**UNIVERSITI SAINS MALAYSIA**

Peperiksaan Semester Pertama
Sidang Akademik 1997/98

September/Oktober 1997

**IKK 304/2 - OPERASI UNIT II**

Masa : [3 jam]

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Sila pastikan bahawa kertas soalan ini mengandungi DUABELAS (12) mukasurat yang bercetak termasuk Lampiran sebelum anda memulakan peperiksaan ini.

Jawab sebarang **TIGA (3)** soalan. Semua soalan mesti dijawab di dalam Bahasa Malaysia.

1. (a) Bincangkan tentang pemindahan haba konduksi menerusi plat rata, silinder panjang, dan sfera.

(20 markah)

(b) Satu penukar haba dwipaip digunakan untuk meningkatkan suhu cecair A dari 408 hingga 427°F. Garispusat paip dalaman yang nipis ialah 6.35 in Cecair A mengalir di dalam paip dalaman manakala cecair B mengalir di dalam anulus. Suhu cecair B yang mengalir secara arus lawan dengan cecair A diturun dari 551 hingga 526°F. Sifat-sifat kedua-dua cecair adalah seperti berikut:

| **Cecair A** | **Cecair B** |
|---|---|
| m = 143 400 lb/h | |
| $\rho$ = 46.8 lb/ft$^3$ | $\rho$ = 51.5 lb/ft$^3$ |
| $C_p$ = 0.68 Btu/lb-°F | $C_p$ = 075 Btu/lb-°F |
| k = 0.075 Btu/ft-h-°F | k = 0.075 Btu/ft-h-°F |
| $\mu$ = 0.00164 lb/ft-s | |

Dengan mengabaikan rintangan dan kesan kepada kelikatan daripada dinding paip, dan $h_o$ = 340 Btu/ft$^2$-h-°F, kirakan

(i) kadar haba yang dipindah

(ii) kadar aliran jisim cecair B

(iii) koefisien pemindahan haba untuk cecair A

(iv) panjang paip dalaman yang diperlukan

(80 markah)

2. (a) Bincangkan tentang pemindahan haba kondensasi.

(15 markah)

(b) Air pada kadar 3.8 kg/s dipanaskan dari 37.8°C hingga 54.5°C di dalam satu penukar haba petala-dan-tiub. Di sisi petala, satu laluan digunakan dengan air sebagai bendalir pemanasan yang memasuki pada 93.4°C. Koefisien pemindahan haba keseluruhan ialah 1420 $W/m^2$-°C dan halaju air di dalam tiub nipis yang bergarispusat 1.9 cm ialah 0.37 m/s. Oleh kerana ruang terhad, panjang tiub tidak boleh melebihi 2.44 m. Jika aliran adalah arus lawan, kirakan

(i) kadar pemindahan haba, kW

(ii) suhu air panas keluar

(iii) jumlah luas permukaan

(iv) jumlah luas keratan-rentas tiub

(v) jumlah bilangan tiub

(vi) bilangan laluan tiub

(vii) panjang tiub selaluan

$\rho$ (air) = 1000 kg/m$^3$, $C_p$ (air) = 4.18 kJ/kg-°C

(85 markah)

3. (a) Huraikan sifat-sifat satu kondenser dengan bantuan profil suhu dan imbangan haba.

(20 markah)

(b) Ceritakan tentang pendidihan cecair tepu.

(30 markah)

(c) Apakah yang anda boleh jelaskan tentang perkara-perkara berikut berkaitan dengan sinaran haba?

(i) faktor bentuk, F

(ii) kesan rumah kaca (green house effect)

(50 markah)

4. (a) (i) Jelaskan tentang perkara-perkara yang mempengaruhi pemilihan sesuatu penyejat.

(ii) Bagaimana anda dapat menentukan saiz sesuatu penyejat.

(50 markah)

(b) Suatu filamen lampu tungsten dipanaskan sehingga suhu 2500 K. Jika filamen itu boleh dianggap sebagai suatu jasad hitam,

(i) kira fluks sinaran haba maksimum dari filamen tersebut.

(ii) tentukan pecahan dari tenaga yang terjana yang boleh dikaitkan dengan julat cahaya boleh dilihat. (iaitu dari $\lambda$ = 0.4 μm sehingga $\lambda$ = 0.7μm).

