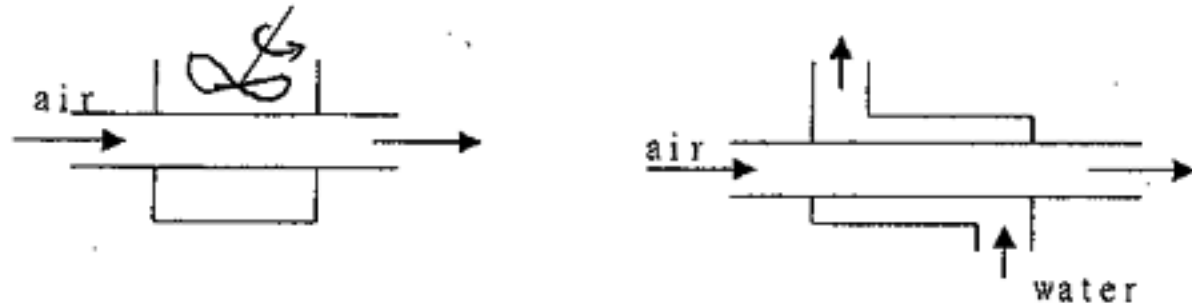
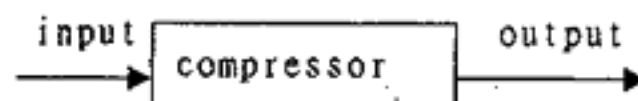


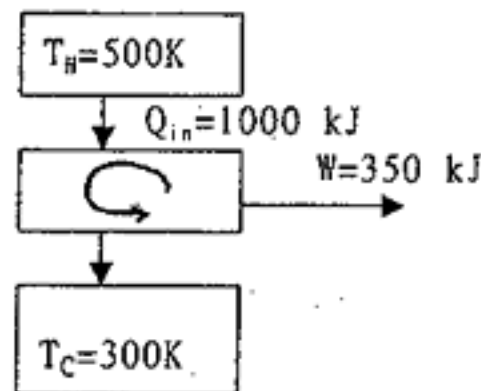
1. 您認為熱力學是一門.....?請加以說明。(10%)
2. 說明 Carnot cycle 及其效率;並請設計另一個 cycle 使其效率如 Carnot cycle。(10%)
3. 若欲使質量 1kg, 壓力 1bar, 溫度 17°C 之空氣變成壓力 1bar, 溫度 52°C, 現擬以(1)攪拌器做功方式 (2)由 1bar 飽和蒸汽加熱變成 1bar 飽和液體之熱交換器方式為之, 請比較此兩者之 entropy production. 以熱力學觀點請問何者較符合節能。(15%) (表在下一頁)



4. 一個壓縮機系統若是可逆之運轉, 其做功應如何表示? 若是維持等溫或等熵, 則何者較省能? (15%)



5. 如何定出 Kelvin 溫度之尺度(Kelvin temperature scale)? (10%)
6. 如圖所示, 試問此系統(1)最大效率(2)實際效率(3)造成實際效率低於最大效率之原因為何? (10%)



7. (1)繪圖表示 ideal Brayton refrigeration cycle 之 T-s 圖, (2)若欲提升其效率試問應如何改善? (15%)
8. A system undergoing a thermodynamic cycle receives Q_H at temperature T'_H and discharges Q_C at temperature T'_C . There are no other heat transfers. Show that the net work developed per cycle is given by

$$W_{\text{cycle}} = Q_H \left(1 - \frac{T'_C}{T'_H}\right) - T'_C \sigma$$

Where σ is the amount of entropy produced per cycle owing to irreversibilities within the system. (15%)

(背面仍有題目, 請繼續作答)

TABLE A-22 Ideal Gas Properties of Air

T (K), h and u (kJ/kg), s° (kJ/kg·K)

