BY S.VISHAL
CH18B020

CH4010 Assignment-2

[Excerpts from HW1 for using some of the values found out there]

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	Σ ($FC_{p,\ hot}$) (in kW/C)	Σ($FC_{p,\ cold}$) (in kW/C)	ΔT (in C)	ΔH (in kW)	$q_{transfer}$ (in kW)
184.5	0	0	1	0	0	3	9	27	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

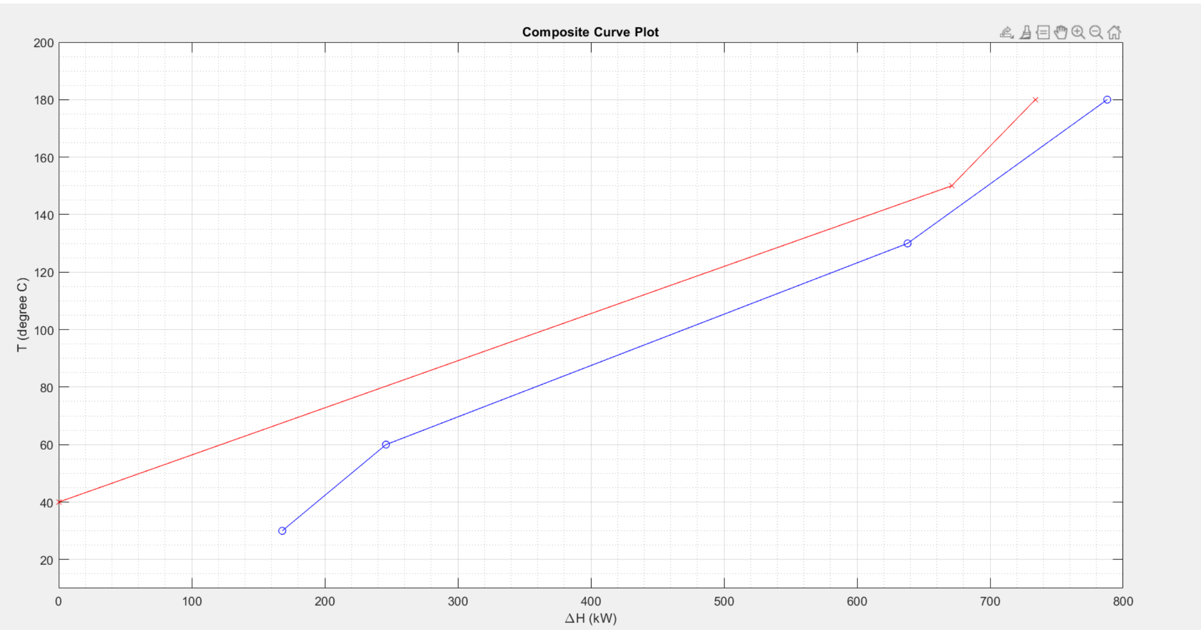
Hence from the above Problem Table we obtain the following:

Pinch point: i) cold stream pinch = 145.5°C – 4.5°C = **141°C**

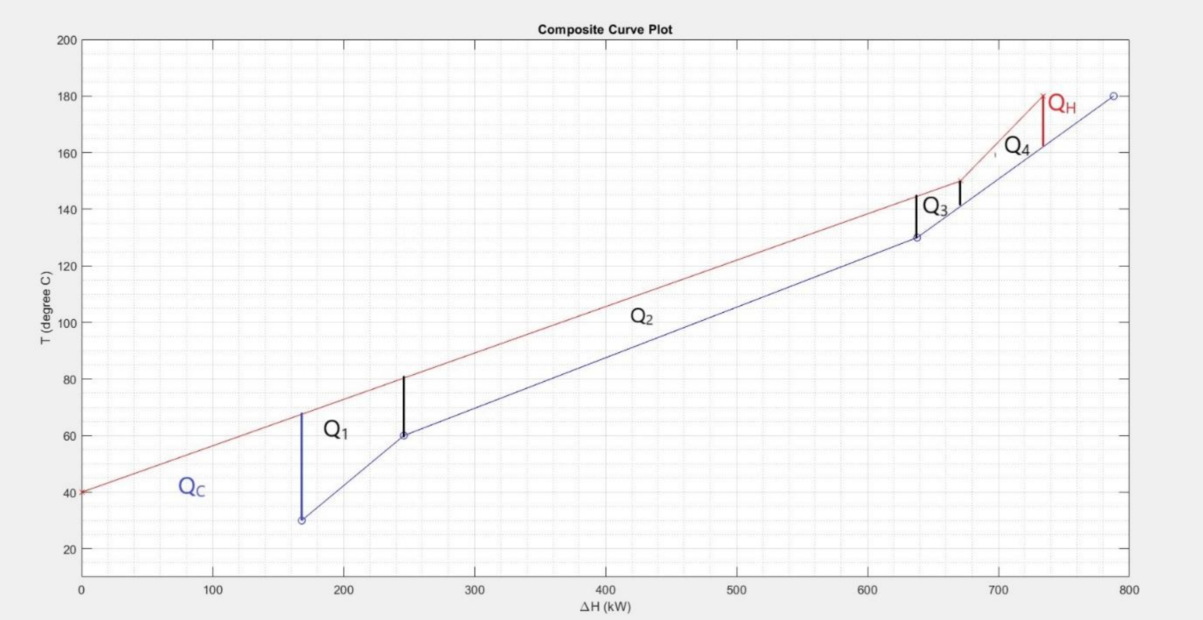
ii) hot stream pinch = 145.5°C + 4.5°C = **150°C**

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

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



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



Plot 2: Showing different segments of the heat exchanger network used for Spaghetti Design

[Excerpts over]

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CH4010 ASSIGNMENT-2

(1)

H1 : 180° $\xrightarrow{F c_p = 2.1}$ 40°

H2 : 180° $\xrightarrow{F c_p = 4}$ 40°.

