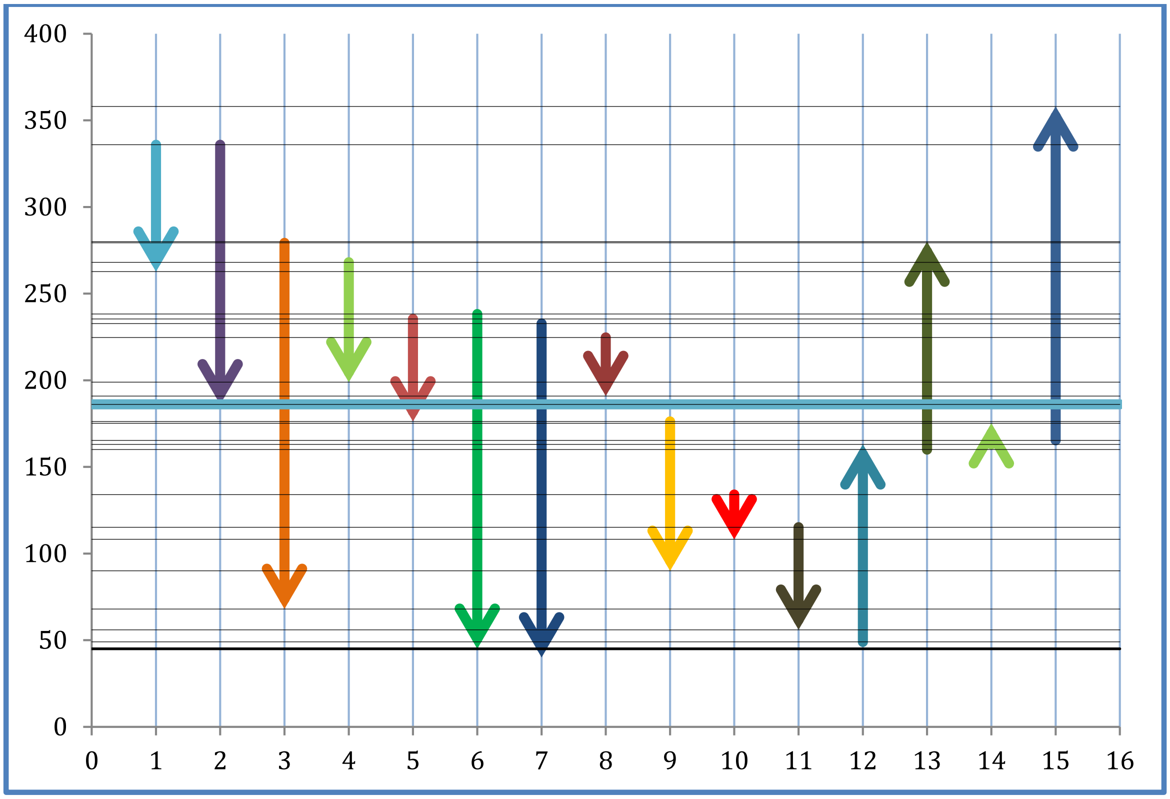
a) Use super-targeting to get the right minimum heat recovery approach temperature (HRAT) for the data of problem 2. Use the following cost data.

