

§4-4. Vapor and Steam

- ◆ 水蒸氣是相當重要的商業化流體 → 廣用於各化學工廠中。
 - ◆ 在一般的條件下，水蒸氣或蒸汽是”很不理想”的氣體。
 - ◆ 目前 steam 的性質已被準確的量測與列表
 - steam table 與 superheat steam table → 是目前工程師非常廣用的數據。
2. saturated vapor pressure 只和 (1)液、氣的種類 (2)溫度有關。
 - ◆ 液體的溫度固定 → 其 saturated vapor pressure 固定，會依環境而調整液態或氣態來維持其 vapor pressure。
 - ◆ 液體的溫度越高 → saturated vapor pressure 越高，其關係為

$$\ln \frac{P_2}{P_1} = -\frac{\Delta \hat{H}_{vap}}{R} \left(\frac{1}{T_2} - \frac{1}{T_1} \right) \quad \text{----- Clausius-Clapeyron equation}$$

- ◆ 其中， $\Delta \hat{H}_{vap}$ 為該液體的莫耳汽化熱 (standard heat of vaporization)。

Example 4-11:

已知 30°C 的水之 saturated vapor pressure 為 31.81 mm-Hg，假設水蒸氣可用 ideal gas law 來計算，今取 0.2 g 的液態水在 10 liter 的容器中，則最後的水蒸氣壓力是多少？若改取 1.0 g 的液態水在 10 liter 的容器中，則最後的水蒸氣壓力是多少？

Example 4-12:

10 升的密閉容器內裝 0.5 g 的水，在 303 K 時和外界之 1 atm 平衡且容器內尚有液體水，若水蒸氣與空氣都可用 ideal gas law 來計算，且此溫度下，水的 saturated vapor pressure 為 31.81 mm-Hg，則

- (1) 容器內的總壓力是多少？
- (2) 容器內乾燥氣體的壓力是多少？
- (3) 溫度不變下，將容器的體積壓縮一半，則容器內的總壓力是多少？乾燥氣體的壓力是多少？水蒸氣的壓力是多少？
- (4) 溫度不變下，將容器的體積膨脹為原來的 3 倍，則容器內的總壓力是多少？乾燥氣體的壓力是多少？水蒸氣的壓力是多少？

3. steam table 與 superheat steam table 的應用：

★★飽和蒸氣與 steam table：

(1) 100°C 時：

① 水的 saturated vapor pressure：

$$101.33 \text{ kPa} = 1 \text{ atm} = 760 \text{ mm-Hg}$$

② 飽和液體水的 H 值(比焓) = _____

飽和汽體的 H 值(比焓) = _____

∴ 1 atm、100°C 的飽和液體水變成 1 atm、100°C 的飽和蒸汽，

$$\Delta H =$$

即吸收熱量 $Q =$ _____ kJ/kg

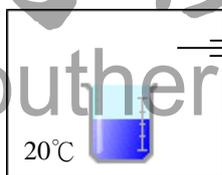
③ 飽和液體水的比體積 = _____

飽和汽體的比體積 = _____

(2) 20°C 時：

① 水的 saturated vapor pressure：

$$2.337 \text{ kPa} = (2.337/101.33) \text{ atm} = 0.0231 \text{ atm} = 17.53 \text{ mm-Hg}$$



◆ 用抽掉氣體的方式使空氣的壓力降到 17.53 mm-Hg，則 20°C 的水會沸騰。

② 飽和液體水的 H 值(比焓) = _____

飽和汽體的 H 值(比焓) = _____

∴ 0.0237 atm、20°C 的飽和液體水變成 0.0237 atm、20°C 的飽和蒸汽，

$$\Delta H =$$

即吸收熱量 $Q =$ _____ kJ/kg

(3)若要使水在 110°C 沸騰：

①則外壓必需是 _____ kPa = _____ atm

②飽和液體水的 H 值(比焓) = _____

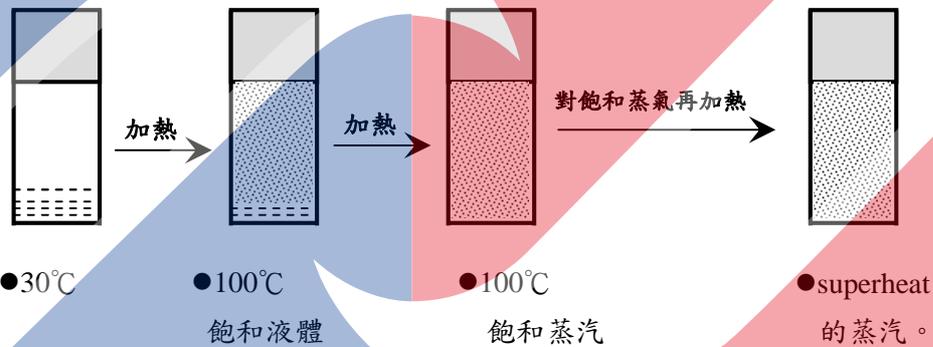
飽和汽體的 H 值(比焓) = _____

∴ _____ atm、110°C 的飽和液體水變成 _____ atm、110°C 的飽和蒸汽，

$\Delta H =$

即吸收熱量 $Q =$ _____ kJ/kg

**superheat steam table :



(1) 101.33 kPa, 350°C 時，

steam 的 H 值(specific enthalpy 比焓) = _____

U 值(specific internal energy 比內能) = _____

(2) 200 kPa, 420°C 時，

steam 的 H 值(specific enthalpy 比焓) = _____

U 值(specific internal energy 比內能) = _____

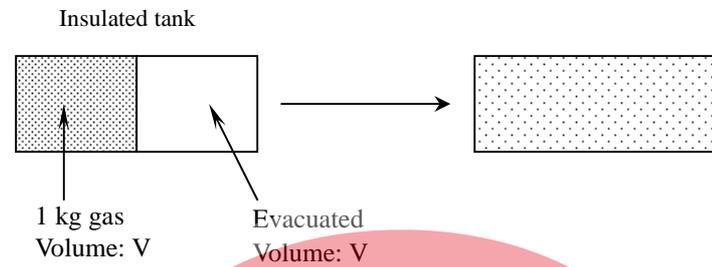
Example 4-13:

一固定體積的容器內裝 0.2 kg 的 steam，其溫度與壓力為 300°C、125 kpa。現將 112.94 kJ 的熱量加入 steam 中，則 steam 的最後溫度、壓力與焓值各是多少？

Example 4-14:

Find T and P after expansion if: (A) the gas is an ideal gas at 1.02 atm and 315°C .