C1 : 180° $\xleftarrow{F c_p = 3}$ 60°

C2 : 130° $\xleftarrow{F c_p = 2.6}$ 30°

even Roll

$\Rightarrow (\Delta T)_{min} = 9°C$

In the earlier SAT / assignment, the pinch was found to be at $T_{hot\ pinch} = 150°C$

$T_{cold\ pinch} = 141°C$

Also, $Q_h = 54$ kW, $Q_c = 168$ kW

Spaghetti Design

[H1]: 180° $\xrightarrow{F c_p = 2.1}$ 150°

[C1]: 180° $\xleftarrow{F c_p = 3}$ 141°

From the composite curve plot, the first segment of interest is $T_{h,entry} = 180°$, $T_{h,exit} = 150°$.

$3(T_{exit} - 141) = 2.1(180 - 150)$ [energy balance]

$\Rightarrow T_{c,exit} = 162°$.

H1: 180° $\xrightarrow{F c_p = 2.1}$ 150°

C1: 162° $\xleftarrow{F c_p = 3}$ 141°

$$LMTD = \frac{(180-162) - (150-141)}{\ln\left(\frac{180-162}{150-141}\right)}$$

$= 12.98625$

$U = 0.001\ MW/m^2\,°C = 1\ kW/m^2\,°C$

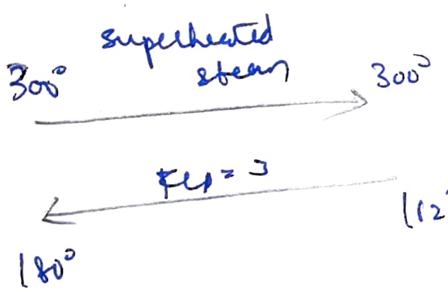
$Q = 2.1 \times 30 = \underline{63\ kW}$

$\therefore\ A_1 = \underline{4.852}\ m^2 \quad \left(\because A = \frac{Q}{U \times LMTD} \right)$

Now, just the cold stream remains, for which we can use a heater

$Q = 3(180 - 162) = \underline{54\ kW}$

– matches with Q_{hmin} calculated in PTA

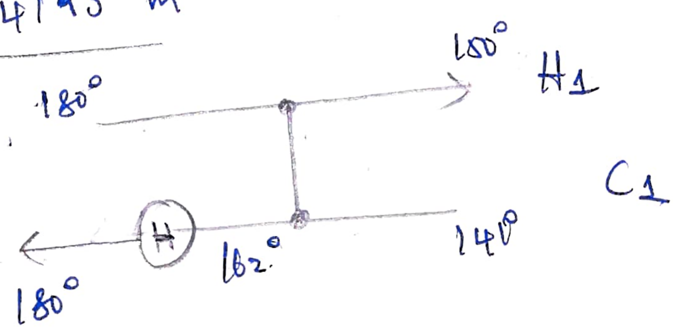


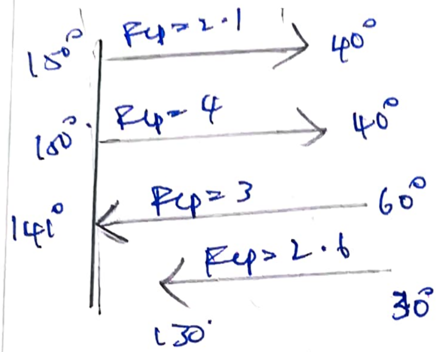
$$LMTD = \frac{(\Delta T)_1 - (\Delta T)_2}{\ln\left(\frac{(\Delta T)_1}{(\Delta T)_2}\right)}$$

$= \underline{128.79°}$

$A_2 = \frac{54}{1 \times 128.79} \quad \left(\frac{Q}{U \times LMTD} \right)$

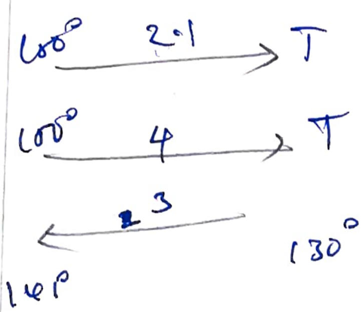
$= \underline{0.4193\ m^2}$





We can use the composite curve to divide the segments

Segment (a) : Tcold goes from ~~1300~~ 130° to 141°



energy balance :

$6.1(T_h - 100) = 3(141 - 130)$

$\Rightarrow T_h = \underline{144.859°C}$

Need to split the cold stream so that both hot streams can be cooled.

$x(141 - 130) = 2.1(150 - T)$

$\Rightarrow x = \underline{1.033}$ (for match with H1)

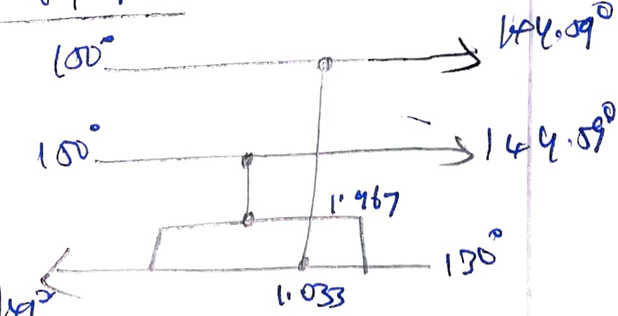
$\Rightarrow Q_{a1} = 1.033(11) = \underline{11.361\ kW}$

with H_2 then, $3 - x = 1.967$ goes (overall ΔH match so no need to check this)

$Q_{a2} = 1.967(141 - 130) = \underline{21.64\ kW}$

$$LMTD = \frac{(\Delta T)_1 - (\Delta T)_2}{\ln\left(\frac{(\Delta T)_1}{(\Delta T)_2}\right)}$$

(same for both) $= 11.571°$



A_{a1} (match with H_1) = $\underline{0.9819}$ m^2

A_{a2} (match with H_2) = $\underline{1.8702}$ m^2

Next, segment ①: Till $T_C = 60^\circ$

144.59° $\xrightarrow{2.1}$ T_h

~~144~~ 144.59° $\xrightarrow{4}$ T_h ~~80°~~

$130^\circ \xleftarrow{3}$ 60°

$130^\circ \xleftarrow{2.6}$ 60°

overall balance

$(6.1)(144.59 - T)$

$= 5.6\,(70)$

$\Rightarrow T_h = \underline{80.328^\circ}$

Match C_1 with ~~H_1~~ H_2 (split H_2 to x & $4-x$)

$x(144.59 - 80.327) = 3(130 - 60)$

$\Rightarrow x = 3.2678$.