Step 1: Choose HRAT =10

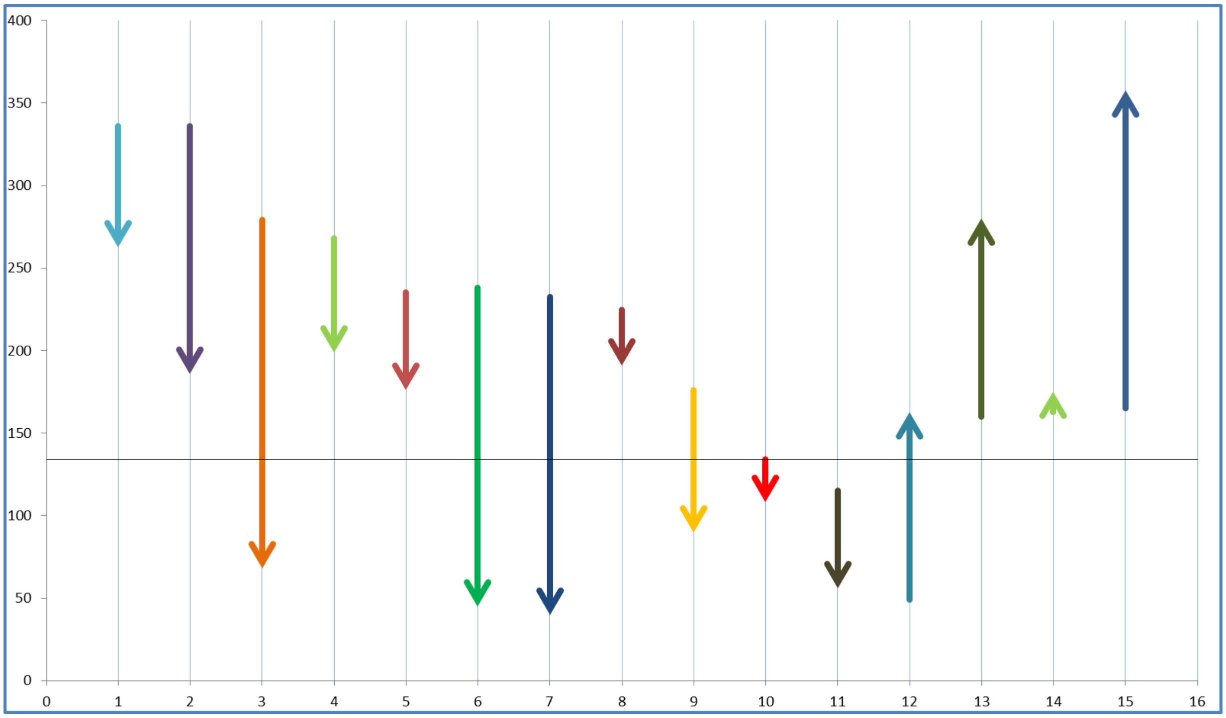


Step 2: Cascade the heat surplus through the intervals, add heat so that no deficit is cascaded. Find the pinch position, minimum heating utility and cooling utility.

	T (degree C)			
	358		54616	Min Heat Ultility
1		-14049		
	335.9		40568	
2		-22219		
	280		18348	
3		-415		
	279.3		17934	
4		-5776		
	268.1		12158	
5		-369		
	262.7		11789	
6		-5585		
	238.2		6204	
7		-503		
	235.4		5701	
8		226		
	232.7		5927	
9		1758		
	224.7		7686	
10		15893		
	198.9		23579	
11		1350		
	190.9		24928	
12		-1092		
	186.1		23836	
13		-3031		
	176.2		20805	
14		-484		
	175.2		20321	
15		-11623		
	165.3		8698	
16		-1238		
	163		7460	
17		-1296		
	160		6164	
18		-6164		
	134		**0**	Pinch
19		18061		
	115.2		18061	
20		7845		
	108.2		25907	
21		-1402		
	90		24504	
22		-3570		
	68		20934	
23		-2866		
	56		18068	
24		-2792		
	49		15276	
25		738		
	45		16014	
26		680		
	40		16694	Min Cool Ultility

