**BIRLA INSTITUTE OF TECHNOLOGY & SCIENCE, PILANI**

**DEPARTMENT OF CHEMICAL ENGINEERING**

**SEMESTER-I, 2017-2018**

**PROCESS DESIGN PRINCIPLES I (CHE F314)**

**ASSIGNMENT-1**

**TOTAL MARKS 15**

**LAST DATE FOR SUBMISSION: 24-11-2017 (FRIDAY) BEFORE 5 PM**

**(REQUEST FOR EXTENSION OF DEADLINE WILL NOT BE ENTERTAINED)**

**Q.** For the problem given with *ΔTmin* = 100C/0F or K, depending upon the units in a given problem, carry out the Energy Integration Analysis (Heat Exchanger Network Synthesis) using Pinch Technology by determining the following:

1. Net amount of heat available in the streams based on I law.
2. Shifted temperature scales diagram with net heat in respective intervals.
3. Construction of cascade diagram.
4. Minimum hot and cold utilities requirement.
5. Pinch temperature.
6. Temperature-Enthalpy diagram and Area estimation in *priori*.
7. Hot end Design (Design above the Pinch).
8. Cold end Design (Design below the Pinch).
9. Identify the loops and break them and propose final network after breaking the loops.
10. Area estimation based on final network and comparison with prior estimated area using temperature-enthalpy diagram.

If the heat transfer coefficient values for hot and cold utilities are not given, assume the values to be *h*HU = 0.3 kW/m2K and *h*CU = 0.35 kW/m2K.

**Instructions:**

1. Start solving the problem with a *ΔTmin* = 100C/0F or K, depending upon the units in a given problem. If no pinch is identified, then take *ΔTmin* = 200C/ 0F or K accordingly.
2. Each student has to submit the assignment separately.
3. Use only A4 size white papers and graph sheets for (b), (c) and (f).
4. On the first page, write ID number and full name of group members. Put signature against your name.
5. **Submit the assignment on or before the deadline to the undersingned.**
6. Give justification for the assumptions made.
7. Include all the alternatives of networks you tried at various stages of the network design.

**The data for 10 problems are given below:**

**Problem No. 1**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stream No** | **Condition** | ***FC*p (kW/oC)** | ***h* (kW/m2 oC)** | **Source Temperature (oC)** | **Target Temperature (oC)** |
| 1 | Hot | 2 | 0.4 | 180 | 40 |
| 2 | Hot | 4 | 0.55 | 150 | 40 |
| 3 | Cold | 3 | 0.75 | 60 | 180 |
| 4 | Cold | 2.6 | 0.65 | 30 | 130 |
| 5 | Hot Utility | - | 0.5 | - | - |
| 6 | Cold Utility | - | 0.5 | - | - |

**Problem No. 2**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stream No** | **Condition** | ***FC*p (kW/oC)** | ***h* (kW/m2 oC)** | **Source Temperature (K)** | **Target Temperature (K)** |
| 1 | Hot | 4 | 0.4 | 395 | 343 |
| 2 | Hot | 6 | 0.55 | 405 | 288 |
| 3 | Cold | 5 | 0.75 | 293 | 493 |
| 4 | Cold | 10 | 0.65 | 353 | 383 |
| 5 | Hot Utility | - | 0.5 | - | - |
| 6 | Cold Utility | - | 0.5 | - | - |

**Problem No. 3**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stream No** | **Condition** | ***FC*p (kW/oC)** | ***h* (kW/m2 oC)** | **Source Temperature (oC)** | **Target Temperature (oC)** |
| 1 | Hot | 4.87 | 0.1 | 159 | 77 |
| 2 | Hot | 0.434 | 0.04 | 267 | 80 |
| 3 | Cold | 2 | 0.01 | 26 | 127 |
| 4 | Cold | 4.18 | 0.5 | 118 | 265 |
| 5 | Hot Utility | - | 0.5 | - | - |
| 6 | Cold Utility | - | 0.5 | - | - |