$Q_{b1} = 3(70) = \underline{210\text{ kW}}$. C_1 done!

Match remainder of $H_2 = 4 - 3.2678$

$= 0.7321$ W/°C

with C_2 (split C_2 into y & $2.6 - y$)

$y(130 - 60) = 0.7321\,(144.59 - 80.327)$

$\Rightarrow y = 0.6721$; $Q_{b2} = 0.7321(144.59 - 80.327)$

$= \underline{47.05\text{ kW}}$ H_2 done!

Match remainder of C_2 with H_1

$\rightarrow 2.6 - 0.6721 = 1.9279$

$$Q_{b_3} = \cancel{0.x224}\,(2.6 - 0.6721)(70)$$

$$= (2.1)(144.59 - 80.327)$$

$$= \underline{139.951 \text{ kW}} \qquad C_2 \;\&\; H_1 \text{ done!}$$

LMTD (same for all 3 hex)

$$= \frac{(144.59 - \overset{130}{\cancel{80.328}}) - (80.328 - 60)}{\ln\left(\frac{144.59 - 130}{80.328 - 60}\right)}$$

$$= \underline{17.3007\ ^\circ C}$$

$$A = \frac{Q}{U \times LMTD}$$

$$A_{b1} = \underline{12.138 \text{ m}^2}, \quad A_{b2} = \underline{2.719 \text{ m}^2}$$

$$A_{b3} = \underline{8.0893 \text{ m}^2}$$

Segment (c) : till T cold = 30°

80.328 $F_{cp} = 2.1 \rightarrow T_{h,out}$ $\qquad 2.1(80.328 - T) = (2.6)(60 - 30)$

80.328 $F_{cp} = 4 \rightarrow T_{h,out}$

$F_{cp} = 2.6$ ← 60° $\qquad$ 30°

$$\Rightarrow T_{h,out} = \underline{67.541^\circ}$$

Split C_2 & match with H_1, match remaining with H_2

$$x(30) = 2.1(80.328 - 67.541)$$

$$\Rightarrow x = 0.8951 \text{ kW/}^\circ C$$

H_1 ~~ticked off~~ done!

Remaining $2.6 - \cancel{8}\,0.895 = 1.705$

will ~~take~~ off ~~the~~ complete H_2

$Q_{C1} = 0.895(60-30) = \underline{26.85\ kW}$

$Q_{C2} = 1.705(60-30) = \underline{51.15\ kW}$

LMTD $= 28.06°C$

$A_{c1} = \underline{0.957\ m^2}$ & $A_{c2} = \underline{1.823\ m^2}$

Just the 2 hot streams remain, use ~~cold~~ coolers to both.

H_1 : 67.54 (C) → 40° F_{cp} 2.1

H_2 : 67.54 (C) → 40 4

water in cooler : 30° ← 15°

$Q_{cooler\,1} = (67.54-40)(2.1) = 57.834$

$Q_{cooler\,2} = (67.54-40)(4) = 110.16$

$Q_{cooling\ utility} =$ 168 kW (as calculated in earlier ~~PI~~ SAT / Assgn)

$$LMTD = \frac{(67.54 - 30) - (40 - 15)}{\log\left(\frac{(67.54 - 30)}{(40 - 25)}\right)}$$

$$= \underline{30.846^{\circ}}$$

$A_{cooler-1} = \underline{1.8768}$ m^2

$A_{cooler-2} = \underline{3.5712}$ m^2

total Area of heat exchangers = 0.419 + 4.892 + 1.87 + 0.982 + 12.138 + 2.719 + 8.089 + 0.957 + 1.828 + 1.877 + 3.571 =

$$\Rightarrow \boxed{A_{total} = 38.879 \ m^2}$$

Total no of heat exchangers = 8 + 1 heater + 2 coolers

$$= \boxed{11}$$

$$\text{capital cost} = 11 \times \left(40000 + \frac{500 \times 38.879}{11}\right)$$

$$= ₹\,459439.56$$

$$= \boxed{₹\,4.594 \times 10^5}$$

Utility cost = Ƶ 120×54 + 10×(57.89 + 110.16)

$= \boxed{Ƶ\ 8160}$

Total cost = 0.25 × capital cost + ~~tot~~ Utility cost

$= \boxed{Ƶ\ 123020.43} = \boxed{Ƶ\ 1.23 \times 10^5}$

comparing with HW1 targets

	HW1 Target	Spaghetti
Area	39.01 m^2	38.879 m^2
capital cost	Ƶ 259503.7	Ƶ 459439.86
Utility cost	Ƶ 8160/year	Ƶ 8160 ~~484~~/year
Total cost	Ƶ 73036/year	Ƶ 123020.43/year

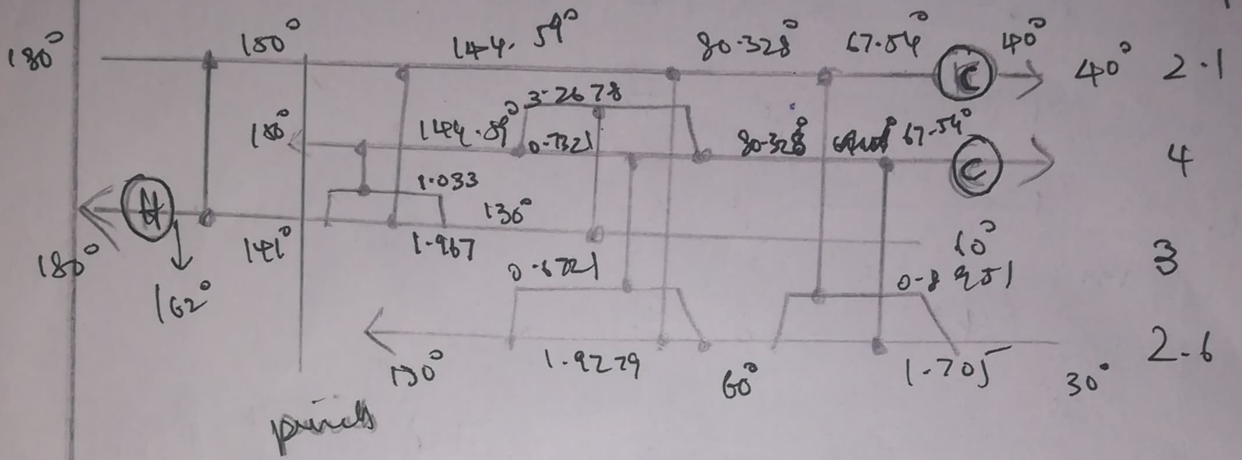
Utility costs same! → max heat recovered in Spaghetti

