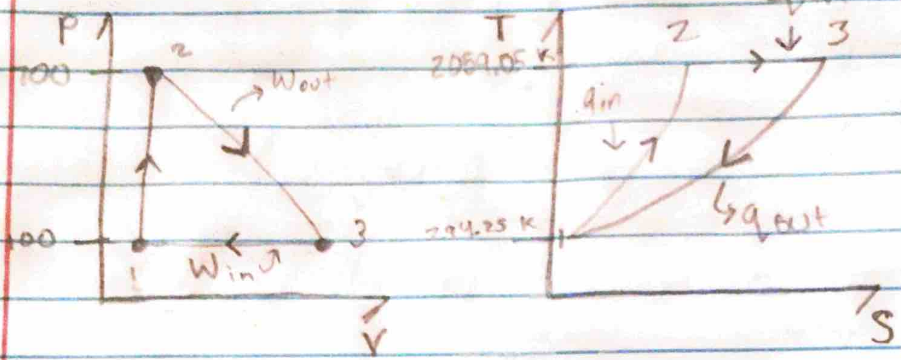
1. Purpose

Determine the P-v and T-s diagrams, back work ratio & thermal efficiency.

Drawings & Diagrams



Sources

- Cengel & Boles, Thermodynamics, An Engineering Approach, 8th edition
- Lectures

Design Considerations

- Mixture acts as ideal gas
- Variable specific heat
- Isobaric compression

Data & Variables

$y_{N_2} = .78$ $P_1 = 100$ kPa

$y_{O_2} = .20$ $T_1 = 21.1°C \approx 70°F$

$y_{H_2O} = .01$ $P_2 = 700$ kPa

$y_{CO_2} = .01$

Procedure

a) Take given information and evaluate all stages.

b) Calculate back work with proper equation

$$\frac{W_{comp}}{W_{exp}} = \frac{W_{in_{3-1}}}{W_{out_{2-3}}}$$

For $W_{in_{3-1}}$; $W_{in_{3-1}} = P_3(V_3 - V_1)$

For $W_{out_{2-3}}$; $W_{out_{2-3}} = RT_3 \ln(V_3/V_2)$

c) Calculate thermal efficiency with equation for thermal efficiency

$$\eta_{th} = \frac{W_{net}}{q_{in}}$$

For W_{net} ; $W_{net} = W_{out_{2-3}} - W_{in_{3-1}}$

For q_{in} ; $q_{in} = c_v(T_2 - T_1) + W_{out}$

Calculations

a) $M_{N_2} = 28.013$ kg/kmol $C_v = 0.743$ kJ/kg·K
$M_{O_2} = 31.999$ kg/kmol $C_v = 0.658$ kJ/kg·K
$M_{H_2O} = 18.015$ kg/kmol $C_v = 1.4108$ kJ/kg·K
$M_{CO_2} = 44.01$ kg/kmol $C_v = 0.657$ kJ/kg·K

$M_m = (.78)(28.013) + (.20)(31.999) + (.01)(18.015) + (.01)(44.01)$
$M_m = 28.869$ kg/kmol

$C_v = 0.7568(.743) + 0.2216(.685) + 0.624(1.4108) + 0.015245(.657)$
$C_v = 0.73825$ kJ/kg·K

$R_m = 8.31447 / 28.869$
$R_m = 0.2880$ kJ/kg·K

$v_1 = (.288)(294.25) / 100 = 0.847$ m³/kg

$T_2 = (700/100)(294.25)$
$T_2 = 2059.75$ K

$v_3 = 7(.847) = 5.93$ m³/kg

$P_3 = P_1$; $T_3 = T_2$

b) $W_{in} = 100(5.92 - 0.847)$
$W_{in} = 507.3$ kJ/kg

$W_{out} = (.286)(2059.75) \cdot \ln(5.93/.847)$
$W_{out} = 1145.4$ kJ/kg

$W_{comp} / W_{exp} = 507.3 / 1146.4 = .4425$
$\approx .44$

c) $W_{net} = 1145.4 - 507.3 = 638.1$
$q_{in} = .73825(2059.75 - 294.25) + 1146.4$
$q_{in} = 2449.78$ kJ/kg