**Problem No. 4**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stream No** | **Condition** | ***FC*p (kW/oC)** | ***h* (kW/m2 oC)** | **Source Temperature (oC)** | **Target Temperature (oC)** |
| 1 | Hot | 21.3 | 0.1 | 300 | 200 |
| 2 | Hot | 213.2 | 1.0 | 200 | 190 |
| 3 | Cold | 106.6 | 0.1 | 160 | 180 |
| 4 | Cold | 21.3 | 1.0 | 180 | 190 |
| 5 | Hot Utility | - | 0.5 | - | - |
| 6 | Cold Utility | - | 0.5 | - | - |

**Problem No. 5**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stream No** | **Condition** | ***FC*p (kW/oC)** | ***h* (kW/m2 oC)** | **Source Temperature (oC)** | **Target Temperature (oC)** |
| 1 | Hot | 3.0 | 0.35 | 170 | 45 |
| 2 | Hot | 1.2 | 0.45 | 150 | 30 |
| 3 | Cold | 2.0 | 0.1 | 20 | 135 |
| 4 | Cold | 4.0 | 0.1 | 80 | 150 |
| 5 | Hot Utility | - | 0.5 | - | - |
| 6 | Cold Utility | - | 0.5 | - | - |

**Problem No. 6**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stream No** | **Condition** | ***FC*p (kW/oC)** | ***h* (kW/m2 oC)** | **Source Temperature (oC)** | **Target Temperature (oC)** |
| 1 | Hot | 2 | 0.35 | 490 | 110 |
| 2 | Hot | 5 | 0.45 | 420 | 220 |
| 3 | Cold | 3 | 0.1 | 120 | 410 |
| 4 | Cold | 7 | 0.1 | 35 | 430 |
| 5 | Hot Utility | - | 0.5 | - | - |
| 6 | Cold Utility | - | 0.5 | - | - |

**Problem No. 7**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stream No** | **Condition** | ***FC*p (kW/oC)** | ***h* (kW/m2 oC)** | **Source Temperature (oC)** | **Target Temperature (oC)** |
| 1 | Hot | 18 | 0.4 | 270 | 160 |
| 2 | Hot | 35 | 0.55 | 220 | 70 |
| 3 | Cold | 50 | 0.75 | 160 | 210 |
| 4 | Cold | 20 | 0.65 | 60 | 205 |
| 5 | Hot Utility | - | 0.5 | - | - |
| 6 | Cold Utility | - | 0.5 | - | - |

**Problem No. 8**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stream No** | **Condition** | ***FC*p (W/oC)** | ***h* (W/m2 oC)** | **Source Temperature (oC)** | **Target Temperature (oC)** |
| 1 | Hot | 24012.16 | 2390.0 | 169.2 | 30.5 |
| 2 | Hot | 19032.7 | 3125.0 | 144 | 31.5 |
| 3 | Cold | 15537.6 | 572.6 | 38.4 | 147.6 |
| 4 | Cold | 2712789.2 | 3533.0 | 230.7 | 234.1 |
| 5 | Hot Utility | - | 1000 | - | - |
| 6 | Cold Utility | - | 1000 | - | - |

**Problem No. 9**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stream No** | **Condition** | ***FC*p (kW/oC)** | ***h* (kW/m2 oC)** | **Source Temperature (oC)** | **Target Temperature (oC)** |
| 1 | Hot | 3.0 | 0.4 | 170 | 45 |
| 2 | Hot | 1.2 | 0.55 | 150 | 30 |
| 3 | Cold | 2.0 | 0.75 | 20 | 135 |
| 4 | Cold | 4.0 | 0.65 | 80 | 150 |
| 5 | Hot Utility | - | 0.5 | - | - |
| 6 | Cold Utility | - | 0.5 | - | - |

