Reg. No.

MANIPAL INSTITUTE OF TECHNOLOGY

MANIPAL

A Constituent Institution of Manipal University

V SEMESTER B.TECH. (CHEMICAL ENGINEERING)

END SEMESTER EXAMINATIONS, NOVEMBER 2017

SUBJECT: PINCH TECHNOLOGY [CHE 4021]

REVISED CREDIT SYSTEM

Time: 3 Hours MAX. MARKS: 50

Instructions to Candidates:

- Answer **ALL** questions.
- Use of Graph sheet is permitted.
- Missing data may be suitably assumed.

1A.	Explain the importance of energy integration in process industries.	**04**
1B.	List out the basic heuristic rules to be followed for data collection in Pinch Technology and explain the same	**04**
1C.	A process flow diagram of a typical process is shown in Figure 1C. Extract the stream data for this process	**02**

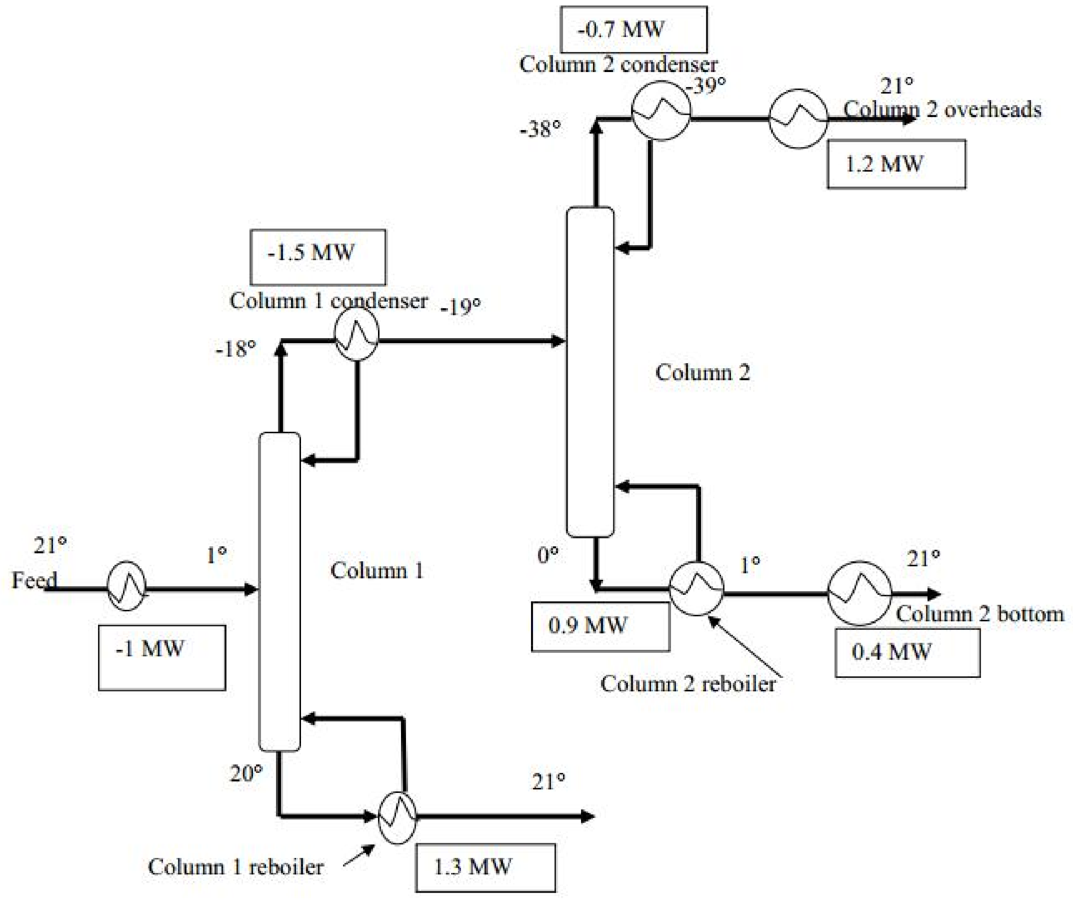

Figure: 1C: Process flow diagram for Problem 1C.

2A.	Define the threshold problem in pinch design method and explain how this will affect the energy integration process.	**04**

2B.	Find the minimum utilities required for four stream case for load integration with ΔT_{min} =10 ^{0}C by constructing composite curves. The stream data given in Table 2B. Table 2B: The stream data for the process. stream | T_S (°C) | T_t (°C) | CP (kW/°C) C1 | 25 | 160 | 2 C2 | 40 | 135 | 3 H1 | 135 | 40 | 2 H2 | 90 | 40 | 4	**06**

Table 2B: The stream data for the process.

stream	T_S (°C)	T_t (°C)	CP (kW/°C)
C1	25	160	2
C2	40	135	3
H1	135	40	2
H2	90	40	4

3A. The stream data for the process is given in Table 3A. For this process compute the amount of hot and cold utility required considering ΔT_{min} as 10°C by making use of Problem Table Algorithm. **06**

Table 3A: The stream data for the process

Stream	Supply Temp. (^{O}C)	Target Temp. (^{O}C)	Heat Capacity Flow rate (MW $^0C^{-1}$)
Hot	415	25	0.5
Hot	50	20	1.2
Cold	25	380	0.18
Cold	30	420	0.6
Cold	90	120	10
Hot	300	35	1

3B Discuss the Capital-energy trade-off for threshold problems in HENS **04**

4A. For a process the stream data together with utility data and heat transfer coefficients are shown in Table 4A, where ΔT_{min} is selected as 10 °C. From PTA the following results are found: Amount of hot utility: 12.9MW, Amount of cold utility: 8.90MW, Pinch point: 150°C , Hot pinch: 155°C and Cold pinch: 145°C

Table 4A: The stream and utility data for the process

Stream	Supply Temp. (^{O}C)	Target Temp. (^{O}C)	H (MW)	Heat Capacity Flow rate (MW $^0C^{-1}$)	Film transfer coefficients h (Mw. m^{-2}. $^oC^{-1}$)
C1	25	185	32	0.25	0.0008
H1	260	50	-31.5	0.16	0.0009
C2	145	235	27	0.32	0.0009
H2	190	70	-30.0	0.26	0.0010
HU	250	249			0.0040
CU	25	35			0.0010

(i) Construct a balanced cold and hot composite curves. **02**

(ii) Evaluate the unknown temperatures of balanced hot and cold composite curves **02**

(iii) Evaluate a Cumulative enthalpies at different temperature intervals along with known interval temperatures of BHCC and BCCC **02**

(iv) Target the heat exchange area for this process **02**

4B	Discuss the subset and loops affecting the minimum number of units in HENS	**02**
5A	For a particular process, the total area targeted found to be 6520.636 m^2 using Pinch Design Methods. Also, the present problem requirement of minimum hot and cold utility are found to be 12.9 MW and 8.90 MW, respectively. The Cost of hot utility=150 ($\$.kW^{-1}.y^{-1}$), Cost of cold utility =15 ($\$.kW^{-1}.y^{-1}$), Installed capital cost = 40000 $\times$ $A^{0.83}$, Rate of interest = 12% and Plant life = 6 year. Conversion of the capital cost into annual capital cost using conversion factor as: = $\frac{i(1+i)^n}{(1+i)^n - 1}$. Target the cost for this process (Total Annual Cost).	**04**
5B.	Discuss the different feasibility criteria in detail for Pinch Design Methods of Heat Exchange Networks (HENS) Synthesis.	**06**

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