Total No. of Questions : 12]

SEAT No. :

P744

[Total No. of Pages : 7

[4659] - 48

B.E. (Mechanical) (Semester - II)

INDUSTRIAL HEAT TRANSFER EQUIPMENTS

(2008 Pattern) (Elective - IV (a))

Time : 3 Hours] *[Max. Marks : 100*

Instructions to the candidates:

1) ***Answer both sections on separate answer books.***
2) ***Answer Q1 or Q2, Q3 or Q4, Q5 or Q6, Q7 or Q8, Q9 or Q10, Q11 or Q12.***
3) ***Assume suitable additional data if necessary.***

SECTION - I

Q1) a) Classify heat exchangers according to flow pattern of fluid. **[5]**

b) What is hydraulic diameter? Explain its calculation for shell side with an example. **[5]**

c) State general steps for thermal design of heat exchanger LMTD method. **[6]**

OR

Q2) a) Explain parallel arrangement of hairpin heat exchangers with figure and state advantages of arrangement. **[5]**

b) State advantages of double pipe heat exchangers. **[5]**

c) What will be the hydraulic diameter of an annulus with following specification?

Inner diameter of shell 0.0525m

Outer diameter of tube 0.0266m

Number of tubes in a shell is one.

Q3) a) Describe effect of variable physical properties of fluid on heat exchanger design. **[8]**

b) Explain selection criteria for tube pitch. **[4]**

c) What is baffle cut orientation? Explain its type with figures. **[4]**

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OR

Q4) a) Draw block diagram and temperature profile for 'E' Shell 1-2 heat exchanger: Two Nozzles are at opposite ends, segmental baffles, Hot fluid enters from shell whereas cold fluid passes from tube. **[5]**

b) Explain effect of spacing of baffle on flow distribution. **[5]**

c) State disadvantages of Kern's method of heat exchanger design. **[6]**

Q5) a) State salient features of compact heat exchanger. **[5]**

b) Compare 'Fin tube Heat Exchanger' and 'plate heat exchanger'. **[5]**

c) Determine the area required for a shell and tube heat exchanger with two tube passes to cool oil at rate of 10 kg/s from 60°C to30°C flowing in the shell using water at 20°C passing through the tubes and heated up to 26°C. The specific heat of the oil is 2200J/kg K. The value of overall heat transfer coefficient is 300 W/m^2 K. Use LMTD methods. Use graphs attached. **[8]**

OR

Q6) a) Draw sketch showing plate fin heat exchanger (PFHE) flow arrangement:
a) crossflow; b) counter flow; and
c) cross-counter flow **[5]**

b) What are Constructional types of compact HEX. **[5]**

c) The inlet and outlet temperature of hot and cold fluids in a double pipe heat exchanger are 220°C, 100°C and 80°C and 120°C respectively. Determine whether the exchanger is parallel flow or counter flow. Also determine the LMTD and effectiveness of the exchanger and the capacity ratio. **[8]**

SECTION - II

Q7) a) Explain horizontal in tube condenser with figure. **[5]**

b) Write note on air cooled condenser with their disadvantages. **[5]**

c) Draw sketch and explain in brief spiral condenser. **[6]**

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OR

Q8) a) Explain vertical shell side condenser. **[5]**

b) Why condenser operations fail? State any five reasons. **[5]**

c) Define and describe direct contact type Spray condenser. **[6]**

Q9) a) Write a note on constructional material of cooling tower. **[5]**

b) What is 'fill' and its use in the cooling tower. **[5]**

c) Explain hyperbolic cooling tower and its principle of working. **[6]**

OR

Q10)a) Compare forced and induced draft cooling tower. **[5]**

b) Explain Horizontal Spray cooling tower with figure. **[5]**

c) How cooling tower is to be maintained in good working condition? **[6]**

Q11)a) Describe heat pipe start up process. **[6]**

b) How heat balance is performed and useful in electronics cooling? **[6]**

c) Electronics cooling effectiveness will help for improving life of a component, Explain. **[6]**