(B) the gas is steam at 300 kpa and 400°C



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表 F.1 飽和蒸汽, SI 單位制

V = 比體積 $\text{cm}^3 \text{g}^{-1}$
 U = 比內能 kJ kg^{-1}
 H = 比焓 kJ kg^{-1}
 S = 比熵 $\text{kJ kg}^{-1} \text{K}^{-1}$

| t $^{\circ}\text{C}$ | T K | P kPa | 比體積 V | | 內能 U | | | | 焓 H | | 熵 S | | 飽和 | | |
|---------------------------|-------------------|---------------------|---------|---------|---------|-------|--------|--------|-------|--------|--------|--------|--------|--------|----|
| | | | 液體 | 蒸發 | 液體 | 蒸發 | 液體 | 蒸發 | 液體 | 蒸發 | 液體 | 蒸發 | 液體 | 蒸發 | 液體 | 蒸發 |
| 0 | 273.15 | 0.611 | 1.000 | 206300. | 206300. | -0.04 | 2375.7 | 2375.6 | -0.04 | 2501.7 | 2501.6 | 0.0000 | 9.1578 | 9.1578 | |
| 0.01 | 273.16 | 0.611 | 1.000 | 206200. | 206200. | 0.00 | 2375.6 | 2375.6 | 0.00 | 2501.6 | 2501.6 | 0.0000 | 9.1575 | 9.1575 | |
| 1 | 274.15 | 0.657 | 1.000 | 192600. | 192600. | 4.17 | 2372.7 | 2376.9 | 4.17 | 2499.2 | 2503.4 | 0.0153 | 9.1158 | 9.1311 | |
| 2 | 275.15 | 0.705 | 1.000 | 179900. | 179900. | 8.39 | 2369.9 | 2378.3 | 8.39 | 2496.8 | 2505.2 | 0.0306 | 9.0741 | 9.1047 | |
| 3 | 276.15 | 0.757 | 1.000 | 168200. | 168200. | 12.60 | 2367.1 | 2379.7 | 12.60 | 2494.5 | 2507.1 | 0.0459 | 9.0326 | 9.0785 | |
| 4 | 277.15 | 0.813 | 1.000 | 157300. | 157300. | 16.80 | 2364.3 | 2381.1 | 16.80 | 2492.1 | 2508.9 | 0.0611 | 8.9915 | 9.0526 | |
| 5 | 278.15 | 0.872 | 1.000 | 147200. | 147200. | 21.01 | 2361.4 | 2382.4 | 21.01 | 2489.7 | 2510.7 | 0.0762 | 8.9507 | 9.0269 | |
| 6 | 279.15 | 0.935 | 1.000 | 137800. | 137800. | 25.21 | 2358.6 | 2383.8 | 25.21 | 2487.4 | 2512.6 | 0.0913 | 8.9102 | 9.0014 | |
| 7 | 280.15 | 1.001 | 1.000 | 129100. | 129100. | 29.41 | 2355.8 | 2385.2 | 29.41 | 2485.0 | 2514.4 | 0.1063 | 8.8699 | 8.9762 | |
| 8 | 281.15 | 1.072 | 1.000 | 121000. | 121000. | 33.60 | 2353.0 | 2386.6 | 33.60 | 2482.6 | 2516.2 | 0.1213 | 8.8300 | 8.9513 | |
| 9 | 282.15 | 1.147 | 1.000 | 113400. | 113400. | 37.80 | 2350.1 | 2387.9 | 37.80 | 2480.3 | 2518.1 | 0.1362 | 8.7903 | 8.9265 | |
| 10 | 283.15 | 1.227 | 1.000 | 106400. | 106400. | 41.99 | 2347.3 | 2389.3 | 41.99 | 2477.9 | 2519.9 | 0.1510 | 8.7510 | 8.9020 | |
| 11 | 284.15 | 1.312 | 1.000 | 99910. | 99910. | 46.18 | 2344.5 | 2390.7 | 46.18 | 2475.5 | 2521.7 | 0.1658 | 8.7119 | 8.8776 | |
| 12 | 285.15 | 1.401 | 1.000 | 93830. | 93830. | 50.38 | 2341.7 | 2392.1 | 50.38 | 2473.2 | 2523.6 | 0.1805 | 8.6731 | 8.8536 | |
| 13 | 286.15 | 1.497 | 1.001 | 88180. | 88180. | 54.56 | 2338.9 | 2393.4 | 54.56 | 2470.8 | 2525.4 | 0.1952 | 8.6345 | 8.8297 | |
| 14 | 287.15 | 1.597 | 1.001 | 82900. | 82900. | 58.75 | 2336.1 | 2394.8 | 58.75 | 2468.5 | 2527.2 | 0.2098 | 8.5963 | 8.8060 | |
| 15 | 288.15 | 1.704 | 1.001 | 77980. | 77980. | 62.94 | 2333.2 | 2396.2 | 62.94 | 2466.1 | 2529.1 | 0.2243 | 8.5582 | 8.7826 | |
| 16 | 289.15 | 1.817 | 1.001 | 73380. | 73380. | 67.12 | 2330.4 | 2397.6 | 67.12 | 2463.8 | 2530.9 | 0.2388 | 8.5205 | 8.7593 | |
| 17 | 290.15 | 1.936 | 1.001 | 69090. | 69090. | 71.31 | 2327.6 | 2398.9 | 71.31 | 2461.4 | 2532.7 | 0.2533 | 8.4830 | 8.7363 | |
| 18 | 291.15 | 2.062 | 1.001 | 65090. | 65090. | 75.49 | 2324.8 | 2400.3 | 75.49 | 2459.0 | 2534.5 | 0.2677 | 8.4458 | 8.7135 | |
| 19 | 292.15 | 2.196 | 1.002 | 61340. | 61340. | 79.68 | 2322.0 | 2401.7 | 79.68 | 2456.7 | 2536.4 | 0.2820 | 8.4088 | 8.6908 | |
| 20 | 293.15 | 2.337 | 1.002 | 57840. | 57840. | 83.86 | 2319.2 | 2403.0 | 83.86 | 2454.3 | 2538.2 | 0.2963 | 8.3721 | 8.6684 | |
| 21 | 294.15 | 2.485 | 1.002 | 54560. | 54560. | 88.04 | 2316.4 | 2404.4 | 88.04 | 2452.0 | 2540.0 | 0.3105 | 8.3356 | 8.6462 | |
| 22 | 295.15 | 2.642 | 1.002 | 51490. | 51490. | 92.22 | 2313.6 | 2405.8 | 92.22 | 2449.6 | 2541.8 | 0.3247 | 8.2994 | 8.6241 | |
| 23 | 296.15 | 2.808 | 1.002 | 48620. | 48620. | 96.40 | 2310.7 | 2407.1 | 96.41 | 2447.2 | 2543.6 | 0.3389 | 8.2634 | 8.6023 | |
| 24 | 297.15 | 2.982 | 1.003 | 45920. | 45920. | 100.6 | 2307.9 | 2408.5 | 100.6 | 2444.9 | 2545.5 | 0.3530 | 8.2277 | 8.5806 | |
| 25 | 298.15 | 3.166 | 1.003 | 43400. | 43400. | 104.8 | 2305.1 | 2409.9 | 104.8 | 2442.5 | 2547.3 | 0.3670 | 8.1922 | 8.5592 | |
| 26 | 299.15 | 3.360 | 1.003 | 41030. | 41030. | 108.9 | 2302.3 | 2411.2 | 108.9 | 2440.2 | 2549.1 | 0.3810 | 8.1569 | 8.5379 | |
| 27 | 300.15 | 3.564 | 1.003 | 38810. | 38810. | 113.1 | 2299.5 | 2412.5 | 113.1 | 2437.8 | 2550.9 | 0.3949 | 8.1218 | 8.5168 | |
| 28 | 301.15 | 3.778 | 1.004 | 36730. | 36730. | 117.3 | 2296.7 | 2413.8 | 117.3 | 2435.4 | 2552.7 | 0.4088 | 8.0870 | 8.4959 | |
| 29 | 302.15 | 4.004 | 1.004 | 34770. | 34770. | 121.5 | 2293.8 | 2415.1 | 121.5 | 2433.1 | 2554.5 | 0.4227 | 8.0524 | 8.4751 | |
| 30 | 303.15 | 4.241 | 1.004 | 32930. | 32930. | 125.7 | 2291.0 | 2416.7 | 125.7 | 2430.7 | 2556.4 | 0.4365 | 8.0180 | 8.4546 | |
| 31 | 304.15 | 4.491 | 1.005 | 31200. | 31200. | 129.8 | 2288.2 | 2418.0 | 129.8 | 2428.3 | 2558.2 | 0.4503 | 7.9839 | 8.4342 | |
| 32 | 305.15 | 4.753 | 1.005 | 29570. | 29570. | 134.0 | 2285.4 | 2419.4 | 134.0 | 2425.9 | 2560.0 | 0.4640 | 7.9500 | 8.4140 | |