Pinch T = 134 C, Hot utility =54616 kW, Cold utility = 16694 kW

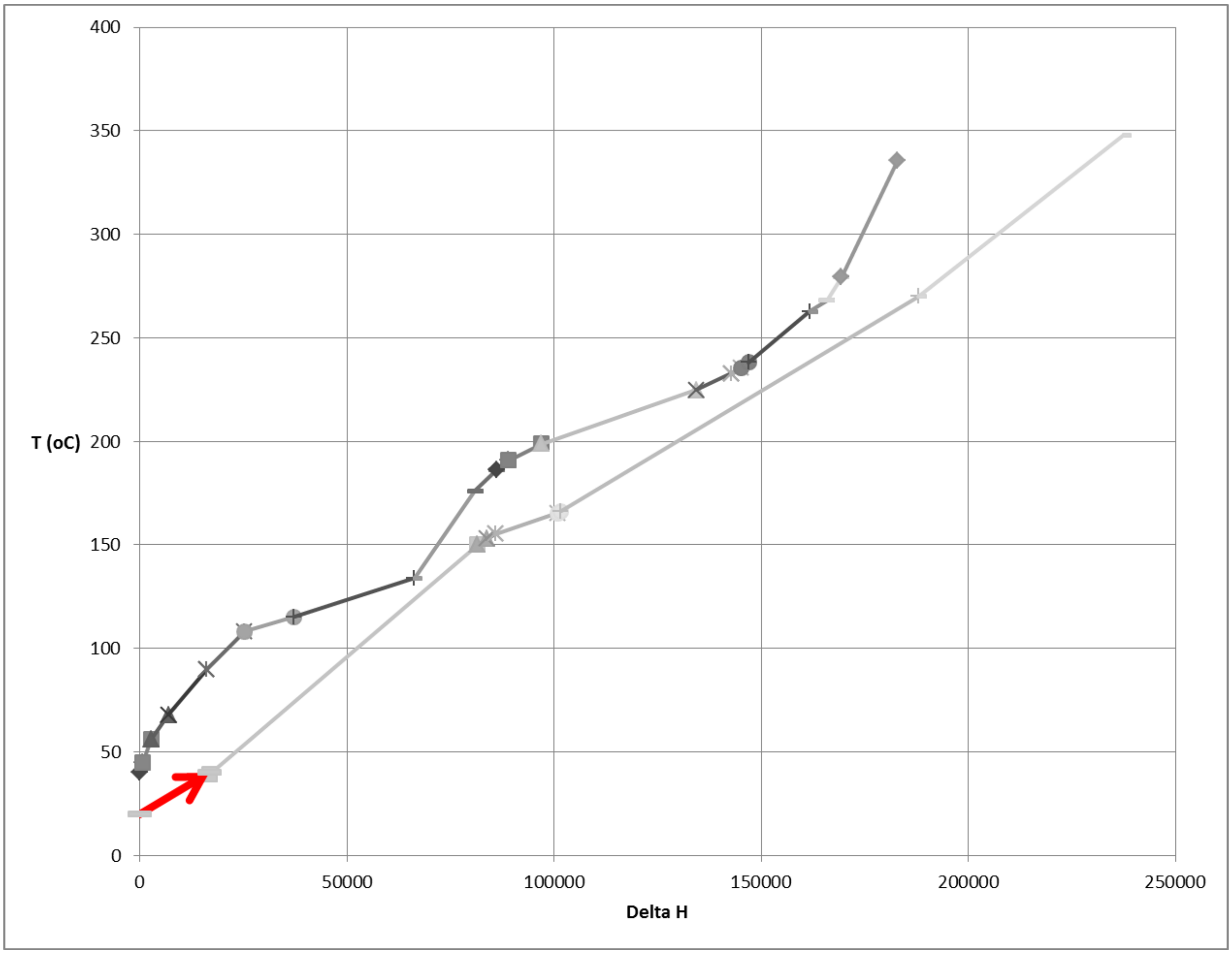
Step 3: Find number of exchangers



There are 13 streams above the pinch + 1 utility and 7 streams below the pinch+ one utility:

The number of exchangers $(N\text{-}1)_{above} + (N\text{-}1)_{below} = 13 + 7 = 20$ exchangers.

4. Create composite curves:



The total area is estimated from the composite curve diagram.

A=Q/(U*LMTD)

	Q	Th1	Th2	Tc1	Tc2	ΔTml	A	
1	680	45	40	20	21	22.03	123.52	
2	2029	56	45	21	23	28.25	287.27	
3	4134	68	56	23	28	36.16	457.26	
4	9264	90	68	28	39	45.03	822.83	
5	587	91	90	39	40	50.93	46.10	
6	8628	108	91	39	54	53.28	647.77	
7	11929	115	108	54	74	47.37	1007.32	
8	29028	134	115	74	131	15.22	7630.46	
9	14612	176	134	131	149	11.53	5067.12	
10	555	177	176	149	150	27.20	81.59	
11	2334	182	177	150	153	27.98	333.75	
12	2035	186	182	153	155	29.49	275.93	
13	267	186	186	155	155	30.46	35.05	
14	2894	191	186	155	157	32.05	361.22	
15	7993	199	191	157	163	34.87	916.83	
16	3896	202	199	163	165	36.33	429.00	
17	830	202	202	165	166	36.18	91.82	
18	32593	225	202	166	205	26.75	4874.29	
19	8402	233	225	205	216	18.18	1849.17	
20	2469	235	233	216	219	17.00	580.80	
21	1823	238	235	219	221	17.17	424.73	
22	14762	263	238	221	239	20.65	2859.43	
23	4115	268	263	239	243	24.42	674.17	
24	3525	279	268	243	248	27.97	504.12	
25	13482	336	279	248	264	49.04	1099.70	
26	5033	600	336	264	270	169.43	118.82	
27	49583	600	600	270	348	289.25	685.68	
						Total area	**32285.72316**	**m2**

