Advanced Heat Transfer & Energy Recovery

Assignment: Heat Integration

Deadline **Friday 26/04/2023 at 18:00**

A list of streams and stream sets follows this page. Your name is listed on the final page(s) against the two stream sets. For the two sets of streams associated with your assignment numbers:

(i) Calculate the minimum hot and cold utility loads, as well as the hot and cold pinch temperatures.

(5 marks each set)

(ii) Draw the grand composite curve for the set.

(3 marks each set)

(iii) Using the grand composite curve, choose which hot and cold utilities you will aim to use, giving reasons for your choice. You also have a heat pump with a 35° lift and a 55% efficiency at your disposal, which you should use to reduce utility demand if possible.

(7 marks each set)

(iv) Design a heat exchangers network (HEN) that will achieve maximum energy recovery (MER) while using no more exchangers than necessary.

(10 marks each set)

(v) Check if your HEN design achieved the aim: $N_{min(MER)} = N_{min}$. If your response is 'no', then adapt your network so that it has the minimum number of units.

(5 marks each set)

(vi) Identify the threshold temperature for both of your stream sets, with a problem table as evidence. If one cannot be calculated, please provide a problem table to demonstrate this.

(10 marks each set)

(vii) Find the capital cost of both heat exchanger networks that achieve maximum energy recovery (assuming carbon steel exchangers working at ambient pressure in single-pass mode, with negligible tube wall resistance). Use suitable heat transfer coefficients for your chosen utilities from part (iii).

(10 marks each set)

Streams Data:

Stream ID	Supply Temp. (°C)	Target Temp. (°C)	Heat load (kW)	Heat transfer coefficient (W $m^{-2}K^{-1}$)
A	400	80	1280	50
B	300	120	360	35
C	120	119.9	800	4000
D	200	40	480	500
E	140	20	600	700
F	180	60	240	200
G	-20	120	420	250
H	80	500	420	10
I	20	200	360	100
J	60	320	1040	600
K	99.9	100	650	3000
L	50	150	500	350
M	10	120	220	150
N	30	180	600	400
O	250	100	150	80
P	220	30	950	75
Q	150	70	1250	300

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Stream set	Streams						ΔT_{min} (°C)	Student allocated
1	B	C	E	F	G	J	15	Ali, Usman
2	B	C	E	G	H	J	25	Arshad, Sohaib
3	F	G	H	C	D	E	20	Khalid, Muhammad Shafique
4	A	B	C	F	G	H	15	Lukha, Muhammad Muzammil
5	A	C	D	F	H	I	10	Nazir, Hafiz Tahir
6	A	C	E	F	H	J	15	Rafique, Mansab
7	B	C	D	F	G	H	5	Yousaf, Jamil
8	A	B	D	F	G	I	25	Ali, Usman
9	A	B	E	F	G	J	20	Arshad, Sohaib
10	A	D	E	F	I	J	20	Khalid, Muhammad Shafique
11	A	B	C	E	G	J	15	Lukha, Muhammad Muzammil
12	A	C	D	E	F	J	15	Nazir, Hafiz Tahir
13	B	C	D	E	F	G	10	Rafique, Mansab
14	A	B	H	J	L	N	10	Yousaf, Jamil

