Quiz Questions

For Process Integration

Fill in the blanks type Questions

1. _____ is the key parameter used in the Pinch Technology. (ΔT_{min})
2. In onion diagram pinch technology in applied at _____. (the boundary of separator and heat exchanger network)
3. _____ works as a link between process and pinch analysis. (data extraction)
4. Composite curve consists of _____. (hot composite curve and cold composite curve)
5. To maintain temperature cross in a heat exchanger the value of F_T factor should be more than or equal to ____. (0.8)
6. _____ is a plot of the overall variation of heat supply and demand across the entire process. (Grand Composite Curve)
7. _____ is used for designing heat exchanger network when feasibility criteria do not match. (stream splitting)
8. While designing heat exchanger network number of stream as well as CP criterion should be satisfied for _____. (Pinch match)
9. The temperature that a process stream is available at, before any heating or cooling is performed, is called _____. (Source Temperature)
10. The temperature up to which the process stream is to be heated or cooled is _____. (Target Temperature)
11. _____ is the temperature at which the ability to transfer heat between the process streams is most constrained. (Pinch temperature)
12. In composite curves the areas where the hot and cold composite curves do not _____ show the minimum utility requirements by reading the enthalpy axis. (overlap)
13. These are referred to _____ when either heating or cooling utility is required, but not both. (threshold problems)
14. A source of heating or cooling that does not come from a process stream is known as _____. (utility)
15. The distillation column should not be placed _____ with the background process. (across the pinch)
16. If _____ does not meet in a pinch match the temperature difference between a hot and cold stream of that match becomes lesser than ΔT_{min}. (CP criterion)
17. For a case when feed temperature is equal to temperature of effect a single effect evaporator is represented by a _____ in T-H diagram. (Rectangle)
18. In T-H diagram for a case when feed temperature is lower than the temperature of effect the upper line of trapezoid is _____ than the below line. (longer)

19. When a pair of hot and cold process streams is matched a _____ is created to handle the transfer of heat from the hot stream to the cold stream. (heat exchanger)
20. In _____ hot stream moves from left to right whereas cold stream moves from right to left. (grid diagram)

True/False Type Questions

1. Thermodynamics in process integration (PI) is used to analyze driving forces in the design and the existing driving forces are then reduced so that energy is saved while capital is spent (True/~~False~~)
2. Thermodynamics in PI is not only used to analyze driving forces to reduce them but to distribute them differently to generate different options in design for lower capital cost at a constant level of energy recovery (True/~~False~~)
3. Pinch technology identifies different options leading to:
   (i) Energy savings (True/~~False~~) (ii) Capital savings (True/~~False~~) (iii) Preferred integration alternatives in the interest of given constraints in plant layout, control, safety, etc. (True/~~False~~) (iv) Optimal heat exchanger design (~~True~~/False) (v) Optimal heat exchanger network design (True/~~False~~)
4. In pinch technology the design task is to find the best network of exchangers, heaters and coolers that can handle exchange of heat amongst hot and cold streams and utilities at minimum operating and annualized capital cost (True/~~False~~)
5. The total cost of a HEN tends to dominate by the amount of heating and cooling utility demands and by the number of capital items in the network (True/~~False~~)
6. In pinch technology the prime aim is to produce a design which consumes minimum quantities of utilities (hot and cold) and employs the smallest possible number of units (heater, coolers and exchangers) (True/~~False~~)
7. The hot composite curve can be shifted vertically but not horizontally (~~True~~/False)
8. The pinch design method says that cold utility can be placed above the pinch (~~True~~/False)
9. Capability to set performance target prior to design is the prime aim of targeting step in pinch design (True/~~False~~)
10. Minimum hot utility requirement predicted by composite curve is a function of ΔT_{min} (True/~~False~~)
11. Minimum cold utility requirement predicted by composite curve is a function of ΔT_{min} (True/~~False~~)
12. Minimum cold utility requirement predicted by composite curve is not a function of ΔT_{min} (~~True~~/False)
13. Because of the “kinked” nature of composite curves they approach most closely at one point of enthalpy axis called pinch (True/~~False~~)
14. The point at which any composite curve experiences change in slope is either the supply or target temperature of a hot or cold stream (True/~~False~~)
15. The section above the pinch in conventional composite curve is heat sink (True/~~False~~)
16. The section below the pinch in conventional composite curve is heat source (True/~~False~~)

