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BE VIII - CBGS Energy System Design. Q.P. Code : 727700

Chemical

(3 Hours) [Total Marks: 80

N.B. :

1) Question – 1 is compulsory. Answer any three questions from remaining.
2) Assume data if necessary and specify the assumptions clearly.
3) Draw neat sketches wherever required.
4) Answer to the sub-questions of an individual question should be grouped and written together i.e. one below the other.

Answer the following sub- questions briefly. Each sub-question carries equal marks. **(20)**

1. What is "Energy Use Profile"?
2. "Interlocking the equipments with related process helps in saving the energy"; justify this sentence.
3. What is the difference between primary energy source and secondary energy source? Give few examples of each.
4. Define the concept of "pinch temperature" in heat exchanger networking.
5. Define 'cogeneration'.
6. Why 'steam economy' is more in case of multiple effect evaporator compared to single effect evaporator?
7. "Waste heat recovery reduces environmental pollution"; justify this sentence.
8. Write and explain the formula to calculate minimum number of heat exchangers in any heat exchanger network.
9. What is the use of an instrument, "foot candle meter" while carrying energy audit of any facility?
10. What is the meaning of 'heat integration' in any process system?

The process system involves three process streams whose data is as given below. **(20)**

Stream	1	2	3
T_{in} (°C)	280	300	140
T_{out} (°C)	130	200	255
C (kW/°C)	2	1	5

For ΔT_{min} = 30 °C, the temperature interval (TI) diagram for above process system was prepared where 5 temperature intervals were found. The upper and lower temperature limit for these temperature intervals and heat content in respective intervals are tabulated below:

Upper 'T' limit – Lower 'T' limit (°C) (w.r.t. hot stream scale) for TI	Heat content in corresponding TI (kW)
300 – 285	15
285 – 280	- 20
280 – 200	- 160
200 – 170	- 90
170 – 130	80

For this system,

(i) Determine the minimum hot and cold utility required as well as pinch temperature

(ii) Using suitable technique of heat exchanger networking, design a feasible HEN for this system to satisfy minimum utility load.

(a) Explain how to make "motor, belts and drives system" of process plant more efficient. **(12)**

(b) Discuss different types of 'energy sub audits'. **(08)**

(a) Write in detail (i.e. working, advantages, disadvantages, applications) about Gas turbine cogeneration system. **(12)**

(b) Discuss direct and indirect benefits of waste heat recovery. **(08)**

Write short note on **(20)**

(a) Heat pumping in Distillation

(b) Global status of primary energy source

(c) Waste heat boiler

(d) Cogeneration with bottoming cycle

5. A forward feed triple effect evaporator is used to concentrate dilute solution. The steam (at 121°C and 4093 kg/hr) is used as heating source in 1st effect, however in 2nd and 3rd effect vapors generated in previous effect are used as heating source. The latent heat (λ) of steam used in 1st effect is 2200 kJ/kg. Other useful data is as given below: **(20)**

Data:

	Effect 1	Effect 2	Effect 3
U (W/m²K)	3100	2000	1100
ΔT (°C) (adjusted for cold feed condition)	18	17	34
Vapor generated from (kg/hr)	2480	2660	2858
λ (kJ/kg)	2249	2293	2377

Calculate:

(i) Boiling point Temperatures in each effect (ii) Het transfer area in each effect (iii) Steam economy