Perhatian:

Anda boleh menggunakan Lampiran 6 untuk membantu dalam pengiraan.

$\sigma = 5.67 \times 10^{-8}\ W/m^2K^4$

(50 markah)

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# CONVERSION FACTORS AND CONSTANTS OF NATURE

| To convert from | To | Multiply by† |
|---|---|---|
| acre | ft² | 43,560* |
| | m² | 4,046.85 |
| atm | N/m² | 1.01325* × 10⁵ |
| | $lb_f$/in.² | 14.696 |
| Avogadro number | particles/g mol | 6.022169 × 10²³ |
| barrel (petroleum) | ft³ | 5.6146 |
| | gal (U.S.) | 42* |
| | m³ | 0.15899 |
| bar | N/m² | 1* × 10⁵ |
| | $lb_f$/in.² | 14.504 |
| Boltzmann constant | J/K | 1.380622 × 10⁻²³ |
| Btu | $cal_{IT}$ | 251.996 |
| | ft-$lb_f$ | 778.17 |
| | J | 1,055.06 |
| | kWh | 2.9307 × 10⁻⁴ |
| Btu/lb | $cal_{IT}$/g | 0.55556 |
| Btu/lb-°F | $cal_{IT}$/g-°C | 1* |
| Btu/ft²-h | W/m² | 3.1546 |
| Btu/ft²-h-°F | W/m²-°C | 5.6783 |
| Btu-ft/ft²-h-°F | W-m/m²-°C | 1.73073 |
| $cal_{IT}$ | Btu | 3.9683 × 10⁻³ |
| | ft-$lb_f$ | 3.0873 |
| | J | 4.1868* |
| cal | J | 4.184* |
| cm | in. | 0.39370 |
| | ft | 0.0328084 |
| cm³ | ft³ | 3.531467 × 10⁻⁵ |
| | gal (U.S.) | 2.64172 × 10⁻⁴ |
| cP (centipoise) | kg/m-s | 1* × 10⁻³ |
| | lb/ft-h | 2.4191 |
| | lb/ft-s | 6.7197 × 10⁻⁴ |
| cSt (centistoke) | m²/s | 1* × 10⁻⁶ |
| faraday | C/g mol | 9.648670 × 10⁴ |
| ft | m | 0.3048* |
| ft-$lb_f$ | Btu | 1.2851 × 10⁻³ |
| | $cal_{IT}$ | 0.32383 |
| | J | 1.35582 |
| ft-$lb_f$/s | Btu/h | 4.6262 |
| | hp | 1.81818 × 10⁻³ |
| ft²/h | m²/s | 2.581 × 10⁻⁵ |
| | cm²/s | 0.2581 |
| ft³ | cm³ | 2.8316839 × 10⁴ |
| | gal (U.S.) | 7.48052 |
| | l | 28.31684 |
| ft³-atm | Btu | 2.71948 |
| | $cal_{IT}$ | 685.29 |
| | J | 2.8692 × 10³ |
| ft³/s | gal (U.S.)/min | 448.83 |
| gal (U.S.) | ft³ | 0.13368 |
| | in.³ | 231* |
| gravitational constant | N-m²/kg² | 6.673 × 10⁻¹¹ |
| gravity acceleration, standard | m/s² | 9.80665* |
| h | min | 60* |
| | s | 3,600* |
| hp | Btu/h | 2,544.43 |
| | kW | 0.74570 |
| in. | cm | 2.54* |
| in.³ | cm³ | 16.3871 |
| J | erg | 1* × 10⁷ |
| | ft-$lb_f$ | 0.73756 |
| kg | lb | 2.20462 |
| kWh | Btu | 3,412.1 |
| l | m³ | 1* × 10⁻³ |
| lb | kg | 0.45359237* |
| lb/ft³ | kg/m³ | 16.018 |
| | g/cm³ | 0.016018 |
| $lb_f$/in.² | N/m² | 6.89473 × 10³ |
| lb mol/ft²-h | kg mol/m²-s | 1.3652 × 10⁻³ |
| | g mol/cm²-s | 1.3652 × 10⁻⁴ |
| light, speed of | m/s | 2.997925 × 10⁸ |
| m | ft | 3.280840 |
| | in. | 39.3701 |
| m³ | ft³ | 35.3147 |
| | gal (U.S.) | 264.17 |
| N | dyn | 1* × 10⁵ |
| | $lb_f$ | 0.22481 |
| N/m² | $lb_f$/in.² | 1.4498 × 10⁻⁴ |
| Planck constant | J-s | 6.626196 × 10⁻³⁴ |
| proof (U.S.) | percent alcohol by volume | 0.5 |
| ton (long) | kg | 1,016 |
| | lb | 2,240* |
| ton (short) | lb | 2,000* |
| ton (metric) | kg | 1,000* |
| | lb | 2,204.6 |
| yd | ft | 3* |
| | m | 0.9144* |