As expected Spaghetti design costs more because it has more capital cost - due to number of heat exchangers (11) way above minimum (6).

However, total area is slightly lesser, probably because of more exchangers used (more coolers particularly)

$$\left(\frac{\text{cost}}{\text{Area}}\right)_{\text{spaghetti}} = ₹\,3164.177$$

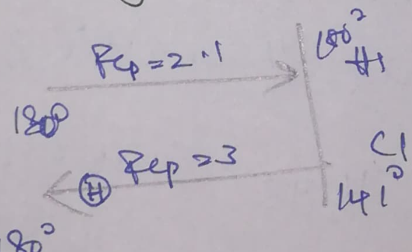
$$\left(\frac{\text{cost}}{\text{Area}}\right)_{\text{target}} = ₹\,1872.238$$



[Spaghetti design HEN]

2nd part : MER using PDM rules

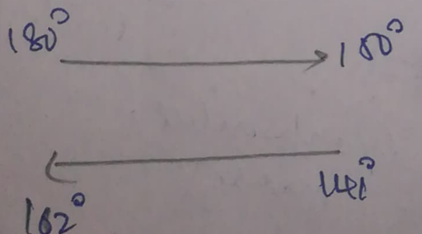
Above pinch :



Tick off H1.

$(T_{c1\,exit} - 141)\,3 = 2.1\,(180-150)$

$\Rightarrow T_{c1\,exit} = 162°$



Same as in spaghetti design

LMTD = 12.984 °

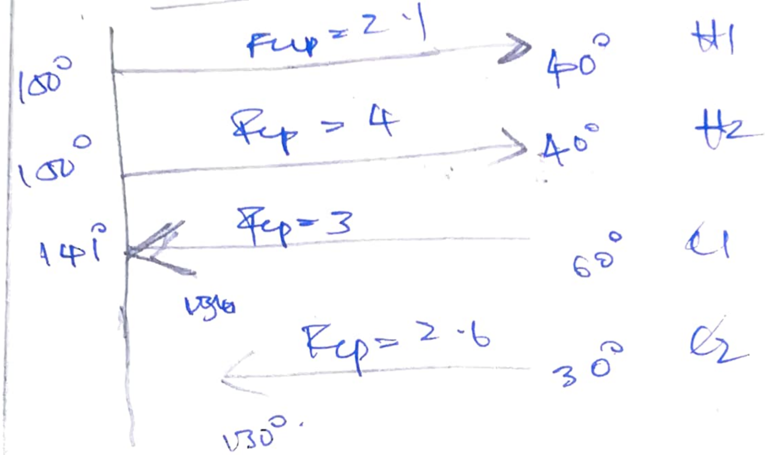
Q = 63 kW A1 = 4.852 m²

Heater value will also be same as Spaghetti design.

$\Rightarrow Q_H = 54$, $A_2 = 0.4192\ m^2$, $LMTD = \cancel{1...}\ 128.79$

C_1 ticked off.

Below pinch.



We notice that $(Fc_p)_{H_1} \leq (Fc_p)_{C_2}$ & $(Fc_p)_{C_1}$ & since we are below pinch, chances are that ~~they~~ (ΔT) will fall below pinch if we try to use tick off heuristic. & In fact, they actually do. ~~If you~~ Since $(Fc_p)_{C_1} \geq (Fc_p)_{C_2}$, it is enough if we show intersection for C_2 & H_1. Tick of H_1: $\{T_{centry} + 8$
$(30)\,2.6$
$= 38$ } $2.1(180-40)$

$\Rightarrow$. $T_{centry} = 41.154^\circ > T_{hexit}$!
match can't be allowed (infeasible match)

To ensure feasible matches, we will resort to splitting streams.

Split C_2 into 2 parts : C_{21} (flow rate : $F c_p = x$)

and C_{22} ($F c_p = 2.6 - x$)

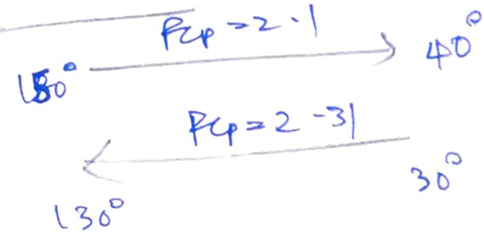
Use C_{21} to tick off H_1 & itself

i.e. $(x)(130 - 30) = 2.1\,(180 - 40)$

$\Rightarrow$ $\underline{x = 2.31}$ & $\underline{Q = 231\text{ kW}}$; $\underline{LMTD = 14.427^\circ C}$

$\Rightarrow$ $Area_3 = \underline{16.012\text{ m}^2}$

So split of C_2 (C_{21}) & H_1 are now ticked off.



We now have $N_c = 2$ (C_{22}, C_1)

$N_H = 1$ (H_2)

Split H_2 so that $N_h = 2$ & we can make feasible matches.

conditions for split (we have 3 'variables' : x, $T_{H21,exit}$, $T_{H22,exit}$)

(i) ensure both streams leave at same temp after being cooled.

(ii) Ensure C_{22} as well as C_1 is ticked off.