| 33 | 306.15 | 5.029 | 1.005 | 28040. | 28040. | 138.2 | 2282.6 | 2420.8 | 138.2 | 2423.6 | 2561.8 | 0.4777 | 7.9163 | 8.3939 | |
| 34 | 307.15 | 5.318 | 1.006 | 26600. | 26600. | 142.4 | 2279.7 | 2422.1 | 142.4 | 2421.2 | 2563.6 | 0.4913 | 7.8828 | 8.3740 | |
| 35 | 308.15 | 5.622 | 1.006 | 25240. | 25240. | 146.6 | 2276.9 | 2423.5 | 146.6 | 2418.8 | 2565.4 | 0.5049 | 7.8495 | 8.3543 | |
| 36 | 309.15 | 5.940 | 1.006 | 23970. | 23970. | 150.7 | 2274.1 | 2424.8 | 150.7 | 2416.4 | 2567.2 | 0.5184 | 7.8164 | 8.3348 | |
| 37 | 310.15 | 6.274 | 1.007 | 22760. | 22760. | 154.9 | 2271.3 | 2426.2 | 154.9 | 2414.1 | 2569.0 | 0.5319 | 7.7835 | 8.3154 | |
| 38 | 311.15 | 6.624 | 1.007 | 21630. | 21630. | 159.1 | 2268.4 | 2427.5 | 159.1 | 2411.7 | 2570.8 | 0.5453 | 7.7509 | 8.2962 | |
| 39 | 312.15 | 6.991 | 1.007 | 20560. | 20560. | 163.3 | 2265.6 | 2428.9 | 163.3 | 2409.3 | 2572.6 | 0.5588 | 7.7184 | 8.2772 | |
| 40 | 313.15 | 7.375 | 1.008 | 19550. | 19550. | 167.4 | 2262.8 | 2430.2 | 167.4 | 2406.9 | 2574.4 | 0.5721 | 7.6861 | 8.2583 | |
| 41 | 314.15 | 7.777 | 1.008 | 18590. | 18590. | 171.6 | 2259.9 | 2431.6 | 171.6 | 2404.5 | 2576.2 | 0.5854 | 7.6541 | 8.2395 | |
| 42 | 315.15 | 8.198 | 1.009 | 17690. | 17690. | 175.8 | 2257.1 | 2432.9 | 175.8 | 2402.1 | 2577.9 | 0.5987 | 7.6222 | 8.2209 | |
| 43 | 316.15 | 8.639 | 1.009 | 16840. | 16840. | 180.0 | 2254.3 | 2434.2 | 180.0 | 2399.7 | 2579.7 | 0.6120 | 7.5905 | 8.2025 | |
| 44 | 317.15 | 9.100 | 1.009 | 16040. | 16040. | 184.2 | 2251.4 | 2435.6 | 184.2 | 2397.3 | 2581.5 | 0.6252 | 7.5590 | 8.1842 | |
| 45 | 318.15 | 9.582 | 1.010 | 15280. | 15280. | 188.3 | 2248.6 | 2436.9 | 188.4 | 2394.9 | 2583.3 | 0.6383 | 7.5277 | 8.1661 | |
| 46 | 319.15 | 10.09 | 1.010 | 14560. | 14560. | 192.5 | 2245.7 | 2438.3 | 192.5 | 2392.5 | 2585.1 | 0.6514 | 7.4966 | 8.1481 | |
| 47 | 320.15 | 10.61 | 1.011 | 13880. | 13880. | 196.7 | 2242.9 | 2439.6 | 196.7 | 2390.1 | 2586.9 | 0.6645 | 7.4657 | 8.1302 | |
| 48 | 321.15 | 11.16 | 1.011 | 13230. | 13230. | 200.9 | 2240.0 | 2440.9 | 200.9 | 2387.7 | 2588.6 | 0.6776 | 7.4350 | 8.1125 | |
| 49 | 322.15 | 11.74 | 1.012 | 12620. | 12620. | 205.1 | 2237.2 | 2442.3 | 205.1 | 2385.3 | 2590.4 | 0.6906 | 7.4044 | 8.0950 | |
| 50 | 323.15 | 12.34 | 1.012 | 12040. | 12040. | 209.2 | 2234.3 | 2443.6 | 209.3 | 2382.9 | 2592.2 | 0.7035 | 7.3741 | 8.0776 | |
| 51 | 324.15 | 12.96 | 1.013 | 11500. | 11500. | 213.4 | 2231.5 | 2444.9 | 213.4 | 2380.5 | 2593.9 | 0.7164 | 7.3439 | 8.0603 | |
| 52 | 325.15 | 13.61 | 1.013 | 10980. | 10980. | 217.6 | 2228.6 | 2446.2 | 217.6 | 2378.1 | 2595.7 | 0.7293 | 7.3138 | 8.0432 | |
| 53 | 326.15 | 14.29 | 1.014 | 10490. | 10490. | 221.8 | 2225.8 | 2447.6 | 221.8 | 2375.7 | 2597.5 | 0.7422 | 7.2840 | 8.0262 | |
| 54 | 327.15 | 15.00 | 1.014 | 10020. | 10020. | 226.0 | 2222.9 | 2448.9 | 226.0 | 2373.2 | 2599.2 | 0.7550 | 7.2543 | 8.0093 | |
| 55 | 328.15 | 15.74 | 1.015 | 9577.9 | 9578.9 | 230.2 | 2220.0 | 2450.2 | 230.2 | 2370.8 | 2601.0 | 0.7677 | 7.2248 | 7.9925 | |
| 56 | 329.15 | 16.51 | 1.015 | 9157.7 | 9158.7 | 234.3 | 2217.2 | 2451.5 | 234.4 | 2368.4 | 2602.7 | 0.7804 | 7.1955 | 7.9759 | |
| 57 | 330.15 | 17.31 | 1.016 | 8758.7 | 8759.8 | 238.5 | 2214.3 | 2452.8 | 238.5 | 2366.0 | 2604.5 | 0.7931 | 7.1663 | 7.9595 | |
| 58 | 331.15 | 18.15 | 1.016 | 8379.8 | 8380.8 | 242.7 | 2211.4 | 2454.1 | 242.7 | 2363.5 | 2606.2 | 0.8058 | 7.1373 | 7.9431 | |
| 59 | 332.15 | 19.02 | 1.017 | 8019.7 | 8020.8 | 246.9 | 2208.6 | 2455.4 | 246.9 | 2361.1 | 2608.0 | 0.8184 | 7.1085 | 7.9269 | |
| 60 | 333.15 | 19.92 | 1.017 | 7677.5 | 7678.5 | 251.1 | 2205.7 | 2456.8 | 251.1 | 2358.6 | 2609.7 | 0.8310 | 7.0798 | 7.9108 | |
| 61 | 334.15 | 20.86 | 1.018 | 7352.1 | 7353.2 | 255.3 | 2202.8 | 2458.1 | 255.3 | 2356.2 | 2611.4 | 0.8435 | 7.0513 | 7.8948 | |
| 62 | 335.15 | 21.84 | 1.018 | 7042.7 | 7043.7 | 259.4 | 2199.9 | 2459.5 | 259.4 | 2353.7 | 2613.2 | 0.8560 | 7.0230 | 7.8790 | |
| 63 | 336.15 | 22.86 | 1.019 | 6748.2 | 6749.3 | 263.6 | 2197.0 | 2460.7 | 263.6 | 2351.3 | 2614.9 | 0.8685 | 6.9948 | 7.8633 | |
| 64 | 337.15 | 23.91 | 1.019 | 6468.0 | 6469.0 | 267.8 | 2194.1 | 2462.0 | 267.8 | 2348.8 | 2616.6 | 0.8809 | 6.9667 | 7.8477 | |
| 65 | 338.15 | 25.01 | 1.020 | 6201.3 | 6202.3 | 272.0 | 2191.2 | 2463.2 | 272.0 | 2346.3 | 2618.4 | 0.8933 | 6.9388 | 7.8322 | |
| 66 | 339.15 | 26.15 | 1.020 | 5947.2 | 5948.2 | 276.2 | 2188.3 | 2464.5 | 276.2 | 2343.9 | 2620.1 | 0.9057 | 6.9111 | 7.8168 | |
| 67 | 340.15 | 27.33 | 1.021 | 5705.2 | 5706.2 | 280.4 | 2185.4 | 2465.8 | 280.4 | 2341.4 | 2621.8 | 0.9180 | 6.8835 | 7.8015 | |
| 68 | 341.15 | 28.56 | 1.022 | 5474.6 | 5475.6 | 284.6 | 2182.5 | 2467.1 | 284.6 | 2338.9 | 2623.5 | 0.9303 | 6.8561 | 7.7864 | |
| 69 | 342.15 | 29.84 | 1.022 | 5254.8 | 5255.8 | 288.8 | 2179.6 | 2468.4 | 288.8 | 2336.4 | 2625.2 | 0.9426 | 6.8288 | 7.7714 | |
| 70 | 343.15 | 31.16 | 1.023 | 5045.2 | 5046.3 | 292.9 | 2176.7 | 2469.7 | 293.0 | 2334.0 | 2626.9 | 0.9548 | 6.8017 | 7.7565 | |
| 71 | | | | | | | | | | | | | | | |