17. For a minimum utility target to meet that should not be any heat flow through pinch (True/~~False~~)
18. External heating in excess demands external cooling in excess of the same amount (True/~~False~~)
19. An inefficient process requires more than the minimum external heating and therefore more than the minimum external cooling (True/~~False~~)
20. An efficient process requires more than the minimum external heating and therefore more than the minimum external cooling (~~True~~/False)
21. For every unit of external heat pushed to a process extra heat transfer area(proportional to heat pushed) to be provide in heaters as well as coolers (True/~~False~~)
22. Composite curve indicate what type of site services (Boiler, cooling tower, steam heater, cooler, steam and gas turbine, etc.) should be used where (above the pinch or below the pinch) (True/~~False~~)
23. Composite curve can never indicate what type of site services (Boiler, cooling tower, steam heater, cooler, steam and gas turbine, etc.) should be used where (above the pinch or below the pinch) (~~True~~/False)
24. A simple relationship exists between a number of streams (process plus utilities) in a problem and the minimum number of heat exchanger unit (i.e. heaters, coolers, heat exchanger) (True/~~False~~)
25. Once the hot and cold composite curves are known one can estimate exactly how much external heating and cooling are required for a given ΔT_{min} (True/~~False~~)
26. If a designer goes for best energy recovery designing the (heat source) and (heat sink) sectional separately he will require more units than if the pinch division is ignored (True/~~False~~)
27. There exists a trade-off between energy recovery and number of units (True/~~False~~)
28. It is always possible to maintain ΔT_{min} in a heat exchanger network while loop breaking (~~True~~/False)
29. In conventional problem (except threshold) increasing ΔT_{min} increases requirement of hot and cold utilities (True/~~False~~)
30. For a given value of ΔT_{min} utilities predicted by composite curves are minimum that are required to solve the heat recovery problem (True/~~False~~)
31. In general ΔT_{min} occurs at only one point termed the “pinch” and heat exchanger at the pinch need to operate at ΔT values down to ΔT_{min} (True/~~False~~)
32. The surplus heat in a problem table analysis can be cascaded down (True/~~False~~)
33. The surplus heat in a problem table analysis can be cascaded up (~~True~~/False)
34. In a problem table analysis full heat interchange within any temperature interval is possible (True/~~False~~)
35. In a problem table analysis full heat interchange within any temperature interval is not possible (~~True~~/False)
36. Problem table analysis ensures that within any interval hot streams and cold streams are at least ΔT_{min} apart (True/~~False~~)
37. Problem table analysis ensures that within any interval hot streams and cold streams are less than ΔT_{min} apart (~~True~~/False)

