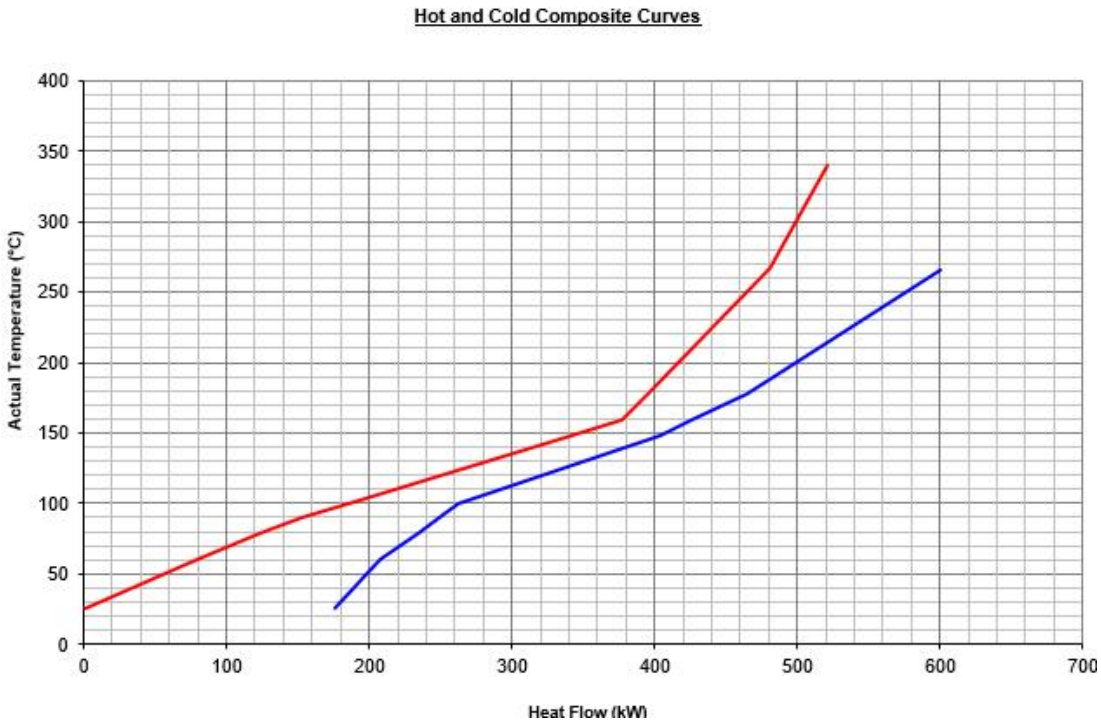


b)min hot utility 50.91 kW; min cold utility 147.77 kW

c)hot pinch 159 C; cold Pinch 149 C;average 154 C

For HRAT=20 ℃

a)