† Values that end in * are exact, by definition.

# PROPERTIES OF LIQUID WATER

| Temperature $T$, °F | Viscosity† $\mu'$, cP | Thermal conductivity‡ $k$, Btu/ft-h-°F | Density§ $\rho$, lb/ft$^3$ | $\psi_f = \left(\frac{k^3\rho^2 g}{\mu^2}\right)^{1/3}$ |
|---|---|---|---|---|
| 32 | 1.794 | 0.320 | 62.42 | 1,410 |
| 40 | 1.546 | 0.326 | 62.43 | 1,590 |
| 50 | 1.310 | 0.333 | 62.42 | 1,810 |
| 60 | 1.129 | 0.340 | 62.37 | 2,050 |
| 70 | 0.982 | 0.346 | 62.30 | 2,290 |
| 80 | 0.862 | 0.352 | 62.22 | 2,530 |
| 90 | 0.764 | 0.358 | 62.11 | 2,780 |
| 100 | 0.682 | 0.362 | 62.00 | 3,020 |
| 120 | 0.559 | 0.371 | 61.71 | 3,530 |
| 140 | 0.470 | 0.378 | 61.38 | 4,030 |
| 160 | 0.401 | 0.384 | 61.00 | 4,530 |
| 180 | 0.347 | 0.388 | 60.58 | 5,020 |
| 200 | 0.305 | 0.392 | 60.13 | 5,500 |
| 220 | 0.270 | 0.394 | 59.63 | 5,960 |
| 240 | 0.242 | 0.396 | 59.10 | 6,420 |
| 260 | 0.218 | 0.396 | 58.53 | 6,830 |
| 280 | 0.199 | 0.396 | 57.94 | 7,210 |
| 300 | 0.185 | 0.396 | 57.31 | 7,510 |

† From *International Critical Tables*, vol. 5, McGraw-Hill Book Company, New York, 1929, p. 10.
‡ From E. Schmidt and W. Sellschopp, *Forsch. Geb. Ingenieurw.*, 3:277 (1932).
§ Calculated from J. H. Keenan and F. G. Keyes, *Thermodynamic Properties of Steam*, John Wiley & Sons., Inc., New York, 1937.