$\eta_{th} = 638.1 / 2449.78$

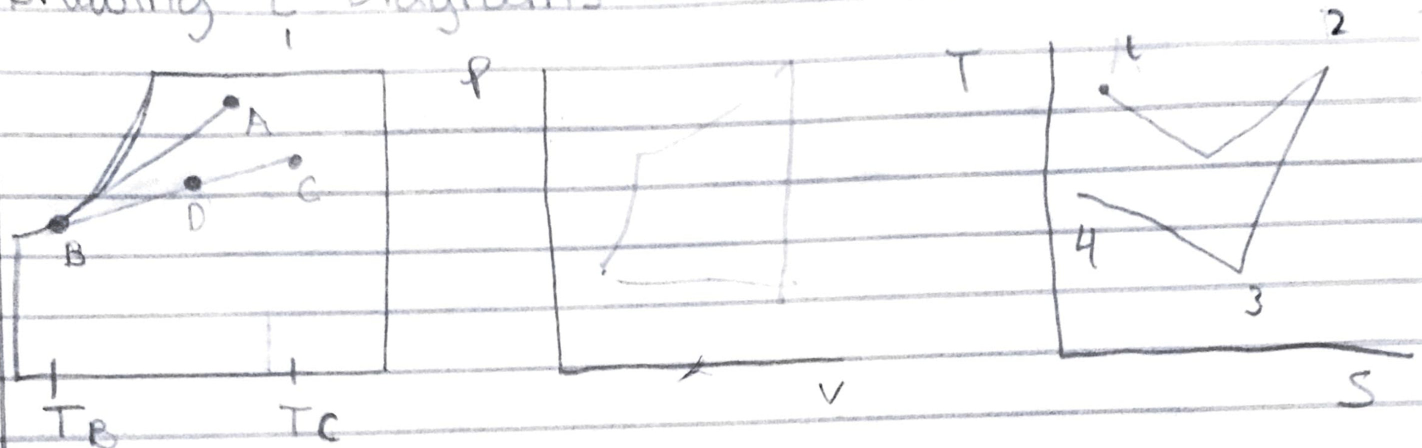
$\eta_{th} = .2607 = 26.1\ \%$

2. Purpose

Find: a) T_B b) ϕ_B c) T_C d) ϕ_C e) T_{H_2O}.

Include psychrometric chart

Drawing & Diagrams



Sources

- Cengel & Boles, Thermodynamics, An Engineering Approach, 8th edition
- Lectures

Design Considerations

Data & Variables

At A:
$T_A = 37°C$
$\phi = 60\%$
$m_{a_1} = 1\ Kg/s$

At B:
$\omega = 0.0078$

At D:
$T_D = 20°C$
$\phi = 80\%$

At C:
$m_{a_2} = 0.5\ kg/s$

cooling coil:
$T_{in} = 5°C$
$\dot{m}\ 10\ kg/s$

Procedure

a/b) Use T and ϕ from A to locate on the chart. Do the same for B.