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Stream set	Streams						ΔT_{min} (°C)	Student allocated
29P	B	D	F	H	I	J	25	Ferguson, Kerr
1P	A	B	C	H	I	J	20	Holland, Thomas
3P	A	B	E	G	H	J	15	MacKinnon, Kieran
4P	A	C	D	G	H	I	20	McLellan, William
17P	B	C	D	G	H	I	10	Modi, Mihir
6P	A	D	E	F	H	J	10	Sherrit, Dylan
7P	B	C	D	F	H	I	20	Taylor, Stephen
8P	B	C	E	F	G	J	15	Ali, Usman
18P	B	C	E	G	H	J	25	Arshad, Sohaib
10P	F	G	H	C	D	E	20	Khalid, Muhammad Shafique
11P	A	B	C	F	G	H	15	Lukha, Muhammad Muzammil
14P	A	C	D	F	H	I	10	Nazir, Hafiz Tahir
15P	A	C	E	F	H	J	15	Rafique, Mansab
22P	B	C	D	F	G	H	5	Yousaf, Jamil
23P	B	C	E	F	G	H	20	Stuart, Jonathan D.
24P	A	C	E	H	I	J	10	., Joyal Kanatte Jose
25P	A	B	G	H	I	J	20	Deschamps, Thomas R.
26P	C	E	F	G	I	J	10	Jose, Albin
19P	B	D	E	G	I	J	30	Karn, Rishav
20P	C	D	E	H	I	J	15	Kollammavukudy Sajeev, Sajith
21P	A	B	D	F	H	I	10	., Sukhchain Singh
31P	A	E	K	L	M	N	15	Anaedu, Blessing O.
32P	C	D	E	K	L	N	20	Bialucki, Bartlomiej T.
39P	A	B	H	J	L	O	15	Boyle, Peter
40P	A	D	H	K	M	O	20	Caveney, Ben M.
44P	A	B	H	J	L	P	10	Kwasie, Samuel
45P	A	D	H	K	M	P	15	Long, James R.
47P	B	E	K	L	M	O	25	MacKenzie, Ross
48P	C	D	F	K	L	O	30	Milne, Hannah K.
57P	B	E	K	L	N	O	15	Modi, Mihir Himansu
63P	A	B	H	J	L	Q	15	Orji, Kamsiyonna Samuel
64P	A	D	H	K	M	Q	20	Serrate, Diego
66P	B	E	K	L	M	O	30	Usman, Temitope Funmilayo

These are all pinched

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Stream set	Streams						ΔT_{min} (°C)	Student allocated
67T	C	D	F	K	L	O	5	Ferguson, Kerr
68T	A	B	G	J	L	O	10	Holland, Thomas
69T	A	D	G	K	M	O	15	MacKinnon, Kieran
70T	A	B	D	L	M	O	20	McLellan, William
2T	A	B	D	G	I	J	10	Modi, Mihir
5T	A	C	E	F	I	J	25	Sherrit, Dylan
9T	F	G	I	B	D	E	10	Taylor, Stephen
12T	A	B	D	F	G	I	25	Ali, Usman
13T	A	B	E	F	G	J	20	Arshad, Sohaib
16T	A	D	E	F	I	J	20	Khalid, Muhammad Shafique
27T	A	B	C	E	G	J	15	Lukha, Muhammad Muzammil
28T	A	C	D	E	F	J	15	Nazir, Hafiz Tahir
30T	B	C	D	E	F	G	10	Rafique, Mansab
33T	A	B	H	J	L	N	10	Yousaf, Jamil
34T	A	D	H	K	M	N	30	Stuart, Jonathan D.
35T	A	B	C	L	M	N	10	., Joyal Kanatte Jose
36T	B	C	D	K	L	M	15	Deschamps, Thomas R.
37T	A	E	K	L	M	O	5	Jose, Albin
38T	C	D	E	K	L	O	10	Karn, Rishav
41T	A	B	C	L	M	O	25	Kollammavukudy Sajeev, Sajith
42T	A	E	K	L	M	P	30	Sure, Venkata Rajesh
43T	C	D	E	K	L	P	5	., Sukhchain Singh
46T	A	B	C	L	M	P	20	Anaedu, Blessing O.
49T	A	B	G	J	L	O	5	Bialucki, Bartlomiej T.
50T	A	D	G	K	M	O	10	Boyle, Peter
51T	A	B	D	L	M	O	15	Caveney, Ben M.
52T	B	E	K	L	M	P	20	Kwasie, Samuel
53T	C	D	F	K	L	P	25	Long, James R.
54T	A	B	G	J	L	P	30	MacKenzie, Ross
55T	B	D	H	K	M	P	5	Milne, Hannah K.
56T	A	B	D	L	M	P	10	Modi, Mihir Himansu
58T	C	D	F	K	M	O	20	Orji, Kamsiyonna Samuel
59T	A	B	G	J	M	O	25	Serrate, Diego
60T	A	D	G	K	N	O	30	Usman, Temitope Funmilayo
61T	A	E	K	L	M	Q	5	., Sukhchain Singh
62T	C	D	E	K	L	Q	10	

65T	A	B	C	L	M	Q	25	

These are all thresholded