# PROPERTIES OF SATURATED STEAM AND WATER†

| Temperature $T$, °F | Vapor pressure $p_A$, $lb_f/in.^2$ | Specific volume, $ft^3/lb$ Liquid $v_x$ | Specific volume, $ft^3/lb$ Saturated vapor $v_y$ | Enthalpy, Btu/lb Liquid $H_x$ | Enthalpy, Btu/lb Vaporization $\lambda$ | Enthalpy, Btu/lb Saturated vapor $H_y$ |
|---|---|---|---|---|---|---|
| 32 | 0.08859 | 0.016022 | 3305 | 0 | 1075.4 | 1075.4 |
| 35 | 0.09992 | 0.016021 | 2948 | 3.00 | 1073.7 | 1076.7 |
| 40 | 0.12166 | 0.016020 | 2445 | 8.02 | 1070.9 | 1078.9 |
| 45 | 0.14748 | 0.016021 | 2037 | 13.04 | 1068.1 | 1081.1 |
| 50 | 0.17803 | 0.016024 | 1704.2 | 18.06 | 1065.2 | 1083.3 |
| 55 | 0.2140 | 0.016029 | 1431.4 | 23.07 | 1062.4 | 1085.5 |
| 60 | 0.2563 | 0.016035 | 1206.9 | 28.08 | 1059.6 | 1087.7 |
| 65 | 0.3057 | 0.016042 | 1021.5 | 33.09 | 1056.8 | 1089.9 |
| 70 | 0.3632 | 0.016051 | 867.7 | 38.09 | 1054.0 | 1092.0 |
| 75 | 0.4300 | 0.016061 | 739.7 | 43.09 | 1051.1 | 1094.2 |
| 80 | 0.5073 | 0.016073 | 632.8 | 48.09 | 1048.3 | 1096.4 |
| 85 | 0.5964 | 0.016085 | 543.1 | 53.08 | 1045.5 | 1098.6 |
| 90 | 0.6988 | 0.016099 | 467.7 | 58.07 | 1042.7 | 1100.7 |
| 95 | 0.8162 | 0.016114 | 404.0 | 63.06 | 1039.8 | 1102.9 |
| 100 | 0.9503 | 0.016130 | 350.0 | 68.05 | 1037.0 | 1105.0 |
| 110 | 1.2763 | 0.016166 | 265.1 | 78.02 | 1031.4 | 1109.3 |
| 120 | 1.6945 | 0.016205 | 203.0 | 88.00 | 1025.5 | 1113.5 |
| 130 | 2.225 | 0.016247 | 157.17 | 97.98 | 1019.8 | 1117.8 |
| 140 | 2.892 | 0.016293 | 122.88 | 107.96 | 1014.0 | 1121.9 |
| 150 | 3.722 | 0.016343 | 96.99 | 117.96 | 1008.1 | 1126.1 |
| 160 | 4.745 | 0.016395 | 77.23 | 127.96 | 1002.2 | 1130.1 |
| 170 | 5.996 | 0.016450 | 62.02 | 137.97 | 996.2 | 1134.2 |
| 180 | 7.515 | 0.016509 | 50.20 | 147.99 | 990.2 | 1138.2 |
| 190 | 9.343 | 0.016570 | 40.95 | 158.03 | 984.1 | 1142.1 |
| 200 | 11.529 | 0.016634 | 33.63 | 168.07 | 977.9 | 1145.9 |
| 210 | 14.125 | 0.016702 | 27.82 | 178.14 | 971.6 | 1149.7 |
| 212 | 14.698 | 0.016716 | 26.80 | 180.16 | 970.3 | 1150.5 |
| 220 | 17.188 | 0.016772 | 23.15 | 188.22 | 965.3 | 1153.5 |
| 230 | 20.78 | 0.016845 | 19.386 | 198.32 | 958.8 | 1157.1 |
| 240 | 24.97 | 0.016922 | 16.327 | 208.44 | 952.3 | 1160.7 |
| 250 | 29.82 | 0.017001 | 13.826 | 218.59 | 945.6 | 1164.2 |
| 260 | 35.42 | 0.017084 | 11.768 | 228.76 | 938.8 | 1167.6 |
| 270 | 41.85 | 0.017170 | 10.066 | 238.95 | 932.0 | 1170.9 |
| 280 | 49.18 | 0.017259 | 8.650 | 249.18 | 924.9 | 1174.1 |
| 290 | 57.53 | 0.017352 | 7.467 | 259.44 | 917.8 | 1177.2 |
| 300 | 66.98 | 0.017448 | 6.472 | 269.73 | 910.4 | 1180.2 |
| 310 | 77.64 | 0.017548 | 5.632 | 280.06 | 903.0 | 1183.0 |
| 320 | 89.60 | 0.017652 | 4.919 | 290.43 | 895.3 | 1185.8 |
| 340 | 117.93 | 0.017872 | 3.792 | 311.30 | 879.5 | 1190.8 |
| 350 | 134.53 | 0.017988 | 3.346 | 321.80 | 871.3 | 1193.1 |
| 360 | 152.92 | 0.018108 | 2.961 | 332.35 | 862.9 | 1195.2 |
| 370 | 173.23 | 0.018233 | 2.628 | 342.96 | 854.2 | 1197.2 |
| 380 | 195.60 | 0.018363 | 2.339 | 353.62 | 845.4 | 1199.0 |
| 390 | 220.2 | 0.018498 | 2.087 | 364.34 | 836.2 | 1200.6 |
| 400 | 247.1 | 0.018638 | 1.8661 | 375.12 | 826.8 | 1202.0 |
| 410 | 276.5 | 0.018784 | 1.6726 | 385.97 | 817.2 | 1203.1 |
| 420 | 308.5 | 0.018936 | 1.5024 | 396.89 | 807.2 | 1204.1 |
| 430 | 343.3 | 0.019094 | 1.3521 | 407.89 | 796.9 | 1204.8 |
| 440 | 381.2 | 0.019260 | 1.2192 | 418.98 | 786.3 | 1205.3 |
| 450 | 422.1 | 0.019433 | 1.1011 | 430.2 | 775.4 | 1205.6 |