Let the common temp be T_{emit} ((i) satisfied)

(ii) $\left\{ \begin{array}{l} x\,(150 - T_{emit}) = 243. \xrightarrow{C_1} (1) \\ \& \\ (4-x)\,(150 - T_{emit}) = (2.6-2.31)(100) \\ \qquad = (0.29)(100) \\ \qquad = 29. \quad (2) \end{array} \right.$ balance for C_{22}

$\frac{(1)}{(2)} \Rightarrow \frac{x}{4-x} = \frac{243}{29}$

$\Rightarrow x = 3.5735$ & $T_{emit} = \underline{81.999^\circ C}$

The 2 exchangers:

with C_1

$150 \xrightarrow{F_{cp} = 3.5735} 81.999$ H_{21}

$141 \xleftarrow{F_{cp} = 3} 60$

$Q = 243$ kW ;

LMTD = $14.547^\circ C$; $A_4 = 16.708\ m^2$

with C_{22}

$150 \xrightarrow{F_{cp} = 0.4265} 81.998$ H_{22}

$130 \xleftarrow{F_{cp} = 0.29} 30$

$Q = 29$ kW

LMTD = $33.489^\circ C$; $A_5 = 0.866\ m^2$

Since T_{emit} is same for both H_{21}, we mix them back at $T = \underline{81.999^\circ C}$

Cooler :

$81.999^\circ \xrightarrow{H_2,\ F_{cp} = 4} 40^\circ$

$30^\circ \longleftarrow 15^\circ$

$Q_c = 4(81.999 - 40)$

$\simeq \underline{168\ kW}$

LMTD = ~~38.48~~ $\underline{90.94^\circ C}$

$A_6 = \underline{1.85\ m^2}$

Total Area = $A_1 + A_2 + A_3 + A_4 + A_5 + A_6$

$= 0.42 + 4.85 + 16.01 + 16.71 + 0.87 + 1.85 \ m^2$

$= \boxed{40.704 \ m^2}$

Total no of exchangers = $\boxed{6}$

Capital cost = $\text{₹}6 \times \left(40000 + 500 \times \frac{40.704}{6}\right)$

$= \text{₹} \ 260352.1 = \boxed{\text{₹} \ 2.603 \times 10^5}$

Utility cost = $120 \times 54 + 10 \times 168$

$= \boxed{\text{₹} \ 8160} \ / \text{year}$

Total cost = $260352.1 \times 0.25 + 8160$

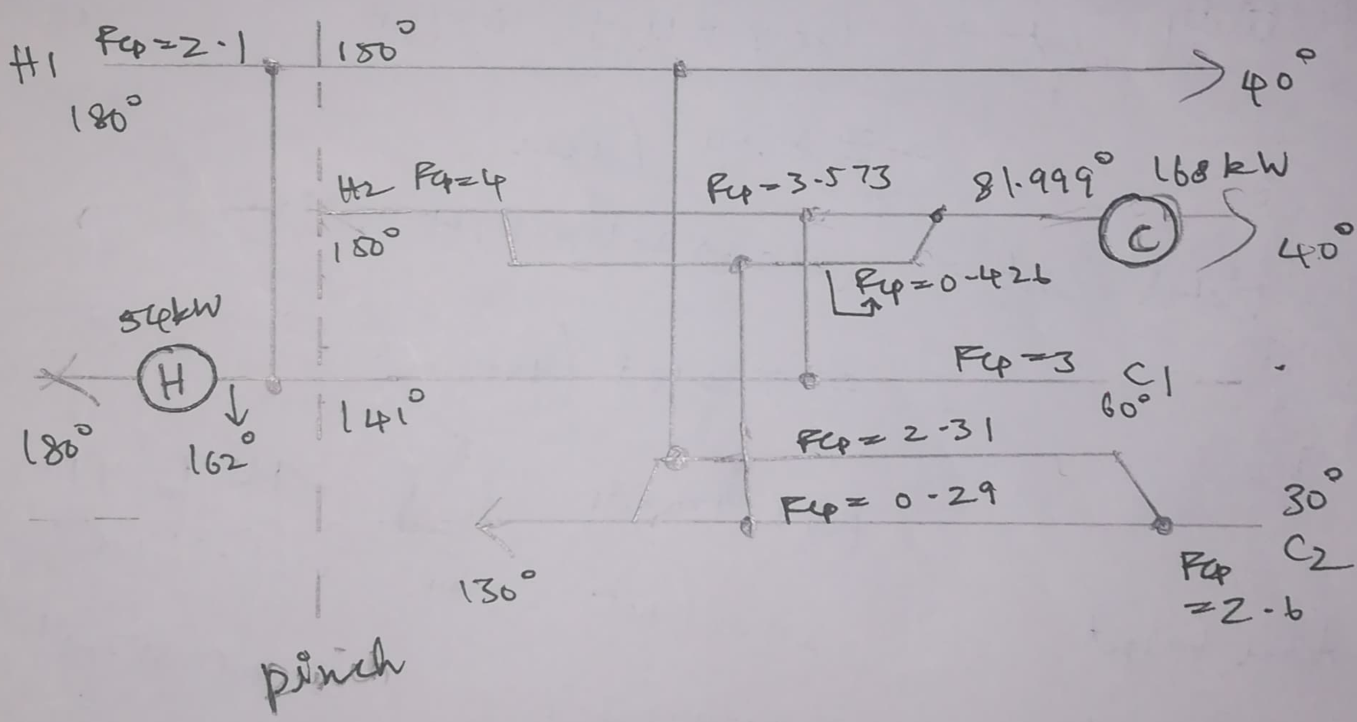
$= \boxed{\text{₹} \ 73248 \ / \text{year}}$

	HW 1 targets	MER - PDM
Area target	39.01 m²	40.704 m²
Capital cost	₹ 259803.7	₹ 260352.1
Utility cost	₹ 8160 / year	₹ 8160 / year
Total cost	₹ 73036 / year	₹ 73248 / year
No of heat exchangers	6	6