38. In a T-H diagram hot stream is represented by the line with the arrow head pointing to the left and cold stream vice-versa (True/~~False~~)
39. In a T-H diagram hot stream is represented by the line with the arrow head pointing to the right and cold stream vice-versa (~~True~~/False)
40. The T-H diagram is used to represent heat exchange as one is interested in enthalpy changes of streams and a given stream can be plotted anywhere on the enthalpy axis provided it has the same slope and runs between the same supply and target temperature (True/~~False~~)
41. While placing composite curves hot composite curve is always kept above the cold composite curve (True/~~False~~)
42. While placing composite curves cold composite curve is always kept below the hot composite curve (True/~~False~~)
43. While placing composite curves hot composite curve is always kept below the cold composite curve (~~True~~/False)
44. The pinch divides energy recovery problem into two thermodynamically distinct regions (Heat source and heat sink) in a MER design (True/~~False~~)
45. "Pinch Design Method" starts the design where the problem is most constrained i.e. pinch point (True/~~False~~)
46. "Pinch Design Method" starts the design where the problem is least constrained (~~True~~/False)
47. Presence of a Loop in a HEN always introduces an extra unit over and above U_{min}. (True/~~False~~)
48. Presence of a Loop in a HEN always reduces U_{min} value by one unity (~~True~~/False)
49. Loop breaking invariably creates ΔT_{min} violation. (True/~~False~~)
50. Loop breaking never creates ΔT_{min} violation. (~~True~~/False)
51. ΔT_{min} restoration after loop breaking is done by energy relaxation through a relaxation path. (True/~~False~~)
52. There exists a correlation between ΔT_{min} and utility usages.(True/~~False~~)
53. There exists no correlation between ΔT_{min} and utility usages.(~~True~~/False)
54. In a grand composite curve where zero heat flow occurs and where the process source profile meets the process sink profile is the pinch point. (True/~~False~~)
55. Grand composite curve can be used to include multiple utilities in the design of HEN. (True/~~False~~)
56. Grand composite curve cannot be used to include multiple utilities in the design of HEN. (~~True~~/False)
57. In a multiple utility design more than one pinch point exists. (True/~~False~~)
58. In a "Threshold" problem there is no trade-off between energy and capital for values of $\Delta T_{min} \leq \Delta T_{threshold}$. (True/~~False~~)
59. In a "Threshold" problem there is no trade-off between energy and capital for values of $\Delta T_{min} \geq \Delta T_{threshold}$. (~~True~~/False)
60. Stream splitting criterion for a HEN design depends on stream number criterion as well as CP criterion. (True/~~False~~)
61. Stream splitting criterion for a HEN design depends on stream number criterion only. (~~True~~/False)

62. For composite curves the criterion above pinch $\Sigma CP_H < \Sigma CP_C$ and below the pinch $\Sigma CP_H > \Sigma CP_C$ holds good. (True/~~False~~)
63. For composite curves the criterion above pinch $\Sigma CP_H > \Sigma CP_C$ and below the pinch $\Sigma CP_H < \Sigma CP_C$ holds good. (~~True~~/False)
64. During data extraction if simple linearization of CP value is not possible streams should be linearized in sections. (True/~~False~~)
65. During data extraction most accurate CP value should be used in the neighborhood of pinch(True/~~False~~)
66. Plus-Minus principle states that energy will be saved by increasing the proportion of the hot composite curve above the pinch or decreasing the proportion of the cold composite curve above the pinch. (True/~~False~~)
67. Plus-Minus principle states that energy will be saved by decreasing the proportion of the hot composite curve above the pinch or increasing the proportion of the cold composite curve above the pinch. (~~True~~/False)
68. The shifting of optimal ΔT_{min} occur for anything which changes the balance of capital cost and energy cost.(True/~~False~~)
69. If capital becomes more expensive or energy becomes cheaper the optimum ΔT_{min} will increase. (True/~~False~~)
70. The flat nature of most cost-ΔT_{min} curves indicates that there is not a single clear-cut best HEN but a range of good HENs. (True/~~False~~)
71. For shell-and-tube exchangers , the number of shells required may be greater than the minimum number of units as the area required for a single heat exchanger may be inconveniently large or there may be temperature cross in a single shell. (True/~~False~~)
72. The Bath formula which is most widely used assumes vertical heat transfer between the composite curves, and the prediction of a minimum value for area is valid only if all film heat transfer coefficients for the streams are equal(True/~~False~~)
73. The Bath formula which is most widely used assumes vertical heat transfer between the composite curves, and the prediction of a minimum value for area is valid only if all film heat transfer coefficients for the streams are different(~~True~~/False)
74. For cases where film heat transfer coefficients are significantly different , mathematical programming route which considers vertical as well as non-vertical heat transfer may be required to achieve a minimum area for the network. (True/~~False~~)
75. For cases where film heat transfer coefficients of streams are almost equal , mathematical programming route which considers vertical as well as non-vertical heat transfer is a must to achieve a minimum area for the network. (~~True~~/False)
76. Experimental and numerical results show that temperature crossover can be achieved in shell and tube heat exchangers(STHX) with L(length)/W(width) $\geq$ 4.62 and can't be achieved any more in STHXs with L/W $\leq$ 3.08.(True/~~False~~)