表 F.1 飽和蒸汽, SI 單位制 (續)

| t °C | T K | P kPa | 比體積 V | | 內能 U | | | 焓 H | | 熵 S | | | | |
|-----------|----------|------------|----------|----------|----------|----------|----------|----------|----------|----------|--------|--------|--------|--------|
| | | | 飽和 液體 | 飽和 汽體 | 飽和 液體 | 飽和 蒸發 | 飽和 汽體 | 飽和 液體 | 飽和 蒸發 | 飽和 汽體 | | | | |
| 75 | 348.15 | 38.55 | 1.026 | 4133.1 | 4134.1 | 313.9 | 2162.1 | 2476.0 | 313.9 | 2321.5 | 2635.4 | 1.0154 | 6.6681 | 7.6835 |
| 76 | 349.15 | 40.19 | 1.027 | 3974.6 | 3975.7 | 318.1 | 2159.2 | 2477.3 | 318.1 | 2318.9 | 2637.1 | 1.0275 | 6.6418 | 7.6693 |
| 77 | 350.15 | 41.89 | 1.027 | 3823.3 | 3824.3 | 322.3 | 2156.3 | 2478.5 | 322.3 | 2316.4 | 2638.7 | 1.0395 | 6.6156 | 7.6551 |
| 78 | 351.15 | 43.65 | 1.028 | 3678.6 | 3679.6 | 326.5 | 2153.3 | 2479.8 | 326.5 | 2313.9 | 2640.4 | 1.0514 | 6.5896 | 7.6410 |
| 79 | 352.15 | 45.47 | 1.029 | 3540.3 | 3541.3 | 330.7 | 2150.4 | 2481.1 | 330.7 | 2311.4 | 2642.1 | 1.0634 | 6.5637 | 7.6271 |
| 80 | 353.15 | 47.36 | 1.029 | 3408.1 | 3409.1 | 334.9 | 2147.4 | 2482.3 | 334.9 | 2308.8 | 2643.8 | 1.0753 | 6.5380 | 7.6132 |
| 81 | 354.15 | 49.31 | 1.030 | 3281.6 | 3282.6 | 339.1 | 2144.5 | 2483.5 | 339.1 | 2306.3 | 2645.4 | 1.0871 | 6.5123 | 7.5995 |
| 82 | 355.15 | 51.33 | 1.031 | 3160.6 | 3161.6 | 343.3 | 2141.5 | 2484.8 | 343.3 | 2303.8 | 2647.1 | 1.0990 | 6.4868 | 7.5858 |
| 83 | 356.15 | 53.42 | 1.031 | 3044.8 | 3045.8 | 347.5 | 2138.6 | 2486.0 | 347.5 | 2301.2 | 2648.7 | 1.1108 | 6.4615 | 7.5722 |
| 84 | 357.15 | 55.57 | 1.032 | 2933.9 | 2935.0 | 351.7 | 2135.6 | 2487.3 | 351.7 | 2298.6 | 2650.4 | 1.1225 | 6.4362 | 7.5587 |
| 85 | 358.15 | 57.80 | 1.033 | 2827.8 | 2828.8 | 355.9 | 2132.6 | 2488.5 | 355.9 | 2296.1 | 2652.0 | 1.1343 | 6.4111 | 7.5454 |
| 86 | 359.15 | 60.11 | 1.033 | 2726.1 | 2727.2 | 360.1 | 2129.7 | 2489.7 | 360.1 | 2293.5 | 2653.6 | 1.1460 | 6.3861 | 7.5321 |
| 87 | 360.15 | 62.49 | 1.034 | 2628.8 | 2629.8 | 364.3 | 2126.7 | 2490.9 | 364.3 | 2290.9 | 2655.3 | 1.1577 | 6.3612 | 7.5189 |
| 88 | 361.15 | 64.95 | 1.035 | 2535.4 | 2536.5 | 368.5 | 2123.7 | 2492.2 | 368.5 | 2288.4 | 2656.9 | 1.1693 | 6.3365 | 7.5058 |
| 89 | 362.15 | 67.49 | 1.035 | 2446.0 | 2447.0 | 372.7 | 2120.7 | 2493.4 | 372.7 | 2285.8 | 2658.5 | 1.1809 | 6.3119 | 7.4928 |
| 90 | 363.15 | 70.11 | 1.036 | 2360.3 | 2361.3 | 376.9 | 2117.7 | 2494.6 | 376.9 | 2283.2 | 2660.1 | 1.1925 | 6.2873 | 7.4799 |
| 91 | 364.15 | 72.81 | 1.037 | 2278.0 | 2279.1 | 381.1 | 2114.7 | 2495.8 | 381.1 | 2280.6 | 2661.7 | 1.2041 | 6.2629 | 7.4670 |
| 92 | 365.15 | 75.61 | 1.038 | 2199.2 | 2200.2 | 385.3 | 2111.7 | 2497.0 | 385.3 | 2278.0 | 2663.4 | 1.2156 | 6.2387 | 7.4543 |
| 93 | 366.15 | 78.49 | 1.038 | 2124.5 | 2125.5 | 389.5 | 2108.7 | 2498.2 | 389.5 | 2275.4 | 2665.0 | 1.2271 | 6.2145 | 7.4416 |
| 94 | 367.15 | 81.46 | 1.039 | 2050.9 | 2051.9 | 393.7 | 2105.7 | 2499.4 | 393.7 | 2272.8 | 2666.6 | 1.2386 | 6.1905 | 7.4291 |
| 95 | 368.15 | 84.53 | 1.040 | 1981.2 | 1982.2 | 397.9 | 2102.7 | 2500.6 | 397.9 | 2270.2 | 2668.1 | 1.2501 | 6.1665 | 7.4166 |
| 96 | 369.15 | 87.69 | 1.041 | 1914.3 | 1915.3 | 402.1 | 2099.7 | 2501.8 | 402.1 | 2267.5 | 2669.7 | 1.2615 | 6.1427 | 7.4042 |
| 97 | 370.15 | 90.94 | 1.041 | 1850.0 | 1851.0 | 406.3 | 2096.6 | 2503.0 | 406.3 | 2264.9 | 2671.3 | 1.2729 | 6.1190 | 7.3919 |