MER using PDM rules comes & very close to the set targets

Maybe the area is slightly higher because of the splitting we did. ~~Splitting towers Q~~ hence

$$\left(\frac{\text{total cost}}{\text{total area}}\right)_{target} = ₹\ 1822.238 \ /year/m^2 \qquad \left(\frac{\text{Cost}}{\text{area}}\right)_{MER} = ₹\ 1299.56 \ /year/m^2$$



Spaghetti Design Calculations

U	1		Annualization factor	0.25				
HEX	Q (kW)	Thentry	Thexit	Tcentry	Tcexit	LMTD	Area	
heater	54	300	300	162	180	128.7904253	0.419285827	
1	63	180	150	141	162	12.98425537	4.852030264	
2	21.64	150	144.59	130	141	11.57082102	1.870221651	
3	11.361	150	144.59	130	141	11.57082102	0.981866367	
4	210	144.59	80.328	60	130	17.30069985	12.13823728	
5	47.05	144.59	80.328	60	130	17.30069985	2.719543163	
6	139.951	144.59	80.328	60	130	17.30069985	8.089325933	
7	26.85	80.328	67.54	30	60	28.05963735	0.956890485	
8	51.15	80.328	67.54	30	60	28.05963735	1.822903103	
cooler	57.894	67.54	40	15	30	30.84634047	1.876851488	
cooler	110.16	67.54	40	15	30	30.84634047	3.571250214	**HW1 values**
						Area Target	38.87911995	39.01
						Cost Hex	459439.56	259503.7
						Utility Costs	8160.54	8160
						Total Cost	123020.43	73036
						Cost/Area	3164.177331	1872.238

MER Calculations

U	1		Annualization factor	0.25				
HEX	Q (kW)	Thentry	Thexit	Tcentry	Tcexit	LMTD	Area	
heater	54	300	300	162	180	128.7904253	0.419286	
1	63	180	150	141	162	12.98425537	4.85203	
2	231	150	40	30	130	14.42695041	16.0117	
3	243	150	81.999	60	141	14.54397082	16.70795	
4	29	150	81.999	30	130	33.48954552	0.865942	
cooler	168	150	81.999	15	30	90.93981194	1.847376	**HW1 values**
						Area Target	40.70429	39.01
						Cost Hex	260352.1	259503.7
						Utility Costs	8160	8160
						Total Cost	73248.04	73036
						Cost/Area	1799.516	1872.238

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(2) HEN Evolution $(\Delta T)_{pinch} = 10°$ (from diagram across BB)

Consider the 4 streams, (ΔT)s can be found. $Q_{absorbed}$ or $Q_{released}$ ~~cu~~ for each stream can be found by adding Q_i + exchangers across the ~~s~~ ties.

So $(FCp)_1 = \dfrac{A + C + F}{180 - 40} = \dfrac{60+78+142}{140}$

$= 2\,kW/°C$

$(FCp)_2 = \dfrac{B + D + E + CU}{150 - 40} = 4\,kW/°C$

$(FCp)_3 = \dfrac{HU + A + B + E}{180 - 60} = 3\,kW/°C$

$(FCp)_4 = \dfrac{C + D + F}{130 - 30} = 2.6\,kW/°C$

Step 1. Loop: D - FF - AA - BB - D. Heat exchanger with lowest Q is D (= 40 kW)

Remove D. Increase F by 40, decrease A by 40, increase B by 40

~~TAC~~ ~~180~~

CU	160 kW	E	90 kW
A	20 kW	F	182 kW
B	190 kW	HU	60 kW
C	78 kW		

~~temperatures across exchangers A, B, D, F will change~~

$$T_{AC} = 180 - \frac{20}{2} = 170^\circ$$

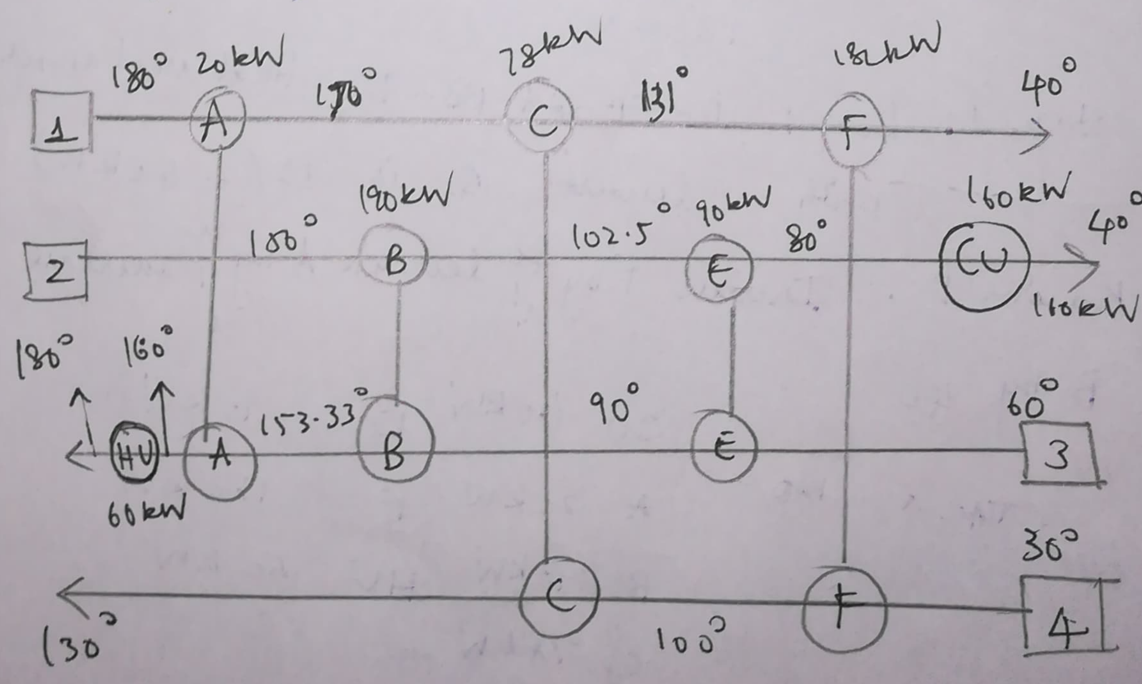
$$T_{CF} = 170 - \frac{78}{2} = 131^\circ$$

$$T_{BA,ent} = 131 - \frac{182}{2} = 40^\circ$$ (exit will be same because we reallocated the heat!!)