Find T_{H_2O} using energy conservation equation

$$T_{H_2O} = \frac{m_a(h_a - h_b)}{m C_p} + T_{in}$$

Repeat first step for D

Use conservation of mass to find ω_c

A

$\omega_1 = .0240$

$h_a = 99$ kJ/kg

B

$\phi = 100\%$

$T_B = 10°C$

$h_B = 29$ kJ/kg

} from chart

D

$W_D = .011$

$h_D = 50$

$$T_{H_2O} = \left[\frac{(1)(100-29)}{10(4.18)}\right] + 5$$

$T_{H_2O} = 6.69°C$

$$W_C = \frac{(1.5)(0.012) - 0.0078(.5)}{}$$

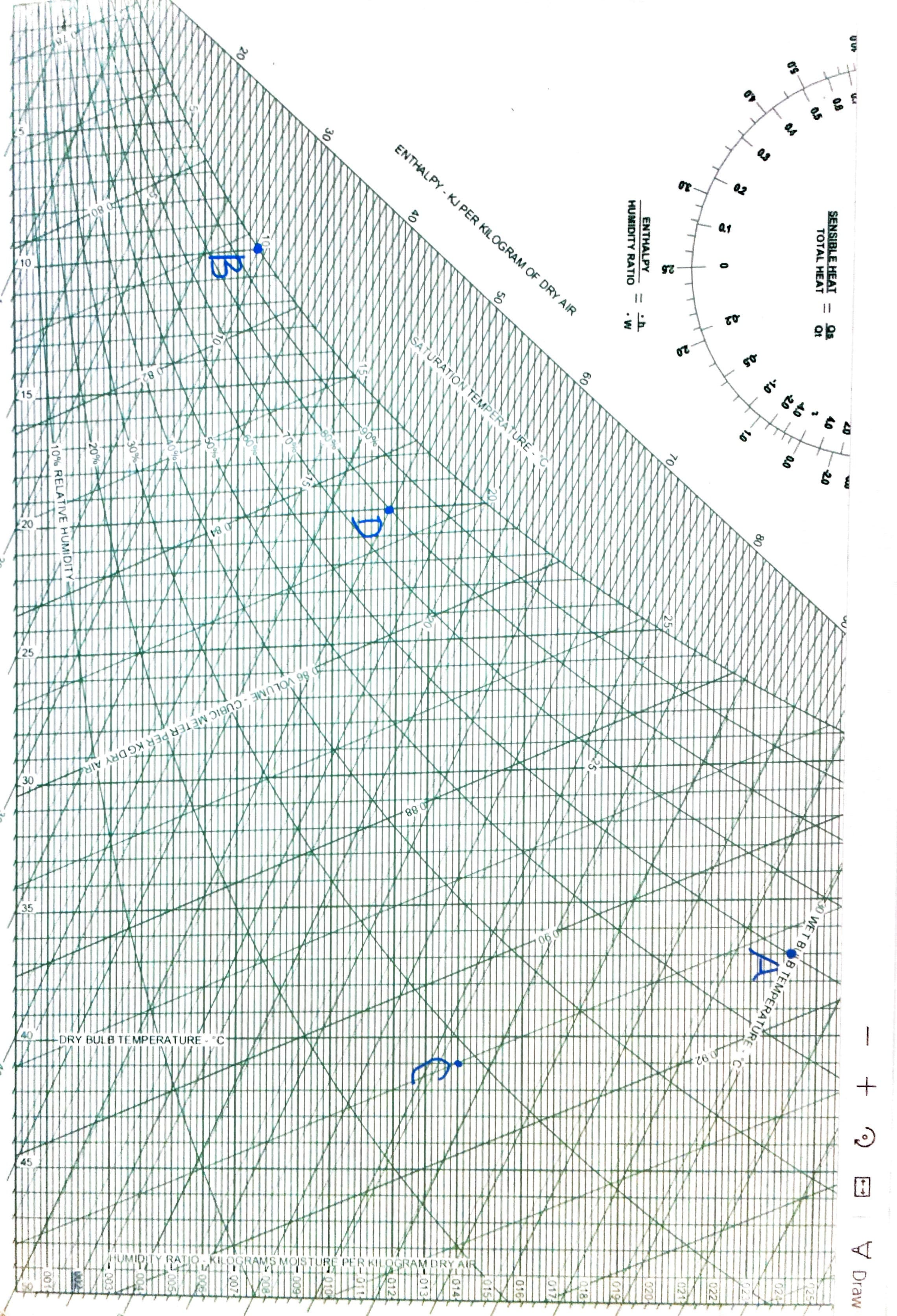
$W_C = 0.0141$

$$W_C = \frac{(1.5)(50) - 29}{.5}$$

$W_C = 92$ kJ/K

$T_c = 40°$

$\phi = 32\%$



ENTHALPY - KJ PER KILOGRAM OF DRY AIR
SATURATION TEMPERATURE - °C
SENSIBLE HEAT / TOTAL HEAT = Qs / Qt
ENTHALPY / HUMIDITY RATIO = Δh / ΔW
10% RELATIVE HUMIDITY
0.86 VOLUME - CUBIC METER PER KG DRY AIR
WET BULB TEMPERATURE - °C
DRY BULB TEMPERATURE - °C
HUMIDITY RATIO - KILOGRAMS MOISTURE PER KILOGRAM DRY AIR
A
B
C
D
Draw