| 98 | 371.15 | 94.30 | 1.042 | 1788.3 | 1789.3 | 410.5 | 2093.6 | 2504.1 | 410.5 | 2262.2 | 2672.9 | 1.2842 | 6.0954 | 7.3796 |
| 99 | 372.15 | 97.76 | 1.043 | 1729.0 | 1730.0 | 414.7 | 2090.6 | 2505.3 | 414.7 | 2259.6 | 2674.4 | 1.2956 | 6.0719 | 7.3675 |
| 100 | 373.15 | 101.33 | 1.044 | 1672.0 | 1673.0 | 419.0 | 2087.5 | 2506.5 | 419.0 | 2256.9 | 2676.0 | 1.3069 | 6.0485 | 7.3554 |
| 102 | 375.15 | 108.78 | 1.045 | 1564.5 | 1565.5 | 427.4 | 2081.4 | 2508.8 | 427.4 | 2251.6 | 2679.1 | 1.3294 | 6.0021 | 7.3315 |
| 104 | 377.15 | 116.68 | 1.047 | 1465.2 | 1466.2 | 435.8 | 2075.3 | 2511.1 | 435.8 | 2246.3 | 2682.2 | 1.3518 | 5.9560 | 7.3078 |
| 106 | 379.15 | 125.04 | 1.049 | 1373.1 | 1374.2 | 444.3 | 2069.2 | 2513.4 | 444.3 | 2240.9 | 2685.3 | 1.3742 | 5.9104 | 7.2845 |
| 108 | 381.15 | 133.90 | 1.050 | 1287.9 | 1288.9 | 452.7 | 2063.0 | 2515.7 | 452.7 | 2235.4 | 2688.3 | 1.3964 | 5.8651 | 7.2615 |
| 110 | 383.15 | 143.27 | 1.052 | 1208.9 | 1209.9 | 461.2 | 2056.8 | 2518.0 | 461.2 | 2230.0 | 2691.3 | 1.4185 | 5.8203 | 7.2388 |
| 112 | 385.15 | 153.16 | 1.054 | 1135.6 | 1136.6 | 469.6 | 2050.6 | 2520.2 | 469.6 | 2224.5 | 2694.3 | 1.4405 | 5.7758 | 7.2164 |
| 114 | 387.15 | 163.62 | 1.055 | 1067.5 | 1068.5 | 478.1 | 2044.3 | 2522.4 | 478.1 | 2219.0 | 2697.2 | 1.4624 | 5.7318 | 7.1942 |
| 116 | 389.15 | 174.65 | 1.057 | 1004.2 | 1005.2 | 486.6 | 2038.1 | 2524.6 | 486.6 | 2213.4 | 2700.2 | 1.4842 | 5.6881 | 7.1723 |
| 118 | 391.15 | 186.28 | 1.059 | 945.3 | 946.3 | 495.0 | 2031.8 | 2526.8 | 495.0 | 2207.9 | 2703.1 | 1.5060 | 5.6447 | 7.1507 |
| 120 | 393.15 | 198.54 | 1.061 | 890.5 | 891.5 | 503.5 | 2025.4 | 2529.0 | 503.5 | 2202.2 | 2706.0 | 1.5276 | 5.6017 | 7.1293 |
| 122 | 395.15 | 211.45 | 1.062 | 839.4 | 840.5 | 512.0 | 2019.1 | 2531.1 | 512.0 | 2196.6 | 2708.8 | 1.5491 | 5.5590 | 7.1082 |
| 124 | 397.15 | 225.04 | 1.064 | 791.8 | 792.8 | 520.5 | 2012.7 | 2533.2 | 520.5 | 2190.9 | 2711.6 | 1.5708 | 5.5167 | 7.0873 |
| 126 | 399.15 | 239.32 | 1.066 | 747.3 | 748.4 | 529.0 | 2006.3 | 2535.3 | 529.0 | 2185.2 | 2714.4 | 1.5925 | 5.4747 | 7.0666 |
| 128 | 401.15 | 254.35 | 1.068 | 705.8 | 706.9 | 537.5 | 1999.9 | 2537.4 | 537.5 | 2179.4 | 2717.2 | 1.6152 | 5.4330 | 7.0462 |
| 130 | 403.15 | 270.13 | 1.070 | 667.1 | 668.1 | 546.0 | 1993.4 | 2539.4 | 546.0 | 2173.6 | 2719.9 | 1.6384 | 5.3917 | 7.0261 |
| 132 | 405.15 | 286.70 | 1.072 | 630.8 | 631.9 | 554.5 | 1986.9 | 2541.4 | 554.5 | 2167.8 | 2722.6 | 1.6555 | 5.3507 | 7.0061 |
| 134 | 407.15 | 304.07 | 1.074 | 596.9 | 598.0 | 563.1 | 1980.4 | 2543.4 | 563.1 | 2161.9 | 2725.3 | 1.6765 | 5.3099 | 6.9864 |
| 136 | 409.15 | 322.29 | 1.076 | 565.1 | 566.2 | 571.6 | 1973.8 | 2545.4 | 571.6 | 2155.9 | 2727.9 | 1.6974 | 5.2695 | 6.9669 |
| 138 | 411.15 | 341.38 | 1.078 | 535.3 | 536.4 | 580.2 | 1967.2 | 2547.4 | 580.2 | 2150.0 | 2730.5 | 1.7182 | 5.2293 | 6.9475 |
| 140 | 413.15 | 361.38 | 1.080 | 507.4 | 508.5 | 588.7 | 1960.6 | 2549.3 | 588.7 | 2144.0 | 2733.1 | 1.7390 | 5.1894 | 6.9284 |
| 142 | 415.15 | 382.31 | 1.082 | 481.2 | 482.3 | 597.3 | 1953.9 | 2551.2 | 597.3 | 2137.9 | 2735.6 | 1.7597 | 5.1499 | 6.9095 |
| 144 | 417.15 | 404.20 | 1.084 | 456.6 | 457.7 | 605.9 | 1947.2 | 2553.1 | 605.9 | 2131.8 | 2738.1 | 1.7803 | 5.1105 | 6.8908 |
| 146 | 419.15 | 427.09 | 1.086 | 433.5 | 434.6 | 614.4 | 1940.5 | 2554.9 | 614.4 | 2125.7 | 2740.6 | 1.8008 | 5.0715 | 6.8723 |