OR

Q12)a) What is thermoelectric cooling? **[6]**

b) Write note on: working fluid in heat pipe. **[6]**

c) Compare natural and forced electronics cooling. **[6]**

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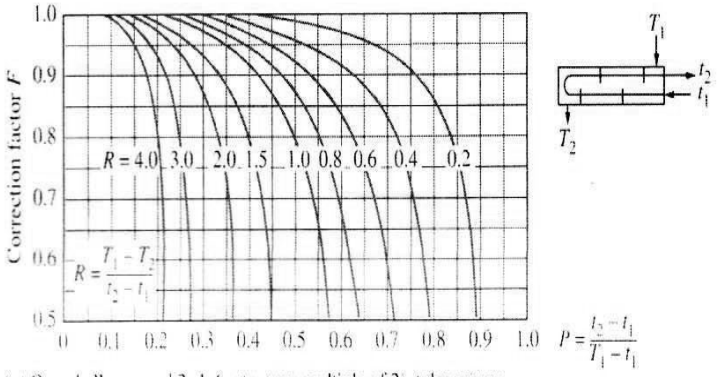
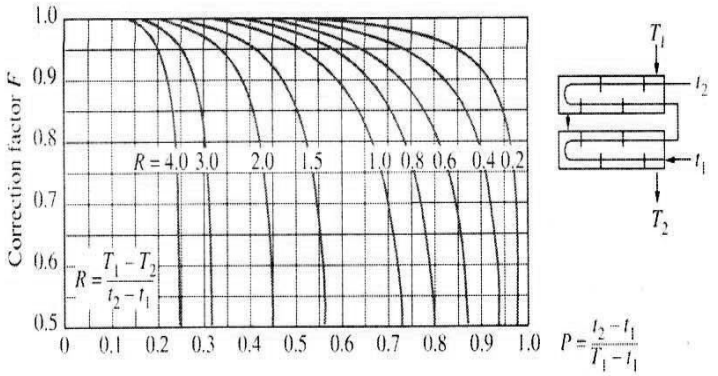
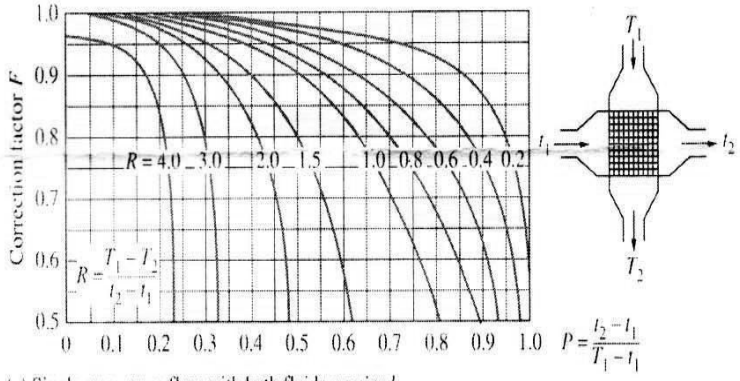


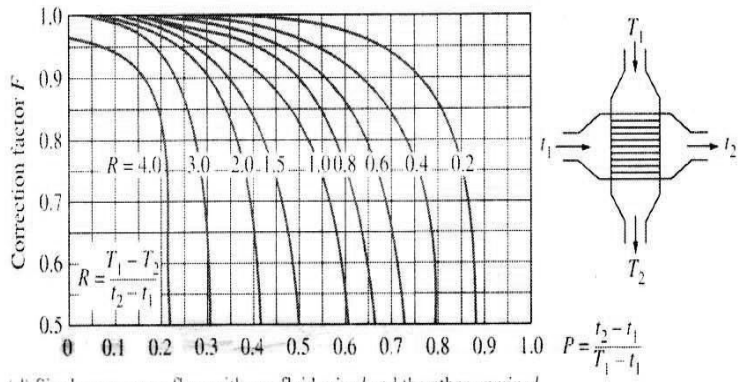
(*a*) One-shell pass and 2, 4, 6, etc. (any multiple of 2), tube passes



(*b*) Two-shell passes and 4, 8, 12, etc. (any multiple of 4), tube passes



(*c*) Single-pass cross-flow with both fluids *unmixed*



(*d*) Single-pass cross-flow with one fluid *mixed* and the other *unmixed*

FIGURE
Correction factor F charts for common shell-and-tube and cross-flow heat exchangers (from Bowman, Mueller, and Nagle, Ref. 2).