Step 5:

Utility cost per year:

= (hot utility)*(hot cost) + (cold utility)*(cold cost) ($)

= $ 5.71 million

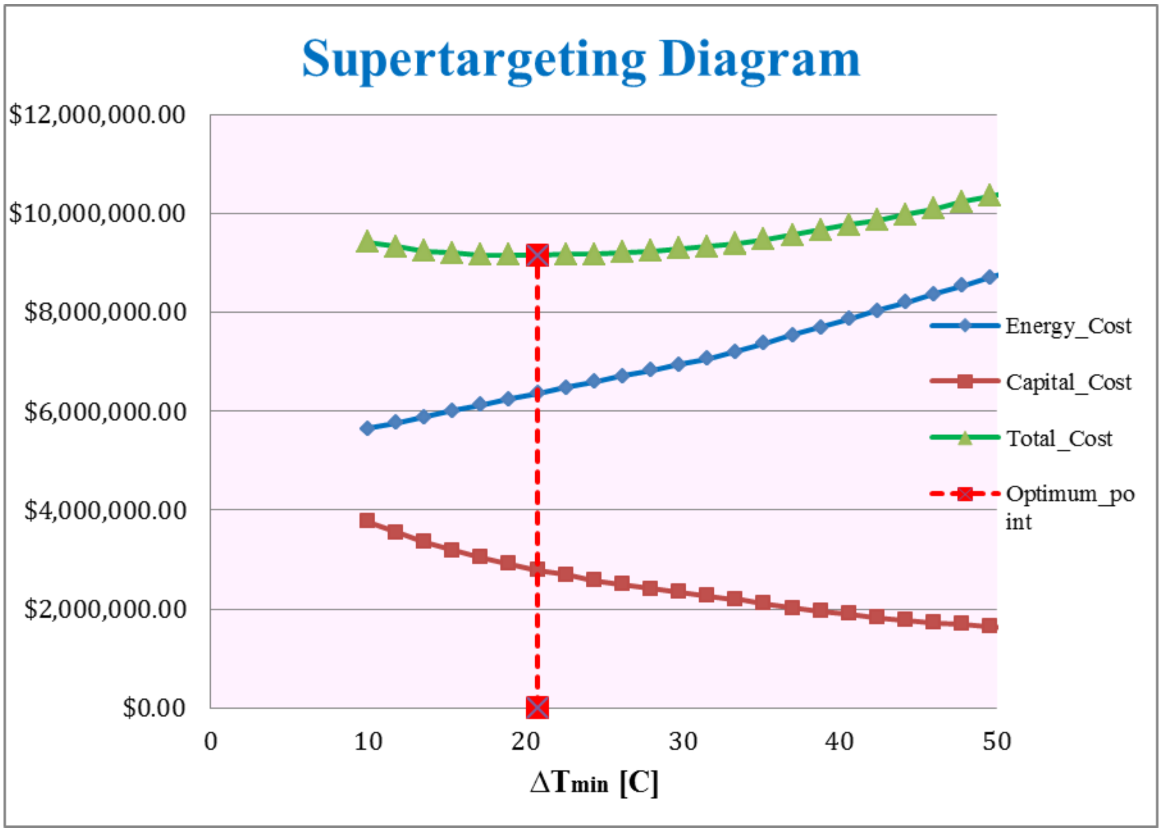
Calculate annual capital cost: (assuming time span of 5 years)