| 148 | 421.15 | 451.01 | 1.089 | 411.8 | 412.9 | 623.0 | 1933.7 | 2556.8 | 623.0 | 2119.5 | 2743.0 | 1.8213 | 5.0327 | 6.8539 |
| 150 | 423.15 | 476.00 | 1.091 | 391.4 | 392.4 | 631.6 | 1926.9 | 2558.6 | 631.6 | 2113.2 | 2745.4 | 1.8416 | 4.9941 | 6.8358 |
| 152 | 425.15 | 502.08 | 1.093 | 372.1 | 373.2 | 640.2 | 1920.1 | 2560.3 | 640.2 | 2106.9 | 2747.7 | 1.8619 | 4.9558 | 6.8178 |
| 154 | 427.15 | 529.29 | 1.095 | 354.0 | 355.1 | 648.9 | 1913.2 | 2562.1 | 648.9 | 2100.6 | 2750.0 | 1.8822 | 4.9178 | 6.8000 |
| 156 | 429.15 | 557.67 | 1.098 | 336.9 | 338.0 | 657.5 | 1906.3 | 2563.8 | 657.5 | 2094.2 | 2752.3 | 1.9023 | 4.8800 | 6.7823 |
| 158 | 431.15 | 587.25 | 1.100 | 320.8 | 321.9 | 666.1 | 1899.3 | 2565.5 | 666.1 | 2087.7 | 2754.5 | 1.9224 | 4.8424 | 6.7648 |
| 160 | 433.15 | 618.06 | 1.102 | 305.7 | 306.8 | 674.8 | 1892.3 | 2567.1 | 674.8 | 2081.3 | 2756.7 | 1.9425 | 4.8050 | 6.7475 |
| 162 | 435.15 | 650.16 | 1.105 | 291.3 | 292.4 | 683.5 | 1885.3 | 2568.8 | 683.5 | 2074.7 | 2758.9 | 1.9624 | 4.7679 | 6.7303 |
| 164 | 437.15 | 683.56 | 1.107 | 277.8 | 278.9 | 692.1 | 1878.2 | 2570.4 | 692.1 | 2068.1 | 2761.0 | 1.9823 | 4.7309 | 6.7133 |
| 166 | 439.15 | 718.31 | 1.109 | 265.0 | 266.1 | 700.8 | 1871.1 | 2571.9 | 700.8 | 2061.4 | 2763.1 | 2.0022 | 4.6942 | 6.6964 |
| 168 | 441.15 | 754.45 | 1.112 | 252.9 | 254.0 | 709.5 | 1863.9 | 2573.4 | 709.5 | 2054.7 | 2765.1 | 2.0219 | 4.6577 | 6.6796 |
| 170 | 443.15 | 792.02 | 1.114 | 241.4 | 242.6 | 718.2 | 1856.7 | 2574.9 | 718.2 | 2047.9 | 2767.1 | 2.0416 | 4.6214 | 6.6630 |
| 172 | 445.15 | 831.06 | 1.117 | 230.6 | 231.7 | 727.0 | 1849.5 | 2576.4 | 727.0 | 2041.1 | 2769.0 | 2.0613 | 4.5853 | 6.6465 |
| 174 | 447.15 | 871.60 | 1.120 | 220.3 | 221.5 | 735.7 | 1842.2 | 2577.8 | 735.7 | 2034.2 | 2770.9 | 2.0809 | 4.5493 | 6.6302 |
| 176 | 449.15 | 913.68 | 1.122 | 210.6 | 211.7 | 744.4 | 1834.8 | 2579.3 | 744.4 | 2027.3 | 2772.7 | 2.1004 | 4.5136 | 6.6140 |
| 178 | 451.15 | 957.36 | 1.125 | 201.4 | 202.5 | 753.2 | 1827.4 | 2580.6 | 753.2 | 2020.2 | 2774.5 | 2.1199 | 4.4780 | 6.5979 |
| 180 | 453.15 | 1002.7 | 1.128 | 192.7 | 193.8 | 762.0 | 1820.0 | 2581.9 | 762.0 | 2013.1 | 2776.3 | 2.1393 | 4.4426 | 6.5819 |
| 182 | 455.15 | 1049.6 | 1.130 | 184.4 | 185.5 | 770.8 | 1812.5 | 2583.2 | 770.8 | 2006.0 | 2778.0 | 2.1587 | 4.4074 | 6.5660 |
| 184 | 457.15 | 1098.3 | 1.133 | 176.5 | 177.6 | 779.6 | 1804.9 | 2584.5 | 779.6 | 1998.8 | 2779.6 | 2.1780 | 4.3723 | 6.5503 |
| 186 | 459.15 | 1148.8 | 1.136 | 169.0 | 170.2 | 788.4 | 1797.3 | 2585.7 | 788.4 | 1991.5 | 2781.2 | 2.1972 | 4.3374 | 6.5346 |
| 188 | 461.15 | 1201.0 | 1.139 | 161.9 | 163.1 | 797.2 | 1789.7 | 2586.9 | 797.2 | 1984.2 | 2782.8 | 2.2164 | 4.3026 | 6.5191 |
| 190 | 463.15 | 1255.1 | 1.142 | 155.2 | 156.3 | 806.1 | 1782.0 | 2588.1 | 806.1 | 1976.7 | 2784.3 | 2.2356 | 4.2680 | 6.5036 |
| 192 | 465.15 | 1311.1 | 1.144 | 148.8 | 149.9 | 814.9 | 1774.2 | 2589.2 | 814.9 | 1969.3 | 2785.7 | 2.2547 | 4.2336 | 6.4883 |
| 194 | 467.15 | 1369.0 | 1.147 | 142.6 | 143.8 | 823.8 | 1766.4 | 2590.2 | 823.8 | 1961.7 | 2787.1 | 2.2738 | 4.1993 | 6.4730 |
| 196 | 469.15 | 1428.9 | 1.150 | 136.8 | 138.0 | 832.7 | 1758.6 | 2591.3 | 832.7 | 1954.1 | 2788.4 | 2.2928 | 4.1651 | 6.4578 |
| 198 | 471.15 | 1490.9 | 1.153 | 131.3</ | | | | | | | | | | |