† Abstracted from *Steam Tables*, by Joseph H. Keenan, Frederick G. Keyes, Philip G. Hill, and Joan G. Moore, John Wiley & Sons, New York, 1969, with the permission of the publisher.

$$J_H = \left(\frac{h_i}{c_p G}\right)\left(\frac{c_p \mu}{k}\right)^{2/3}(\mu_w/\mu)^{0.14}$$

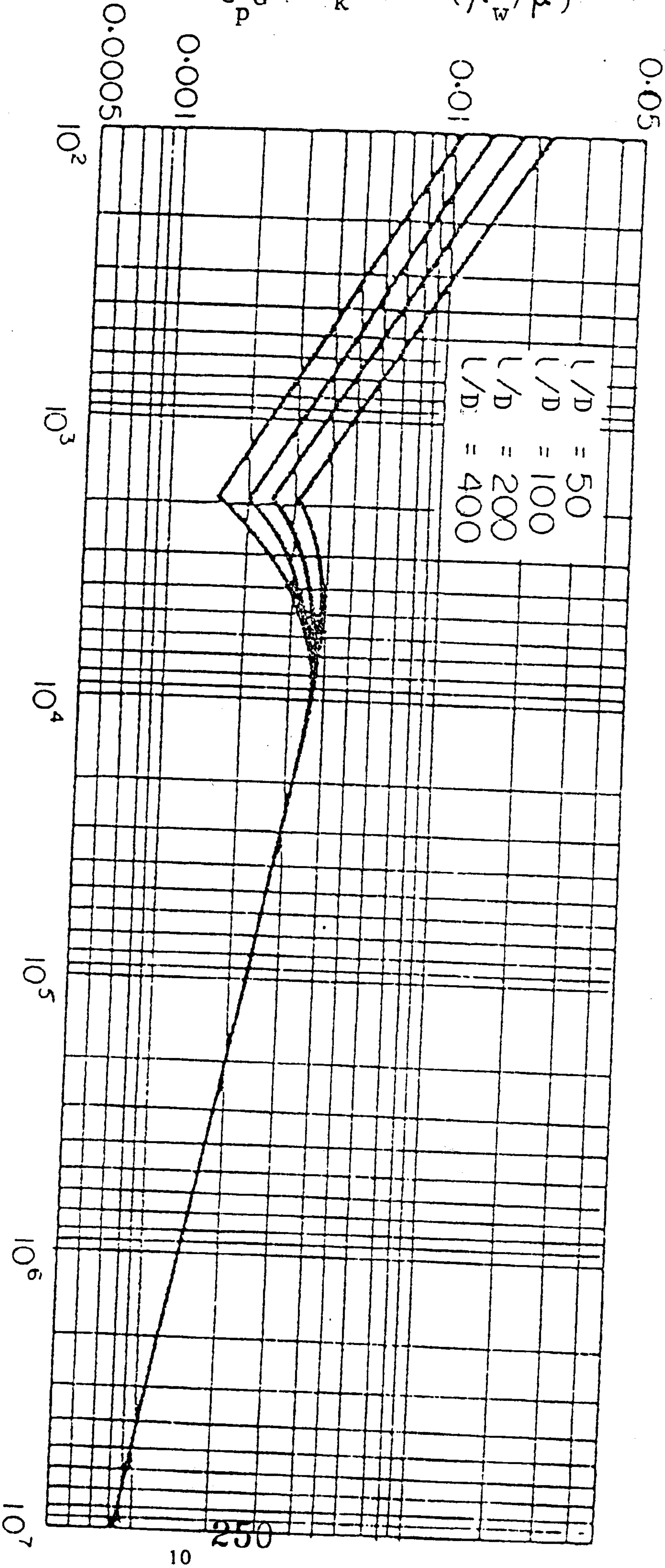


FIG. Effect of length: diameter ratio on heat transfer coefficient.