77. To achieve the minimum capital cost target the design should be directed towards minimum number of units by using "tick off" heuristic while matches are selected for pinch heat exchanger. (True/~~False~~)
78. The "Tick off" heuristic stems from the minimum number of units target equation. (True/~~False~~)
79. The "tick-off" heuristic occasionally punishes the HEN design in terms of increased utility usage. (True/~~False~~)
80. The Pinch Design Method(PDM) requires $CP_H \geq CP_C$ (for cold end design) and $CP_H \leq CP_C$ (for hot end design) for avoiding a T_{min} violation, in pinch matches. (True/~~False~~)
81. The *CP-rules of PDM(Pinch Design Method)* ensure that the temperature profiles of exchangers at the pinch diverge away from the pinch. (True/~~False~~)
82. The design relationship for approaching minimum area around the pinch can therefore be expressed as:
$(CP_H/CP_C)_{\text{pinch match 1}} \approx (CP_H/CP_C)_{\text{pinch match 2}} \approx \ldots\ldots \approx (CP_{\text{Hot composite}}/CP_{\text{Cold composite}})_{\text{pinch}}$
(True/~~False~~)
83. Away from the pinch there is exists more freedom regarding the choice of matches due to the availability of sufficient driving force. (True/~~False~~)
84. The Driving Force Plot provides a rapid and easy to use guideline for designing networks which are close to minimum area. However, it is only a guideline and does not provide quantitative information. (True/~~False~~)
85. Driving Force Plot is only a qualitative tool and does not provide quantitative information due to the fact that it works in temperatures only, neglecting the effect of duty on heat exchange area. (True/~~False~~)
86. Maximum Energy Recovery based designed HENs are not the best HENs as far as total annual cost(TAC) is concerned. (True/~~False~~)
87. The placement of match is as important as the design itself as it can lead to a design which will direct to a higher heat transfer area of HEN than estimated by area target. (True/~~False~~)
88. Remaining problem analysis(RPA) exploits the power of targeting (Energy, Area, shells, cost, etc.) to steer the complete design in correct direction to achieve targets. (True/~~False~~)
89. Maximum Energy Recovery based designed HENs are the best HENs as far as total annual cost(TAC) is concerned. (~~True~~/False)
90. Driving Force Plot is a quantitative tool for designing networks which are close to minimum area. (~~True~~/False)
91. Away from the pinch there is exists less freedom regarding the choice of matches due to the unavailability of sufficient driving force. (~~True~~/False)
92. The *CP-rules of PDM(Pinch Design Method)* ensure that the temperature profiles of exchangers at the pinch converge away from the pinch. (~~True~~/False)