表 F.2 過熱蒸汽, SI 單位制

溫度: $t^{\circ}\text{C}$
(溫度: T 度 K)

| P/kPa ($t^{\text{sat}}/^{\circ}\text{C}$) | 飽和 液體 | 飽和 汽體 | 75 (348.15) | 100 (373.15) | 125 (398.15) | 150 (423.15) | 175 (448.15) | 200 (473.15) | 225 (498.15) | 250 (523.15) | |
|---|----------|----------|----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|-----------------|---------|
| | V | 1.000 | 129200. | 160640. | 172180. | 183720. | 195270. | 206810. | 218350. | 229890. | 241430. |
| 1 (6.98) | U | 29.334 | 2385.2 | 2480.8 | 2516.4 | 2552.3 | 2588.5 | 2624.9 | 2661.7 | 2698.8 | 2736.3 |
| | H | 29.335 | 2514.4 | 2641.5 | 2688.6 | 2736.0 | 2783.7 | 2831.7 | 2880.1 | 2928.7 | 2977.7 |
| | S | 0.1060 | 8.9767 | 9.3828 | 9.5136 | 9.6365 | 9.7527 | 9.8629 | 9.9679 | 10.0681 | 10.1641 |
| | V | 1.010 | 14670. | 16030. | 17190. | 18350. | 19510. | 20660. | 21820. | 22980. | 24130. |
| 10 (45.83) | U | 191.822 | 2438.0 | 2479.7 | 2515.6 | 2551.6 | 2588.0 | 2624.5 | 2661.4 | 2698.6 | 2736.1 |
| | H | 191.832 | 2584.8 | 2640.0 | 2687.5 | 2735.2 | 2783.1 | 2831.2 | 2879.6 | 2928.4 | 2977.4 |
| | S | 0.6493 | 8.1511 | 8.3168 | 8.4486 | 8.5722 | 8.6888 | 8.7994 | 8.9045 | 9.0049 | 9.1010 |
| | V | 1.017 | 7649.8 | 8000.0 | 8584.7 | 9167.1 | 9748.0 | 10320. | 10900. | 11480. | 12060. |
| 20 (60.09) | U | 251.432 | 2456.9 | 2478.4 | 2514.6 | 2550.9 | 2587.4 | 2624.1 | 2661.0 | 2698.3 | 2735.8 |
| | H | 251.453 | 2609.9 | 2638.4 | 2686.3 | 2734.2 | 2782.3 | 2830.6 | 2879.2 | 2928.0 | 2977.1 |
| | S | 0.8321 | 7.9094 | 7.9933 | 8.1261 | 8.2504 | 8.3676 | 8.4785 | 8.5839 | 8.6844 | 8.7806 |
| | V | 1.022 | 5229.3 | 5322.0 | 5714.4 | 6104.6 | 6493.2 | 6880.8 | 7267.5 | 7653.8 | 8039.7 |
| 30 (69.12) | U | 289.271 | 2468.6 | 2477.1 | 2513.6 | 2550.2 | 2586.8 | 2623.6 | 2660.7 | 2698.0 | 2735.6 |
| | H | 289.302 | 2625.4 | 2636.8 | 2685.1 | 2733.3 | 2781.6 | 2830.0 | 2878.7 | 2927.6 | 2976.8 |
| | S | 0.9441 | 7.7695 | 7.8024 | 7.9363 | 8.0614 | 8.1791 | 8.2903 | 8.3960 | 8.4967 | 8.5930 |
| | V | 1.027 | 3993.4 | ..... | 4279.2 | 4573.3 | 4865.8 | 5157.2 | 5447.8 | 5738.0 | 6027.7 |
| 40 (75.89) | U | 317.609 | 2477.1 | ..... | 2512.6 | 2549.4 | 2586.2 | 2623.2 | 2660.3 | 2697.7 | 2735.4 |
| | H | 317.650 | 2636.9 | ..... | 2683.8 | 2732.3 | 2780.9 | 2829.5 | 2878.2 | 2927.2 | 2976.5 |
| | S | 1.0261 | 7.6709 | ..... | 7.8009 | 7.9268 | 8.0450 | 8.1566 | 8.2624 | 8.3633 | 8.4598 |
| | V | 1.030 | 3240.2 | ..... | 3418.1 | 3654.5 | 3889.3 | 4123.0 | 4356.0 | 4588.5 | 4820.5 |
| 50 (81.35) | U | 340.513 | 2484.0 | ..... | 2511.7 | 2548.6 | 2585.6 | 2622.7 | 2659.9 | 2697.4 | 2735.1 |
| | H | 340.564 | 2646.0 | ..... | 2682.6 | 2731.4 | 2780.1 | 2828.9 | 2877.7 | 2926.8 | 2976.1 |
| | S | 1.0912 | 7.5947 | ..... | 7.6953 | 7.8219 | 7.9406 | 8.0526 | 8.1587 | 8.2598 | 8.3564 |
| | V | 1.037 | 2216.9 | ..... | 2269.8 | 2429.4 | 2587.3 | 2744.2 | 2900.2 | 3055.8 | 3210.9 |
| 75 (91.79) | U | 384.374 | 2496.7 | ..... | 2509.2 | 2546.7 | 2584.2 | 2621.6 | 2659.0 | 2696.7 | 2734.5 |
| | H | 384.451 | 2663.0 | ..... | 2679.4 | 2728.9 | 2778.2 | 2827.4 | 2876.6 | 2925.8 | 2975.3 |
| | S | 1.2131 | 7.4570 | ..... | 7.5014 | 7.6300 | 7.7500 | 7.8629 | 7.9697 | 8.0712 | 8.1681 |
| | V | 1.043 | 1693.7 | ..... | 1695.5 | 1816.7 | 1936.3 | 2054.7 | 2172.3 | 2289.4 | 2406.1 |
| 100 (99.63) | U | 417.406 | 2506.1 | ..... | 2506.6 | 2544.8 | 2582.7 | 2620.4 | 2658.1 | 2695.9 | 2733.9 |
| | H | 417.511 | 2675.4 | ..... | 2676.2 | 2726.5 | 2776.3 | 2825.9 | 2875.4 | 2924.9 | 2974.5 |
| | S | 1.3027 | 7.3598 | ..... | 7.3618 | 7.4923 | 7.6137 | 7.7275 | 7.8349 | 7.9369 | 8.0342 |