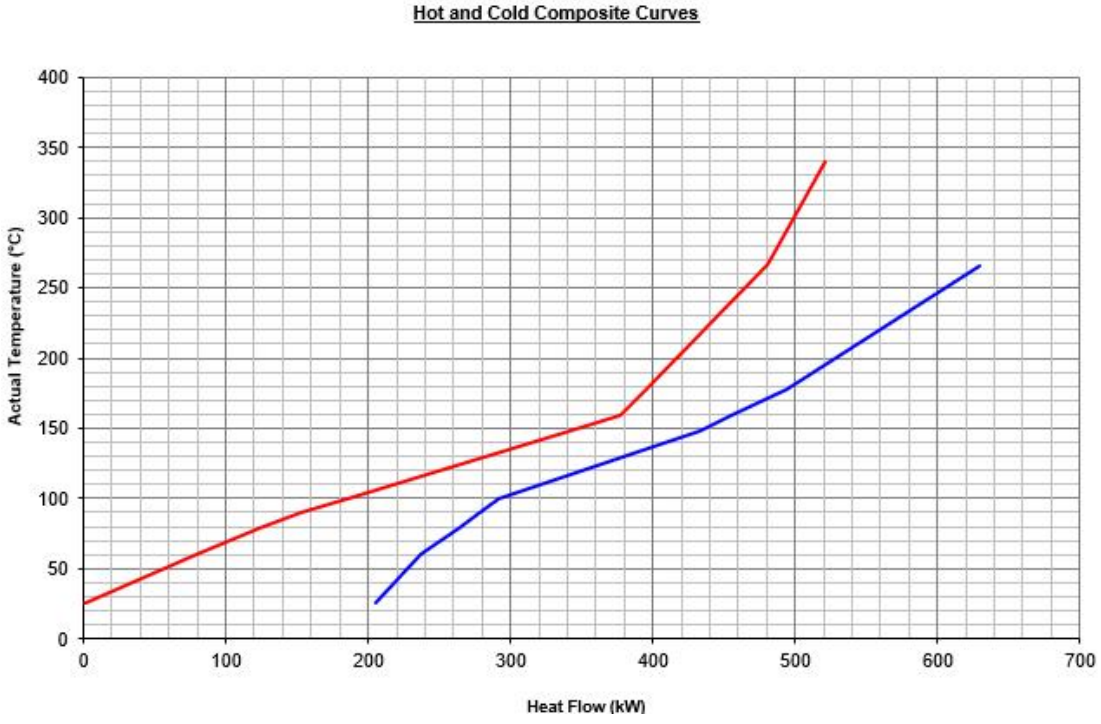


b)min hot utility 79.38 kW; min cold utility 176.24 kW

c)hot pinch 159 C; cold Pinch 139 C;average 149 C

For HRAT=30 ℃

a)

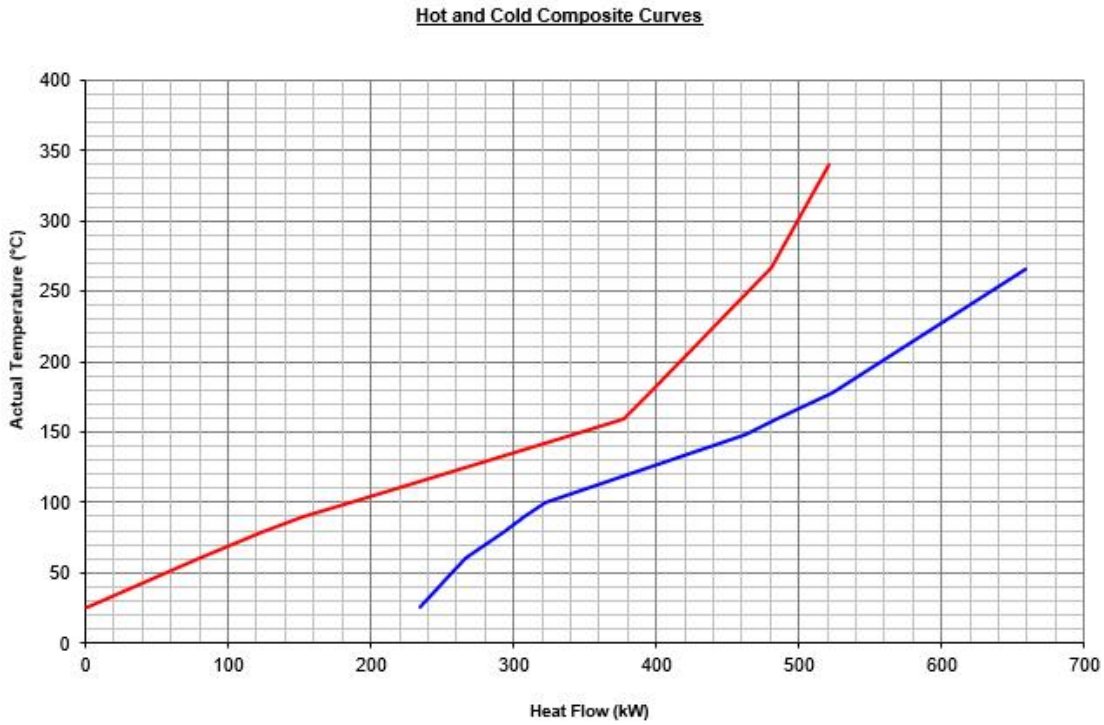


b)min hot utility 108.78 kW; min cold utility 205.64 kW

c)hot pinch 159 C; cold Pinch 129 C;average 144 C

For HRAT=40 ℃

a)



b)min hot utility 138.18 kW; min cold utility 235.04 kW

c)hot pinch 159 C; cold Pinch 119 C;average 139 C