$$T_{BE} = 180 - \frac{190}{4} = 102.5^\circ$$
(∵ no D)

$$T_{BA} = 90 + \frac{190}{3} = 153.33^\circ$$

$$T_{FC} = 30 + \frac{182}{2.6} = 100^\circ$$
(∵ no D)



Temperature violation across BB!!
(hot stream: 180°, cold stream: 153.3°)

To bring back to pinch level (≥10°C), reduce TBA to 140° [Step 2]

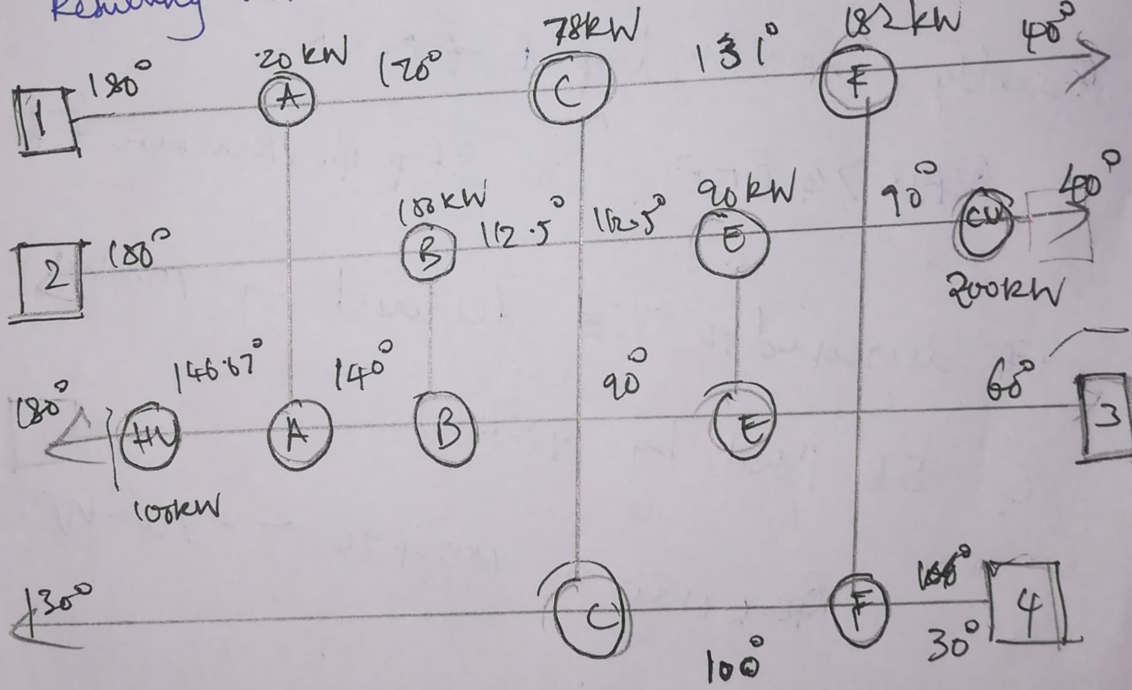
$Q_B = (140-90) \times 3 = 150$ kW

Use utility path HU – BB – CU

~~Increase~~ Increase HU & CU by $\xrightarrow{190-150}$ ~~40kW~~ = 40 kW

decrease B by 40kW

Resulting HEN:

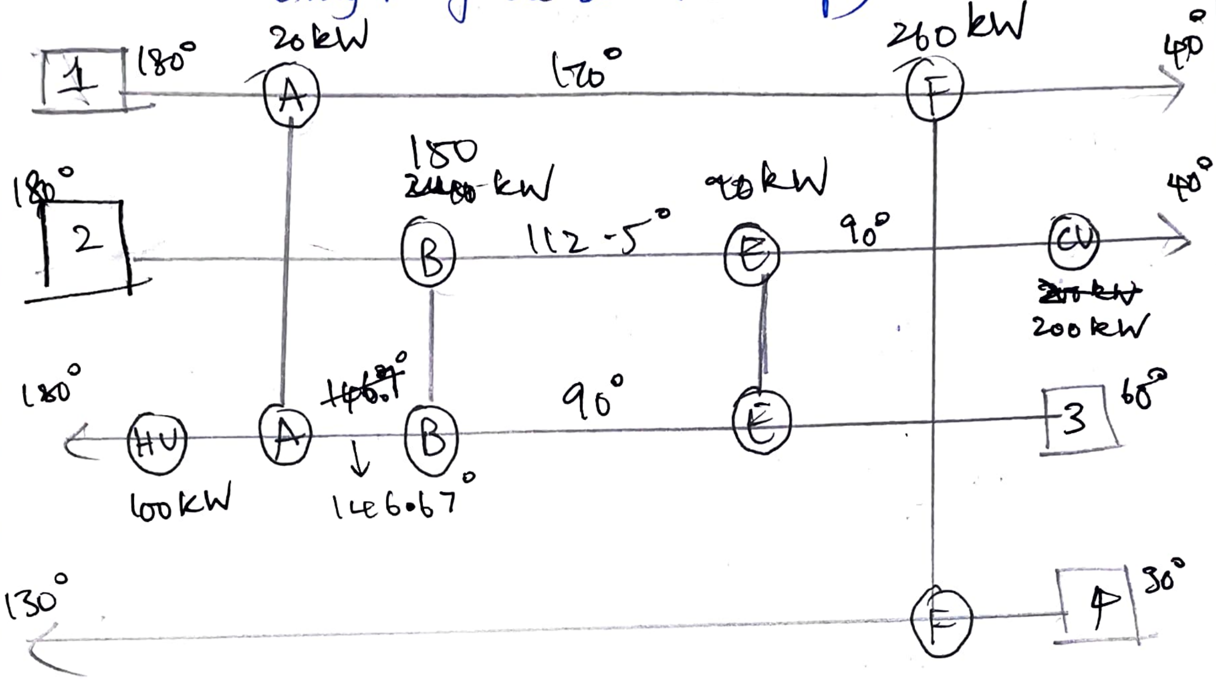


~~Cons~~ Step 3. Remove CE from loop C–FF–C

Reduce C to 0. Increase F by 78

$Q_{FF} = 260$ kW ($\because Q_C = 78$ kW, $Q_F = 182$ kW)