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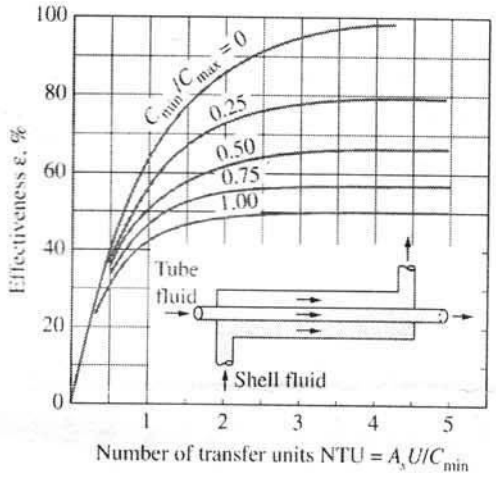
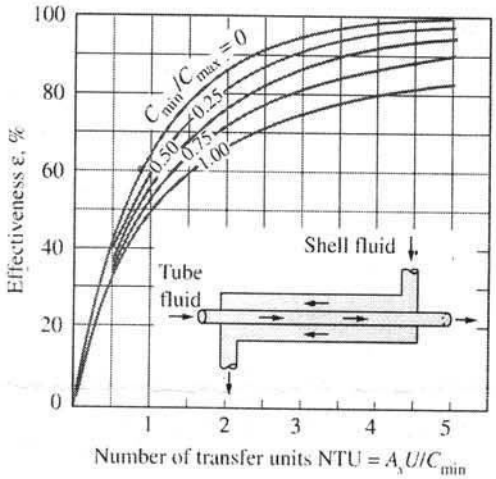
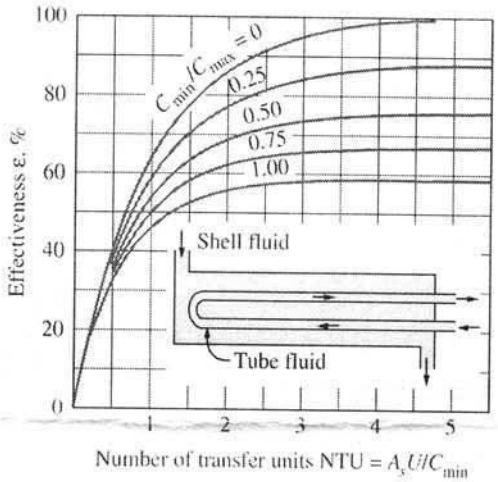


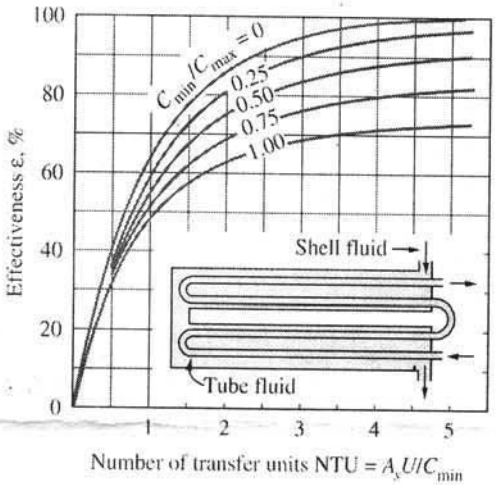
(*a*) Parallel-flow



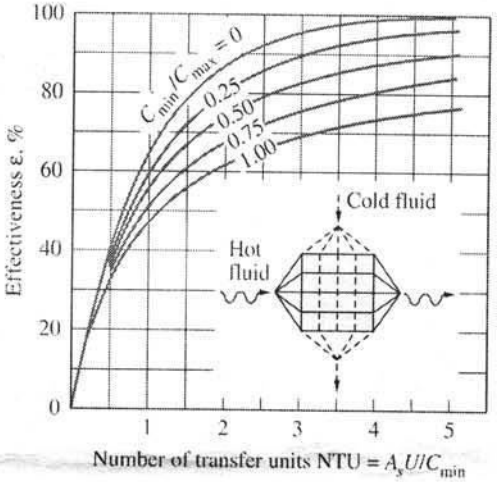
(*b*) Counter-flow



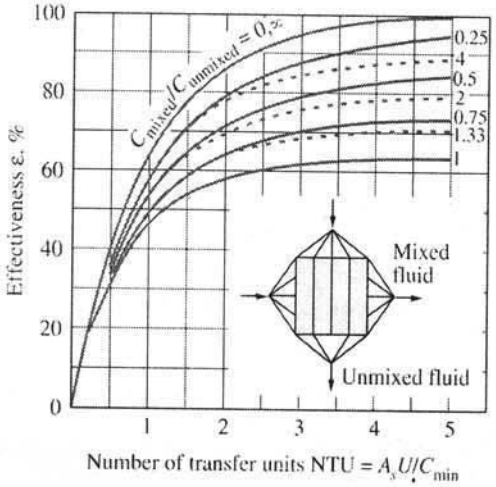
(*c*) One-shell pass and 2, 4, 6, ... tube passes



(*d*) Two-shell passes and 4, 8, 12, ... tube passes



(*e*) Cross-flow with both fluids unmixed



(*f*) Cross-flow with one fluid mixed and the other unmixed

FIGURE

Effectiveness for heat exchangers (from Kays and London, Ref. 5).