93. The Pinch Design Method(PDM) requires $CP_H \leq CP_C$ (for cold end design) and $CP_H \geq CP_C$ (for hot end design) for avoiding a T_{min} violation, in pinch matches. (~~True~~/False)
94. The "Tick off" heuristic stems from the minimum area target equation. (~~True~~/False)
95. The problem Table analysis(PTA) of a problem provides the hot utility(Q_{Hmin}) and cold utility(Q_{Cmin}) consumption data a prior to the design of HEN. (True/~~False~~)
96. Threshold problems either need hot utility or cold utility and not both. (True/~~False~~)
97. Pinch Design Method (PDM) for HEN synthesis yield improved solutions by utilizing the 'Driving Force Plot' (DFP) and 'Remaining Problem Analysis' (RPA). (True/~~False~~)
98. There are three Important steps in HEN design such as the "targeting" of utility and capital needs prior to synthesis of the HEN, synthesis and optimization of the network and, finally, analysts of network performance under network structure changes and varying operating conditions (i.e. feasibility and resilience analyses). (True/~~False~~)
99. Threshold problems only need hot utility or both utilities. (~~True~~/False)
100. Pinch Design Method (PDM) for HEN synthesis yield inferior solutions when it utilizes 'Driving Force Plot' (DFP) and 'Remaining Problem Analysis' (RPA). (~~True~~/False)
101. Low values of F_T indicate inefficient use of the heat transfer area. (True/~~False~~)
102. Low values of F_T indicate efficient use of the heat transfer area. (~~True~~/False)
103. The F_T correction factor is usually correlated in terms of two dimensionless ratios, the ratio of the two heat capacity flowrates(R) and the thermal effectiveness of the exchanger(P): $F_T = f(R,P)$ (True/~~False~~)
104. During data extraction Stream data should be linearized on the safe side(True/~~False~~)
105. During data extraction utility should not be extracted with steam data(True/~~False~~)
106. During data extraction heat loss from a cold stream can be accounted for by the inclusion of a fictitious cold stream(True/~~False~~)
107. During data extraction heat loss from a hot stream can be accounted for by splitting the hot stream to represent the loss(True/~~False~~)
108. During data extraction enforced matches can be accounted for by leaving parts of the stream data out of the problem(True/~~False~~)
109. Non-isothermal mixing degrades temperature driving forces and might transfer heat across the pinch(True/~~False~~)
110. Non-isothermal mixing improves temperature driving forces and but might transfer heat across the pinch(~~True~~/False)
111. Use of complex columns(side strippers, side-rectifiers and thermally coupled prefractionators) reduce the overall heat duties for the separation at the expense of more extreme temperatures for reboiling and condensing. (True/~~False~~)

Multi-choice questions (tick the write answer/answers)

1. Grand composite curve can be directly plotted using
   a) Problem Table analysis data
   b) Stream data table
   c) Composite curve data

d) Grid diagram

2. Pinch technology is not applied in
   a) Hydrogen management
   b) Carbon-constrained planning
   c) Plant layout
   d) Emission targeting
3. Hot streams are those which have
   a) high enthalpy
   b) high temperature
   c) need to be cooled
4. Cold streams are those which have
   d) low enthalpy
   e) low temperature
   f) need to be heated
5. Area targeting can be carried out through
   a) Composite curve
   b) Balanced composite curves
   c) Balanced hot composite curve
   d) Grand composite curve
6. "Over-shoot" of the hot composite curve in composite curves represents
   a) Minimum amount of extra cooling required
   b) Minimum amount of extra heating required
   c) Minimum amount of cold utility required at specified aT_{min} for the composite curves
7. "Over-shoot" of the cold composite curve in composite curves represents
   d) Minimum amount of extra heating required
   e) Minimum amount of extra cooling required
   f) Minimum amount of hot utility required at specified aT_{min} for the composite curves
8. In section above the pinch
   a) The composite hot gives all its heat to composite cold and fully satisfies its requirement
   b) The composite hot gives all its heat to composite cold with only residual heating required
   c) The composite cold takes heat from composite hot with only residual cooling required
9. In section below the pinch
   a) The composite cold takes partial heat from composite hot and requires further heating
   b) **The composite hot gives heat to composite cold with only residual cooling required**
   c) The composite cold takes heat from composite hot with only residual heating required
10. For low temperature processes ΔT_{min} should be
    a) 10-20°C
    b) 3-5°C
    c) 20-30°C
    d) 10-15°C
11. For integrating exhaust of gas turbine with the background process ΔT_{min} should be