| | V | 1.044 | 1673.0 | ..... | 1673.0 | 1792.7 | 1910.7 | 2027.7 | 2143.8 | 2259.3 | 2374.5 |
| 101.325 (100.00) | U | 418.959 | 2506.5 | ..... | 2506.5 | 2544.7 | 2582.6 | 2620.4 | 2658.1 | 2695.9 | 2733.9 |
| | H | 419.064 | 2676.0 | ..... | 2676.0 | 2726.4 | 2776.2 | 2825.8 | 2875.3 | 2924.8 | 2974.5 |
| | S | 1.3069 | 7.3554 | ..... | 7.3554 | 7.4860 | 7.6075 | 7.7213 | 7.8288 | 7.9308 | 8.0280 |
| | V | 1.049 | 1374.6 | ..... | ..... | 1449.1 | 1545.6 | 1641.0 | 1735.6 | 1829.6 | 1923.2 |
| 125 (105.99) | U | 444.224 | 2513.4 | ..... | ..... | 2542.9 | 2581.2 | 2619.3 | 2657.2 | 2695.2 | 2733.3 |
| | H | 444.356 | 2685.2 | ..... | ..... | 2724.0 | 2774.4 | 2824.4 | 2874.2 | 2923.9 | 2973.7 |
| | S | 1.3740 | 7.2847 | ..... | ..... | 7.3844 | 7.5072 | 7.6219 | 7.7300 | 7.8324 | 7.9300 |
| | V | 1.053 | 1159.0 | ..... | ..... | 1204.0 | 1285.2 | 1365.2 | 1444.4 | 1523.0 | 1601.3 |
| 150 (111.37) | U | 466.968 | 2519.5 | ..... | ..... | 2540.9 | 2579.7 | 2618.1 | 2656.3 | 2694.4 | 2732.7 |
| | H | 467.126 | 2693.4 | ..... | ..... | 2721.5 | 2772.5 | 2822.9 | 2872.9 | 2922.9 | 2972.9 |
| | S | 1.4336 | 7.2234 | ..... | ..... | 7.2953 | 7.4194 | 7.5352 | 7.6439 | 7.7468 | 7.8447 |
| | V | 1.057 | 1003.34 | ..... | ..... | 1028.8 | 1099.1 | 1168.2 | 1236.4 | 1304.1 | 1371.3 |
| 175 (116.06) | U | 486.815 | 2524.7 | ..... | ..... | 2538.9 | 2578.2 | 2616.9 | 2655.3 | 2693.7 | 2732.1 |
| | H | 487.000 | 2700.3 | ..... | ..... | 2719.0 | 2770.5 | 2821.3 | 2871.7 | 2921.9 | 2972.0 |
| | S | 1.4849 | 7.1716 | ..... | ..... | 7.2191 | 7.3447 | 7.4614 | 7.5708 | 7.6741 | 7.7724 |
| | V | 1.061 | 885.44 | ..... | ..... | 897.47 | 959.54 | 1020.4 | 1080.4 | 1139.8 | 1198.9 |
| 200 (120.23) | U | 504.489 | 2529.2 | ..... | ..... | 2536.9 | 2576.6 | 2615.7 | 2654.4 | 2692.9 | 2731.4 |
| | H | 504.701 | 2706.3 | ..... | ..... | 2716.4 | 2768.5 | 2819.8 | 2870.5 | 2920.9 | 2971.2 |
| | S | 1.5301 | 7.1268 | ..... | ..... | 7.1523 | 7.2794 | 7.3971 | 7.5072 | 7.6110 | 7.7096 |
| | V | 1.064 | 792.97 | ..... | ..... | 795.25 | 850.97 | 905.44 | 959.06 | 1012.1 | 1064.7 |
| 225 (123.99) | U | 520.465 | 2533.2 | ..... | ..... | 2544.8 | 2575.1 | 2614.5 | 2653.5 | 2692.2 | 2730.8 |
| | H | 520.705 | 2711.6 | ..... | ..... | 2713.8 | 2766.5 | 2818.2 | 2869.3 | 2919.9 | 2970.4 |
| | S | 1.5705 | 7.0873 | ..... | ..... | 7.0928 | 7.2213 | 7.3400 | 7.4508 | 7.5551 | 7.6540 |
| | V | 1.068 | 718.44 | ..... | ..... | 764.09 | 813.47 | 861.98 | 909.91 | 957.41 | 1004.7 |
| 250 (127.43) | U | 535.077 | 2536.8 | ..... | ..... | 2573.5 | 2573.5 | 2613.3 | 2652.5 | 2691.4 | 2730.2 |
| | H | 535.343 | 2716.4 | ..... | ..... | 2764.5 | 2816.7 | 2868.0 | 2918.9 | 2969.6 | 3020.3 |
| | S | 1.6071 | 7.0520 | ..... | ..... | 7.1689 | 7.2886 | 7.4001 | 7.5050 | 7.6042 | 7.6982 |
| | V | 1.071 | 657.04 | ..... | ..... | ..... | 693.00 | 738.21 | 782.55 | 826.29 | 869.61 |
| 275 (130.60) | U | 548.564 | 2540.0 | ..... | ..... | ..... | 2571.9 | 2612.1 | 2651.6 | 2690.7 | 2729.6 |
| | H | 548.858 | 2720.7 | ..... | ..... | ..... | 2762.5 | 2815.1 | 2866.8 | 2917.9 | 2968.7 |
| | S | 1.6407 | 7.0201 | ..... | ..... | ..... | 7.1211 | 7.2419 | 7.3541 | 7.4594 | 7.5590 |
| | V | 1.073 | 605.56 | ..... | ..... | ..... | 633.74 | 675.49 | 716.35 | 756.60 | 796.44 |
| 300 (133.54) | U | 561.107 | 2543.0 | ..... | ..... | ..... | 2570.3 | 2610.8 | 2650.6 | 2689.9 | 2729.0 |
| | H | 561.429 | 2724.7 | ..... | ..... | ..... | 2760.4 | 2813.5 | 2865.5 | 2916.9 | 2967.9 |
| | S | 1.6716 | 6.9909 | ..... | ..... | ..... | 7.0771 | 7.1990 | 7.3119 | 7.4177 | 7.5176 |