Recalculating Temperatures we get,
(only temperatures for streams 1 & 4 change because only they are in the loop)



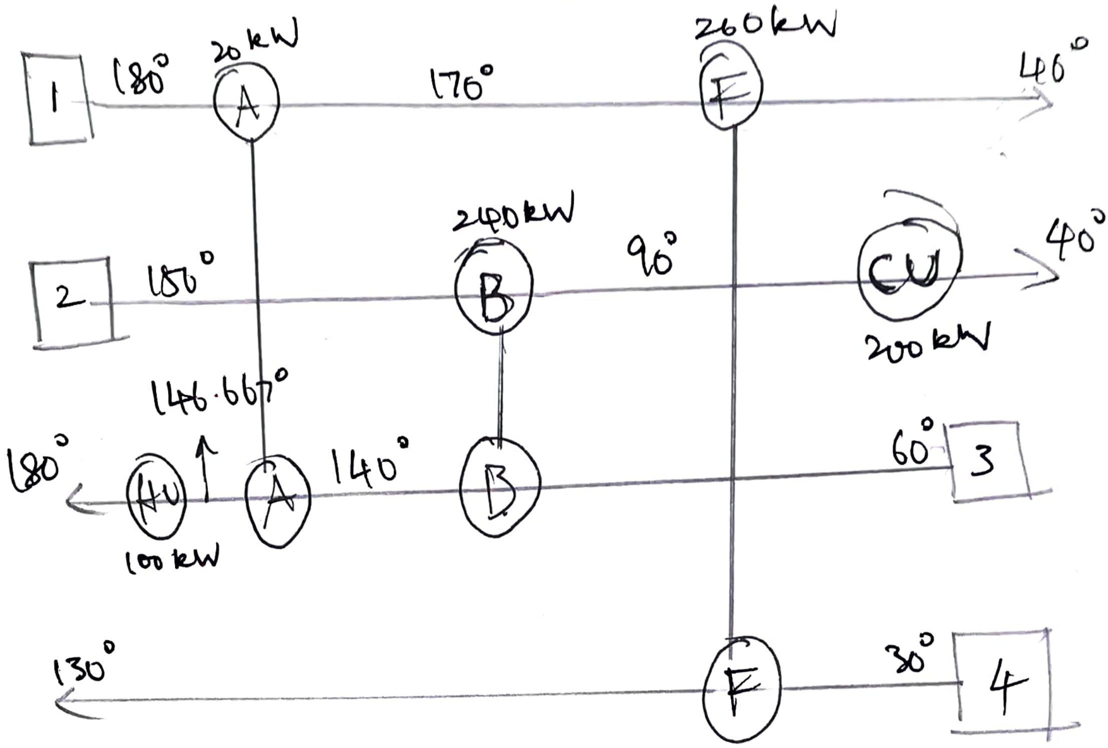
Finally, consider loop B-E-E-B.

$Q_{BB} > Q_{EE}$ So Step 4. Remove EE

~~EE~~ decreased to 0 ⇒ decreased by 90 kW

& BB ↑sed by 90 kW

$Q_{BB,new} = 180 + 90 = 240$ kW



There are no more loops and no temperature violations.

HEN Evolution is completed and reduced to absolute minimum number of HENs

(Absolute minimum : 4 streams + 2 utilities - 1

= 5 exchangers.

(HU , AA , BB , FF , CU))

Excel Sheet used for computing temperatures

	FCp		**Pinch**	10	(look at left of Hex B)					
H1	2									
H2	4									
C1	3									
C2	2.6									
			180		150		60		30	
CU	160		**H1**		**H2**		**C1**		**C2**	
A	60		TAC	150	TBD	112.5	TEB	90	TFD	84.61538
B	150		TCF	111	TDE	102.5	TBA	140	TDC	100
C	78		Texit	40	TE-CU	80	TA-HU	160	Texit	130
D	40				Texit	40	Texit	180		
E	90									
F	142									
HU	60									
Remove D										
Loop	D-FF-AA-BB-D									
			180		150		60		30	
CU	160		**H1**		**H2**		**C1**		**C2**	
A	20		TAC	170	TBD	102.5	TEB	90	TFD	100
B	190		TCF	131	TDE	102.5	TBA	153.3333	TDC	100
C	78		Texit	40	TE-CU	80	TA-HU	160	Texit	130
D	0				Texit	40	Texit	180		
E	90									
F	182									
HU	60									
Use HU-B-CU loop		Decrease B by 40			delta T negative across B!!!!					
			180		150		60		30	
CU	200		**H1**		**H2**		**C1**		**C2**	
A	20		TAC	170	TBD	112.5	TEB	90	TFD	100
B	150		TCF	131	TDE	112.5	TBA	140	TDC	100
C	78		Texit	40	TE-CU	90	TA-HU	146.6667	Texit	130
D	0				Texit	40	Texit	180		
E	90									

F	182									
HU	100									
Remove C	C-FF-C									
CU	200		**H1**		**H2**		**C1**		**C2**	
A	20		TAC	170	TBD	112.5	TEB	90	TFD	130
B	150		TCF	170	TDE	112.5	TBA	140	TDC	130
C	0		Texit	40	TE-CU	90	TA-HU	146.6667	Texit	130
D	0				Texit	40	Texit	180		
E	90									
F	260									
HU	100									
Remove E	E-BB-E									
CU	200		**H1**		**H2**		**C1**		**C2**	
A	20		TAC	170	TBD	90	TEB	60	TFD	130
B	240		TCF	170	TDE	90	TBA	140	TDC	130
C	0		Texit	40	TE-CU	90	TA-HU	146.6667	Texit	130
D	0				Texit	40	Texit	180		
E	0									
F	260									
HU	100									