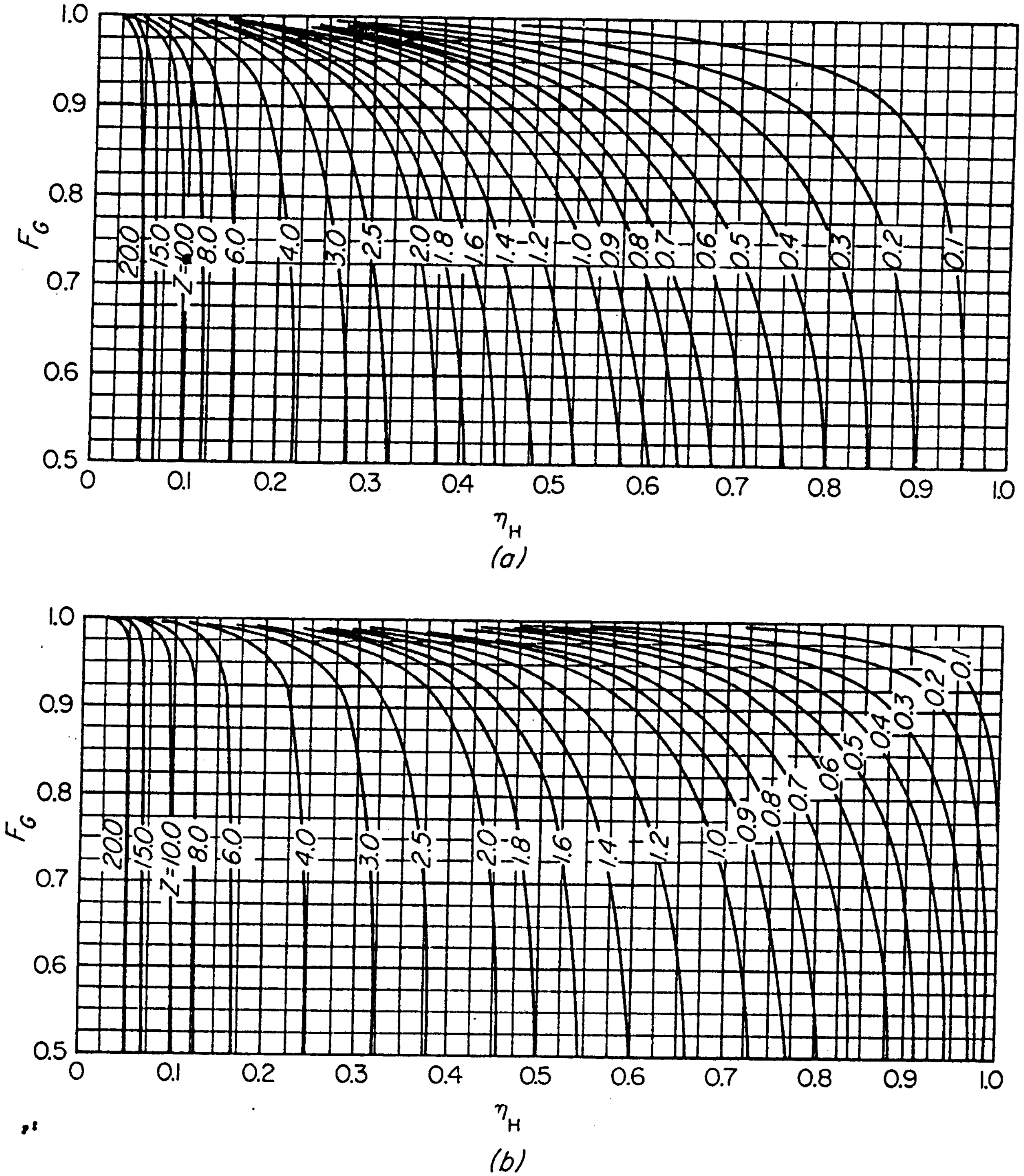


**Figure 15-5** Correction of LMTD: (*a*) 1-2 exchangers; (*b*) 2-4 exchangers. [*From R. A. Bowman, A. C. Mueller, and W. M. Nagle, Trans. ASME,* **62**:283 (1940). *Courtesy of American Society of Mechanical Engineers.*]