| T | h | p _r | u | v _r | s° | T | h | p _r | u | v _r | s° |
|-----|--------|----------------|--------|----------------|---------|-----|--------|----------------|--------|----------------|---------|
| 200 | 199.97 | 0.3363 | 142.56 | 1707. | 1.29559 | 450 | 451.80 | 5.775 | 322.62 | 223.6 | 2.11161 |
| 210 | 209.97 | 0.3987 | 149.69 | 1512. | 1.34444 | 460 | 462.02 | 6.245 | 329.97 | 211.4 | 2.13407 |
| 220 | 219.97 | 0.4690 | 156.82 | 1346. | 1.39105 | 470 | 472.24 | 6.742 | 337.32 | 200.1 | 2.15604 |
| 230 | 230.02 | 0.5477 | 164.00 | 1205. | 1.43557 | 480 | 482.49 | 7.268 | 344.70 | 189.5 | 2.17760 |
| 240 | 240.02 | 0.6355 | 171.13 | 1084. | 1.47824 | 490 | 492.74 | 7.824 | 352.08 | 179.7 | 2.19876 |
| 250 | 250.05 | 0.7329 | 178.28 | 979. | 1.51917 | 500 | 503.02 | 8.411 | 359.49 | 170.6 | 2.21952 |
| 260 | 260.09 | 0.8405 | 185.45 | 887.8 | 1.55848 | 510 | 513.32 | 9.031 | 366.92 | 162.1 | 2.23993 |
| 270 | 270.11 | 0.9590 | 192.60 | 808.0 | 1.59634 | 520 | 523.63 | 9.684 | 374.36 | 154.1 | 2.25997 |
| 280 | 280.13 | 1.0889 | 199.75 | 738.0 | 1.63279 | 530 | 533.98 | 10.37 | 381.84 | 146.7 | 2.27967 |
| 285 | 285.14 | 1.1584 | 203.33 | 706.1 | 1.65055 | 540 | 544.35 | 11.10 | 389.34 | 139.7 | 2.29906 |
| 290 | 290.16 | 1.2311 | 206.91 | 676.1 | 1.66802 | 550 | 554.74 | 11.86 | 396.86 | 133.1 | 2.31809 |
| 295 | 295.17 | 1.3068 | 210.49 | 647.9 | 1.68515 | 560 | 565.17 | 12.66 | 404.42 | 127.0 | 2.33685 |
| 300 | 300.19 | 1.3860 | 214.07 | 621.2 | 1.70203 | 570 | 575.59 | 13.50 | 411.97 | 121.2 | 2.35531 |
| 305 | 305.22 | 1.4686 | 217.67 | 596.0 | 1.71865 | 580 | 586.04 | 14.38 | 419.55 | 115.7 | 2.37348 |
| 310 | 310.24 | 1.5546 | 221.25 | 572.3 | 1.73498 | 590 | 596.52 | 15.31 | 427.15 | 110.6 | 2.39140 |
| 315 | 315.27 | 1.6442 | 224.85 | 549.8 | 1.75106 | 600 | 607.02 | 16.28 | 434.78 | 105.8 | 2.40902 |
| 320 | 320.29 | 1.7375 | 228.42 | 528.6 | 1.76690 | 610 | 617.53 | 17.30 | 442.42 | 101.2 | 2.42644 |
| 325 | 325.31 | 1.8345 | 232.02 | 508.4 | 1.78249 | 620 | 628.07 | 18.36 | 450.09 | 96.92 | 2.44356 |
| 330 | 330.34 | 1.9352 | 235.61 | 489.4 | 1.79783 | 630 | 638.63 | 19.46 | 457.78 | 92.84 | 2.46048 |
| 340 | 340.42 | 2.149 | 242.82 | 454.1 | 1.82790 | 640 | 649.22 | 20.64 | 465.50 | 88.99 | 2.47716 |

TABLE A-3 Properties of Saturated Water (Liquid-Vapor): Pressure Table

| Press. bars | Temp. °C | Specific Volume m ³ /kg | | Internal Energy kJ/kg | | Enthalpy kJ/kg | | | Entropy kJ/kg·K | | Press. bars |
|-------------|----------|--|---------------------------|----------------------------|---------------------------|----------------------------|-----------------------|---------------------------|----------------------------|---------------------------|-------------|
| | | Sat. Liquid v _f × 10 ³ | Sat. Vapor v _g | Sat. Liquid u _f | Sat. Vapor u _g | Sat. Liquid h _f | Evap. h _{fg} | Sat. Vapor h _g | Sat. Liquid s _f | Sat. Vapor s _g | |
| 0.04 | 28.96 | 1.0040 | 34.800 | 121.45 | 2415.2 | 121.46 | 2432.9 | 2554.4 | 0.4226 | 8.4746 | 0.04 |
| 0.06 | 36.16 | 1.0064 | 23.739 | 151.53 | 2425.0 | 151.53 | 2415.9 | 2567.4 | 0.5210 | 8.3304 | 0.06 |
| 0.08 | 41.51 | 1.0084 | 18.103 | 173.87 | 2432.2 | 173.88 | 2403.1 | 2577.0 | 0.5926 | 8.2287 | 0.08 |
| 0.10 | 45.81 | 1.0102 | 14.674 | 191.82 | 2437.9 | 191.83 | 2392.8 | 2584.7 | 0.6493 | 8.1502 | 0.10 |
| 0.20 | 60.06 | 1.0172 | 7.649 | 251.38 | 2456.7 | 251.40 | 2358.3 | 2609.7 | 0.8320 | 7.9085 | 0.20 |
| 0.30 | 69.10 | 1.0223 | 5.229 | 289.20 | 2468.4 | 289.23 | 2336.1 | 2625.3 | 0.9439 | 7.7686 | 0.30 |
| 0.40 | 75.87 | 1.0265 | 3.993 | 317.53 | 2477.0 | 317.58 | 2319.2 | 2636.8 | 1.0259 | 7.6700 | 0.40 |
| 0.50 | 81.33 | 1.0300 | 3.240 | 340.44 | 2483.9 | 340.49 | 2305.4 | 2645.9 | 1.0910 | 7.5939 | 0.50 |
| 0.60 | 85.94 | 1.0331 | 2.732 | 359.79 | 2489.6 | 359.86 | 2293.6 | 2653.5 | 1.1453 | 7.5320 | 0.60 |
| 0.70 | 89.95 | 1.0360 | 2.365 | 376.63 | 2494.5 | 376.70 | 2283.3 | 2660.0 | 1.1919 | 7.4797 | 0.70 |
| 0.80 | 93.50 | 1.0380 | 2.087 | 391.58 | 2498.8 | 391.66 | 2274.1 | 2665.8 | 1.2329 | 7.4346 | 0.80 |
| 0.90 | 96.71 | 1.0410 | 1.869 | 405.06 | 2502.6 | 405.15 | 2265.7 | 2670.9 | 1.2695 | 7.3949 | 0.90 |
| 1.00 | 99.63 | 1.0432 | 1.694 | 417.36 | 2506.1 | 417.46 | 2258.0 | 2675.5 | 1.3026 | 7.3594 | 1.00 |
| 1.50 | 111.4 | 1.0528 | 1.159 | 466.94 | 2519.7 | 467.11 | 2226.5 | 2693.6 | 1.4336 | 7.2233 | 1.50 |
| 2.00 | 120.2 | 1.0605 | 0.8857 | 504.49 | 2529.5 | 504.70 | 2201.9 | 2706.7 | 1.5301 | 7.1271 | 2.00 |