a) 10-20°C
b) 20-25°C
c) 5-10°C
d) 40-50°C

12. Above the pinch which of the following equipments should not be placed
    a) Steam heaters
    b) Furnaces
    c) Coolers
13. Below the pinch which of the following equipments should be placed
    a) Steam heaters
    b) Furnaces
    c) **Coolers**
14. The recommended position of heat pump in background process is
    a) Above the pinch
    b) Below the pinch
    c) Across the pinch
15. The recommended position of heat engine in background process is
    a) Above the pinch
    b) Below the pinch
    c) Across the pinch
16. In background process the endothermic reactor should be placed
    a) Above the pinch
    b) **Below the pinch**
    c) Across the pinch
17. In background process the exothermic reactor should be placed
    a) Above the pinch
    b) Below the pinch
    c) Across the pinch
18. For a minimum utility design select appropriate statements
    a) Do transfer heat across the pinch
    b) Do not use cold utility above the pinch
    c) Do not transfer heat across the pinch
    d) Use cold utility above the pinch
    e) Do not use hot utility below the pinch
19. Select proper pinch design procedure for MER design
    a) Do not divide the problem at pinch and design as one problem
    b) Start at one end of the problem and move to the other end
    c) Immediately adjacent to the pinch obey following constraints: CP hot á CP cold (above the pinch), CP hot ≥CP cold (below the pinch)
    d) Immediately adjacent to the pinch obey following constraints: CP hot ≥ CP cold (above the pinch), CP hot ≤CP cold (below the pinch)
    e) Divide the problem at the pinch and design each part separately

f) Starting the design at the pinch and move away

g) Maximizing exchanger load where possible

h) Supply external heating and external cooling only above and below pinch respectively

i) Do not violate aT_{min} criterion

20. Select the correct statement

a) U_{min} á $U_{min\ MER}$

b) $U_{min} < U_{min\ MER}$

c) $U_{min} = U_{min\ MER}$

d) $U_{min} \geq U_{min\ MER}$

21. For units target select the proper rule

a) $U_{min} = N+L-s$

b) $U_{min} = N-1$

c) $U_{min} = N+L-1$

d) $U_{min} = N+L$

22. Stream splitting above the pinch takes place when:

a) N_H á N_C

b) $N_H \geq N_C$

c) CP_H á CP_C (for every pinch match)

d) $CP_H \geq CP_C$ (for every pinch match)

23. Stream splitting below the pinch takes place when:

e) $N_H \leq N_C$

f) $N_H \geq N_C$

g) $CP_H \leq CP_C$ (for every pinch match)

h) $CP_H \geq CP_C$ (for every pinch match)

24. Select the correct statement of the Plus-Minus principle

a) Increase the total hot stream heat load above the pinch

b) Decrease the total hot stream heat load above the pinch

c) Decrease the total cold stream load above the pinch

d) Increase the total cold stream load above the pinch

e) Decrease the total hot stream load below the pinch

f) Increase the total hot stream load below the pinch

g) Increase the total cold stream load below the pinch

h) decrease the total cold stream load below the pinch

25. Select the proper placement for distillation column w.r.t. process

a) Above the process pinch

b) Below the process pinch

c) Across the process pinch

26. Select correct statements favoring use of multiple utilities

a) Power can be generated using high pressure steam and let down steam can be used for heating

b) The driving forces between utility and process are reduced

c) Lower temperature steam is at low pressure and hence thickness of equipment will be less

d) Each extra level increases complexity of design

e) Steam can be raised more efficiently at a lower temperature level by recovering heat from boiler flue gases

27. Select the wrong sentence in regard to steam pressure and its utilization for a purpose

a) 50 bar(g) is used for power generation

b) 40 bar(g) is normal maximum pressure for distribution

c) 10-40 bar(g) are the conventional distribution pressure levels

d) 2-5 bar(g0 are typically the lowest pressures used for distribution

28. Select the wrong sentence in regard to steam pressure and its utilization for a purpose

e) 100 bar(g) is used for power generation

f) 40 bar(g) is normal maximum pressure for distribution

g) 10-15 bar(g) are the conventional distribution pressure levels

h) 2-5 bar(g) are typically the lowest pressures used for distribution

29. Select the wrong sentence in regard to use of steam for process heating.

a) Energy can be generated at one place and then distributed

b) It has a small range of operating temperature

c) It has a low heat content through the latent heat

d) It is non toxic and losses can be compensated easily.

30. Select the wrong sentence in regard to use of steam for process heating.

e) It requires expensive material of construction for equipment

f) It has a wide range of operating temperature

g) It has a high heat content through the latent heat

h) It is toxic and losses can be compensated easily