={(# exchangers)*(cost per exchanger) + (area)*(cost per square meter)}/(time span)

=$ 5.70 million

Total= Utility + Capital Cost = $11.4 million

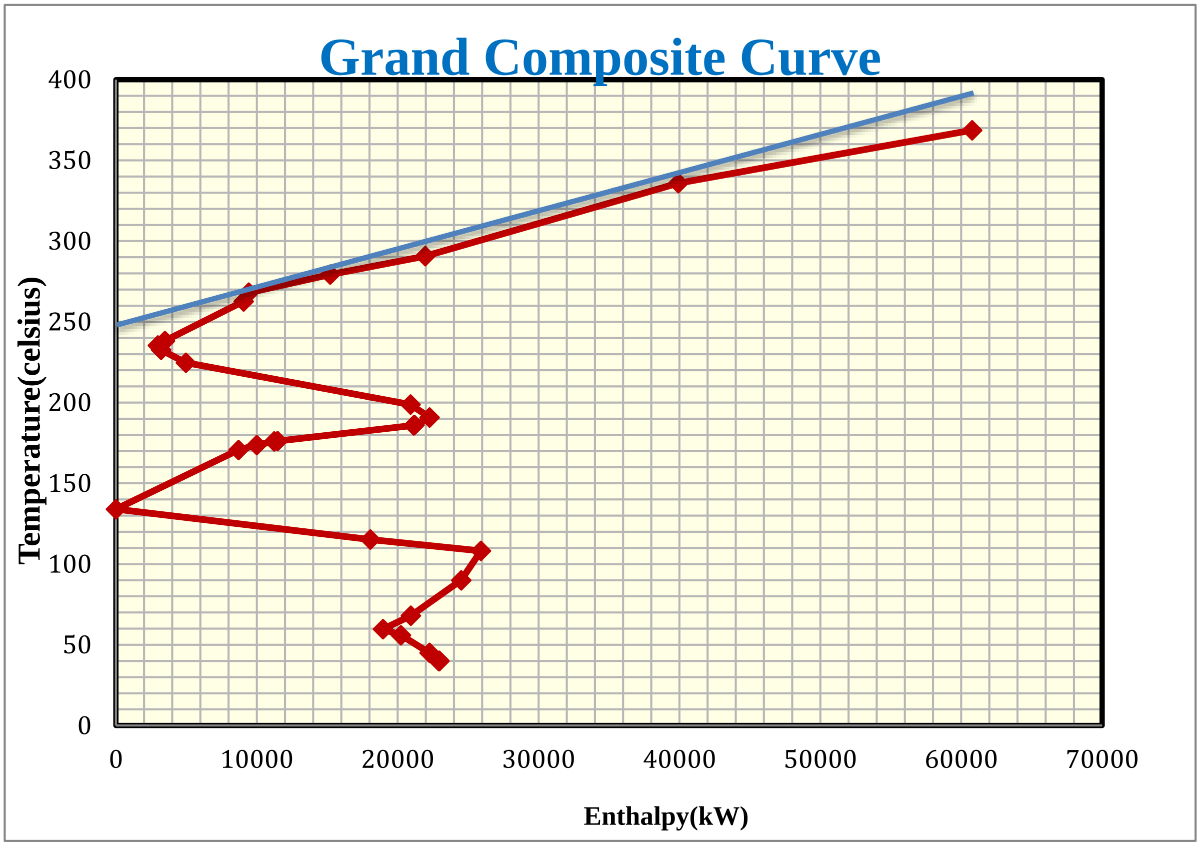
Step 6: Repeat the same procedure for different values of HRAT. HRAT for optimum cost is 20^0C



Supertargeting Diagram
$12,000,000.00
$10,000,000.00
$8,000,000.00
$6,000,000.00
$4,000,000.00
$2,000,000.00
$0.00
0
10
20
30
40
50
ΔTmin [C]
Energy_Cost
Capital_Cost
Total_Cost
Optimum_point

a) Assume that hot oil at 390^{0}C is available as utility. Determine the outlet temperature of this oil, if its usage is minimum. Discuss the costs associated with the usage of heating oil. Is it always advisable using the lowest possible flow rate? Why?