**Problem No. 10**

|  |  |  |  |  |  |
| --- | --- | --- | --- | --- | --- |
| **Stream No** | **Condition** | ***FC*p (kW/oC)** | ***h* (kW/m2 oC)** | **Source Temperature (oC)** | **Target Temperature (oC)** |
| 1 | Hot | 10 | 0.2 | 170 | 40 |
| 2 | Hot | 15 | 0.2 | 120 | 60 |
| 3 | Cold | 20 | 0.2 | 25 | 160 |
| 4 | Cold | 15 | 0.2 | 45 | 117 |
| 5 | Hot Utility | - | 0.3 | - | - |
| 6 | Cold Utility | - | 0.3 | - | - |

**The problem number (to be solved and submitted individually as assignment) is shown against the name and ID number of the student below:**

|  |  |  |
| --- | --- | --- |
| **ID** | **Name** | **Problem No.** |
| 2014A1B10525P | HARSH KANODIA . | 1 |
| 2014B1A10027P | DEEPTANSHU AGARWAL . |
| 2014B1A10106P | KUSHAL TRIPATHI . |
| 2014B1A10221P | SUHAIL KHAN . |
| 2014B1A10290P | SHUBHAM CHOUDHARY . |
| 2014B1A10297P | UMANG GARG . |
| 2014B1A10422P | STUTI MAHESHWARI . |
| 2014B1A10470P | NIPUN VATS . |
| 2014B1A10492P | AESHVARYA MITTAL . |
| 2014B1A10510P | KRITI KHANDELWAL . |
| 2014B1A10636P | SHARAD YADAV . |
| 2014B1A10846P | AYUSH GUPTA . | 2 |
| 2014B2A10019P | NIKHIL SANGHI . |
| 2014B2A10309P | KUNAL SHARMA . |
| 2014B2A10616P | VISHAL MISHRA . |
| 2014B2A10618P | SRI HARSHA PANDA . |
| 2014B2A10826P | ABHISHEK BHARDWAJ . |
| 2014B2A10888P | KREETI JHA . |
| 2014B3A10493P | RITIK KUMAR . |
| 2014B3A10532P | NIRABHI SHARMA . |
| 2014B3A10652P | DASWANI KARAN |
| 2014B3A10687P | ANKIT GUPTA . |
| 2014B3A10703P | SINHA VAIBHAV | 3 |
| 2014B3A10709P | ASHIT SHRIVASTAVA . |
| 2014B3A10747P | SAMEER KUMAR SINGH . |
| 2014B3A10790P | MADHUR KHANDELWAL . |
| 2014B4A10648P | NAVANDAR BHAVESH |
| 2014B4A10738P | HARSHIL BHATT . |
| 2014B4A10803P | SHREYASH ANAND . |
| 2014B4A10804P | SHIVAM ANAND . |
| 2014B5A10832P | VIKASH SINGH . |
| 2014B5A10845P | RAGHAV SHARMA . |
| 2014B5A10874P | PRANATI JAIN . |
| 2014B5A10878P | L SAI SUHAS REDDY . | 4 |
| 2014B5A10881P | NITIN MANKANI . |
| 2015A1PS0372P | RAHUL DASWANI . |
| 2015A1PS0480P | UMMAY AIMAN HAIDRY . |
| 2015A1PS0482P | VARUN JAYANT DEOSKAR . |
| 2015A1PS0495P | K SURYA SIDHARTHA . |
| 2015A1PS0498P | ANIRUDH GARG . |
| 2015A1PS0502P | PARAS GUPTA . |
| 2015A1PS0509P | ANINDYA SEN . |
| 2015A1PS0511P | DEBARCHAN BASU . |
| 2015A1PS0517P | SATYAKI ROY . |
|  |  |  |