**Table 12-1 Blackbody radiation functions**

| $\lambda T$, $\mu m \cdot K$ | $\lambda T$, $\mu m \cdot {}^\circ R$ | $\frac{E_{b\lambda}}{T^5}$, $\frac{W}{m^2 \cdot K^5 \cdot \mu m} \times 10^{11}$ | $f_{0-\lambda}(T)$ | $\lambda T$, $\mu m \cdot K$ | $\lambda T$, $\mu m \cdot {}^\circ R$ | $\frac{E_{b\lambda}}{T^5}$, $\frac{W}{m^2 \cdot K^5 \cdot \mu m} + 10^{11}$ | $f_{0-\lambda}(T)$ |
|---|---|---|---|---|---|---|---|
| 555.6 | 1,000 | $0.400 \times 10^{-5}$ | 0.00000 | 5,777.8 | 10,400 | 0.52517 | 0.71806 |
| 666.7 | 1,200 | $0.120 \times 10^{-3}$ | 0.00000 | 5,888.9 | 10,600 | 0.50261 | 0.72813 |
| 777.8 | 1,400 | 0.00122 | 0.00000 | 6,000.0 | 10,800 | 0.48107 | 0.73777 |
| 888.9 | 1,600 | 0.00630 | 0.00007 | 6,111.1 | 11,000 | 0.46051 | 0.74700 |
| 1,000.0 | 1,800 | 0.02111 | 0.00032 | 6,222.2 | 11,200 | 0.44089 | 0.75583 |
| 1,111.1 | 2,000 | 0.05254 | 0.00101 | 6,333.3 | 11,400 | 0.42218 | 0.76429 |
| 1,222.2 | 2,200 | 0.10587 | 0.00252 | 6,444.4 | 11,600 | 0.40434 | 0.77238 |
| 1,333.3 | 2,400 | 0.18275 | 0.00531 | 6,555.6 | 11,800 | 0.38732 | 0.78014 |
| 1,444.4 | 2,600 | 0.28091 | 0.00983 | 6,666.7 | 12,000 | 0.37111 | 0.78757 |
| 1,555.6 | 2,800 | 0.39505 | 0.01643 | 6,777.8 | 12,200 | 0.35565 | 0.79469 |
| 1,666.7 | 3,000 | 0.51841 | 0.02537 | 6,888.9 | 12,400 | 0.34091 | 0.80152 |
| 1,777.8 | 3,200 | 0.64404 | 0.03677 | 7,000.0 | 12,600 | 0.32687 | 0.80806 |
| 1,888.9 | 3,400 | 0.76578 | 0.05059 | 7,111.1 | 12,800 | 0.31348 | 0.81433 |
| 2,000.0 | 3,600 | 0.87878 | 0.06672 | 7,222.2 | 13,000 | 0.30071 | 0.82035 |
| 2,111.1 | 3,800 | 0.97963 | 0.08496 | 7,333.3 | 13,200 | 0.28855 | 0.82612 |
| 2,222.2 | 4,000 | 1.0663 | 0.10503 | 7,444.4 | 13,400 | 0.27695 | 0.83166 |
| 2,333.3 | 4,200 | 1.1378 | 0.12665 | 7,555.6 | 13,600 | 0.26589 | 0.83698 |
| 2,444.4 | 4,400 | 1.1942 | 0.14953 | 7,666.7 | 13,800 | 0.25534 | 0.84209 |
| 2,555.6 | 4,600 | 1.2361 | 0.17337 | 7,777.8 | 14,000 | 0.24527 | 0.84699 |
| 2,666.7 | 4,800 | 1.2645 | 0.19789 | 7,888.9 | 14,200 | 0.23567 | 0.85171 |
| 2,777.8 | 5,000 | 1.2808 | 0.22285 | 8,000.0 | 14,400 | 0.22651 | 0.85624 |