Create Grand Composite Curve for HRAT = 10

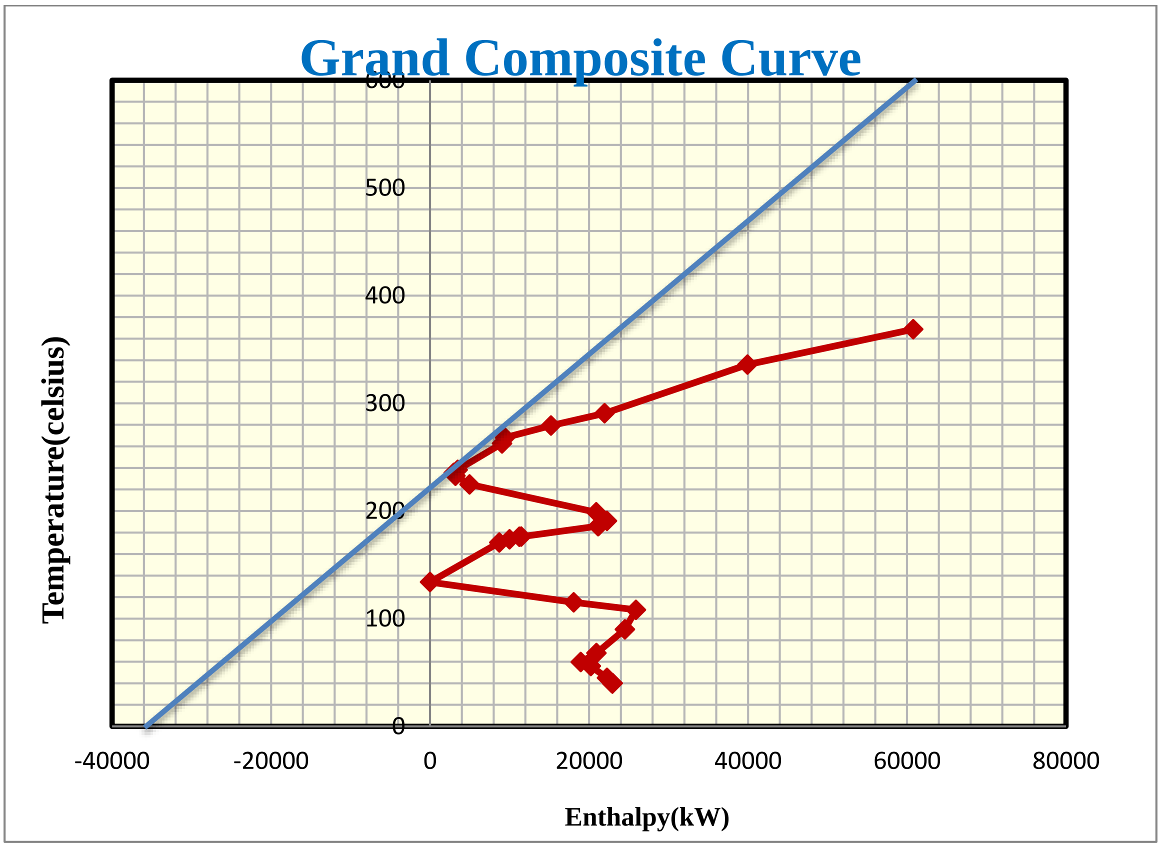


For minimum flow rate, we need the steepest possible line (and minimum return temperature) . The minimum return temperature is approximately 250 C.

A cost of using heating oil is the energy required to heat it to the input temperature. Using the minimum flow rate and exit temperature then requires the oil to be heated over a farther temperature range to bring it back to the input temperature, so energy costs of this could outweigh the advantage of using the minimum flow rate.

b) Assume that all hot utility has to be satisfied using a furnace. What are your stack losses? What is the real utility consumption? Discuss what would be a suitable flame temperature to use.

Assuming the furnace utility temp is 600 C (the utility temp given in the first part of the problem), the minimum usage will be tangent to the composite curve:



Stack loss: 36000 Kw. The total real utility consumption is 60774+36000 Kw. Stack losses can be reduced if the furnace temperature is increased above 600 °C. The limit is given by material considerations.