| 2015A1PS0521P | SUMEGH GARG . | 5 |
| 2015A1PS0522P | YADUL SETHI . |
| 2015A1PS0524P | BHUTADA ANUP ANIL . |
| 2015A1PS0526P | KAPIL SACHAR . |
| 2015A1PS0535P | MUSKAN AGARWAL . |
| 2015A1PS0538P | PRANSHU AGARWAL . |
| 2015A1PS0548P | AKSHANSH SHARMA . |
| 2015A1PS0561P | RAGHAVENDRA |
| 2015A1PS0570P | KANISH KATARIA . |
| 2015A1PS0575P | SUDHIR GUPTA . |
| 2015A1PS0592P | DEBOLINA CHAKRABARTY . |
| 2015A1PS0599P | SATRAJIT NEOGY . | 6 |
| 2015A1PS0604P | PALAK . |
| 2015A1PS0612P | PARIDHI GUPTA . |
| 2015A1PS0617P | ARCHIT GARG . |
| 2015A1PS0635P | ANMOL GUPTA . |
| 2015A1PS0653P | ARIHANT RANKA . |
| 2015A1PS0659P | AKHEEL SHIBLI A . |
| 2015A1PS0667P | GAURAV SHARMA . |
| 2015A1PS0669P | TANMAY JAIN . |
| 2015A1PS0675P | HAROON KHAN . |
| 2015A1PS0679P | TARUN BALODA . | 7 |
| 2015A1PS0687P | SARANSH MOHANTY . |
| 2015A1PS0688P | SHIVAM KHETAN . |
| 2015A1PS0692P | SAURABH VERMA . |
| 2015A1PS0695P | SHIVAM VEDANT . |
| 2015A1PS0703P | ANCHIT BANSAL . |
| 2015A1PS0706P | SHRESHTHA DHANKAR . |
| 2015A1PS0707P | SATYAM KUMAR SINGH . |
| 2015A1PS0712P | AYUSHI AGARWAL . |
| 2015A1PS0716P | PRANAV MAGADI . |
|  |  |  |
| 2015A1PS0717P | SHIVAM JAISWAL . | 8 |
| 2015A1PS0718P | ADITYA ABHISHEK . |
| 2015A1PS0720P | SHREYA PATHAK . |
| 2015A1PS0721P | PALLAVI TRIVEDI . |
| 2015A1PS0722P | P ABHINAV . |
| 2015A1PS0727P | MONARK SHRIMAL . |
| 2015A1PS0728P | AVINASH PATI . |
| 2015A1PS0729P | SANGAI HIMANK |
| 2015A1PS0731P | PRATIK BANSAL . |
| 2015A1PS0746P | JOSHI NEEL AJIT . |
| 2015A1PS0748P | ABHISHEK MURTI . | 9 |
| 2015A1PS0753P | NUKALA BALA SAI |
| 2015A1PS0761P | SHIVAM KUMAR . |
| 2015A1PS0762P | MUDIT GATTANI . |
| 2015A1PS0765P | AMAN KUMAR ANAND . |
| 2015A1PS0768P | SAHIL DESAI . |
| 2015A1PS0769P | ANSHUMAN SHUKLA . |
| 2015A1PS0770P | AAKASH AGGRAWAL . |
| 2015A1PS0772P | PRABHAT GARG . |
| 2015A1PS0774P | CHARUL PASSEY . |
| 2015A1PS0775P | SHUBHAM DUBEY . | 10 |
| 2015A1PS0778P | ARPITA BHADRESH SHAH . |
| 2015A1PS0782P | SHUBHAM GUPTA . |
| 2015A1PS0786P | GAURAV JAIN . |
| 2015A1PS0787P | VIDUSHI CHITRANSHI . |
| 2015A1PS0791P | KABIR AHUJA . |
| 2015A1PS0796P | ASHWAR GUPTA . |
| 2015A1PS0800P | PRIYANKA PRAJAPAT . |
| 2015A1PS0803P | DIVYANSH GUPTA . |
| 2015A1PS0814P | PARIMAL S ATHALEY . |

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