| 2,888.9 | 5,200 | 1.2864 | 0.24803 | 8,111.1 | 14,600 | 0.21777 | 0.86059 |
| 3,000.0 | 5,400 | 1.2827 | 0.27322 | 8,222.2 | 14,800 | 0.20942 | 0.86477 |
| 3,111.1 | 5,600 | 1.2713 | 0.29825 | 8,333.3 | 15,000 | 0.20145 | 0.86880 |
| 3,222.2 | 5,800 | 1.2532 | 0.32300 | 8,888.9 | 16,000 | 0.16662 | 0.88677 |
| 3,333.3 | 6,000 | 1.2299 | 0.34734 | 9,444.4 | 17,000 | 0.13877 | 0.90168 |
| 3,444.4 | 6,200 | 1.2023 | 0.37118 | 10,000.0 | 18,000 | 0.11635 | 0.91414 |
| 3,555.6 | 6,400 | 1.1714 | 0.39445 | 10,555.6 | 19,000 | 0.09817 | 0.92462 |
| 3,666.7 | 6,600 | 1.1380 | 0.41708 | 11,111.1 | 20,000 | 0.08334 | 0.93349 |
| 3,777.8 | 6,800 | 1.1029 | 0.43905 | 11,666.7 | 21,000 | 0.07116 | 0.94104 |
| 3,888.9 | 7,000 | 1.0665 | 0.46031 | 12,222.2 | 22,000 | 0.06109 | 0.94751 |
| 4,000.0 | 7,200 | 1.0295 | 0.48085 | 12,777.8 | 23,000 | 0.05272 | 0.95307 |
| 4,111.1 | 7,400 | 0.99221 | 0.50066 | 13,333.3 | 24,000 | 0.04572 | 0.95788 |
| 4,222.2 | 7,600 | 0.95499 | 0.51974 | 13,888.9 | 25,000 | 0.03982 | 0.96207 |
| 4,333.3 | 7,800 | 0.91813 | 0.53809 | 14,444.4 | 26,000 | 0.03484 | 0.96572 |
| 4,444.4 | 8,000 | 0.88184 | 0.55573 | 15,000.0 | 27,000 | 0.03061 | 0.96892 |
| 4,555.6 | 8,200 | 0.84629 | 0.57267 | 15,555.6 | 28,000 | 0.02699 | 0.97174 |
| 4,666.7 | 8,400 | 0.81163 | 0.58891 | 16,111.1 | 29,000 | 0.02389 | 0.97423 |
| 4,777.8 | 8,600 | 0.77796 | 0.60449 | 16,666.7 | 30,000 | 0.02122 | 0.97644 |
| 4,888.9 | 8,800 | 0.74534 | 0.61941 | 22,222.2 | 40,000 | 0.00758 | 0.98915 |
| 5,000.0 | 9,000 | 0.71383 | 0.63371 | 27,777.8 | 50,000 | 0.00333 | 0.99414 |
| 5,111.1 | 9,200 | 0.68346 | 0.64740 | 33,333.3 | 60,000 | 0.00168 | 0.99649 |
| 5,222.2 | 9,400 | 0.65423 | 0.66051 | 38,888.9 | 70,000 | $0.940 \times 10^{-3}$ | 0.99773 |
| 5,333.3 | 9,600 | 0.62617 | 0.67305 | 44,444.4 | 80,000 | $0.564 \times 10^{-3}$ | 0.99845 |
| 5,444.4 | 9,800 | 0.59925 | 0.68506 | 50,000.0 | 90,000 | $0.359 \times 10^{-3}$ | 0.99889 |
| 5,555.6 | 10,000 | 0.57346 | 0.69655 | 55,555.6 | 100,000 | $0.239 \times 10^{-3}$ | 0.99918 |
| 5,666.7 | 10,200 | 0.54877 | 0.70754 | $\infty$ | $\infty$ | 0. | 1.00000 |