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TABLE A2
Water at Sea-Level Atmospheric Pressure

Temp. T °F	Temp. T °C	Density ρ kg/m³	Coef. Exp. $\beta \times 10^3$ 1/K	Specific Heat c_p J/kg K	Thermal Cond. k W/m K	Absolute Viscosity $\mu \times 10^6$ N s/m²	Kinematic Viscosity $\nu \times 10^6$ m²/s	Prandtl Number Pr –
32	0	999.9	−0.068	4217.5	0.5580	1794	1.794	13.56
41	5	1000	0.018	4202.7	0.5677	1530	1.530	11.33
50	10	999.7	0.095	4192.4	0.5774	1296	1.296	9.410
59	15	999.1	0.16	4185.8	0.5870	1136	1.137	8.101
68	20	998.2	0.22	4181.7	0.5967	993	0.995	6.959
77	25	997.1	0.26	4179.5	0.6064	880.6	0.883	6.069
86	30	995.7	0.31	4178.6	0.6155	792.4	0.796	5.380
95	35	994.1	0.35	4178.5	0.6243	719.8	0.724	4.818
104	40	992.2	0.39	4179.0	0.6325	658.0	0.663	4.348
113	45	990.2	0.42	4179.9	0.6401	605.1	0.611	3.951
122	50	988.1	0.45	4181.1	0.6472	555.1	0.562	3.586
131	55	985.8	0.48	4182.6	0.6536	512.6	0.520	3.280
140	60	983.5	0.51	4184.5	0.6594	470.0	0.478	2.983
149	65	980.8	0.54	4186.8	0.6643	436.0	0.445	2.748
158	70	978	0.57	4189.5	0.6686	402.0	0.411	2.519
167	75	974.9	0.60	4192.9	0.6724	376.6	0.386	2.348
176	80	971.7	0.63	4196.6	0.6753	350.0	0.361	2.175
185	85	968.5	0.66	4201.0	0.6778	330.5	0.341	2.048
194	90	965	0.69	4205.7	0.6797	311.0	0.322	1.924
203	95	961.7	0.72	4210.6	0.6811	294.3	0.306	1.819
212	100	958.4	0.75	4215.5	0.6822	277.5	0.290	1.715

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TABLE A1
Air at Sea-Level Atmospheric Pressure

Temp. T °F	Temp. T °C	Density ρ kg/m³	Coef. Exp. $\beta \times 10^3$ 1/K	Specific Heat c_p J/kg K	Thermal Cond. k W/m K	Absolute Viscosity $\mu \times 10^6$ N s/m²	Kinematic Viscosity $\nu \times 10^6$ m²/s	Prandtl Number Pr -
32	0	1.293	3.664	1003.9	0.02417	17.17	13.28	0.7131
41	5	1.269	3.598	1004.3	0.02445	17.35	13.67	0.7127
50	10	1.242	3.533	1004.6	0.02480	17.58	14.16	0.7122
59	15	1.222	3.470	1004.9	0.02512	17.79	14.56	0.7118
68	20	1.202	3.412	1005.2	0.02544	18.00	14.98	0.7113
77	25	1.183	3.354	1005.4	0.02577	18.22	15.40	0.7108
86	30	1.164	3.298	1005.7	0.02614	18.46	15.86	0.7103
95	35	1.147	3.244	1006.0	0.02650	18.70	16.30	0.7098
104	40	1.129	3.193	1006.3	0.02684	18.92	16.76	0.7093
113	45	1.111	3.142	1006.6	0.02726	19.19	17.27	0.7087
122	50	1.093	3.094	1006.9	0.02761	19.42	17.77	0.7082
131	55	1.079	3.048	1007.3	0.02801	19.68	18.24	0.7077
140	60	1.061	3.003	1007.7	0.02837	19.91	18.77	0.7072
149	65	1.047	2.957	1008.0	0.02876	20.16	19.26	0.7067
158	70	1.030	2.914	1008.4	0.02912	20.39	19.80	0.7062
167	75	1.013	2.875	1008.8	0.02945	20.60	20.34	0.7057
176	80	1.001	2.834	1009.3	0.02979	20.82	20.80	0.7053
185	85	0.986	2.795	1009.8	0.03012	21.02	21.32	0.7048
194	90	0.972	2.755	1010.3	0.03045	21.23	21.84	0.7044
203	95	0.959	2.718	1010.7	0.03073	21.41	22.33	0.7041
212	100	0.947	2.683	1011.2	0.03101	21.58	22.79	0.7038

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