SEPT. 12/17
THERMAL

→ Continuing with Ch. 1 Lecture Slides

Dimensional homogeneity

$A + B = C + D$ → (same unit)

The steady Flow process : (two types)

1) Turbine
2) Pump
3) Compressor
4) HVAC

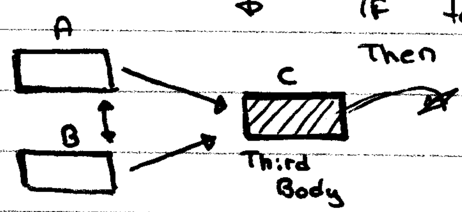
↳ ① Steady
② Unsteady (transient)

When parameters don't change with time; steady process

Temp. Scales :
1) Celcius (°C)
2) Farenheit (°F)
3) Kelvin (K)
4) Rankine (R)

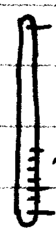
Zeroth Law :

If temp A = temp C, and temp B = temp C
Then temp A = temp B



Temp A = Temp B

Celsius:



100 °C (boiling point)
100 divisions (1 °C)
0 °C (Freezing point)

Δt in °C is 100
Δt in °F is 180
$\therefore \Delta t\ 1°C = \Delta t\ 1.8°F$
$1°C = 9/5\ °F$

Farenheit:

212 °F (boiling point)
180 divisions (1 °F)
32 °F (Freezing point)

$\Delta t\ 20°C = 20 \times 9/5\ °F$

$\begin{cases} K = {}^\circ C + 273 \\ R = {}^\circ F + 460 \end{cases}$ | Δt in K = Δt in °C
Δt in R = Δt in °F

Pressure (P) :

(SI) $P = F/A = N/m^2 \rightarrow$ Pascal (Pa)

(English) " " = lbf/ft^2 (lbf/in^2) → psi

1. Abs. Pressure
2. Gage Pressure

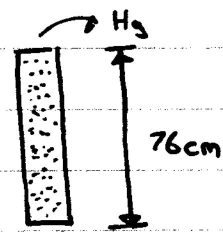
$P = \rho g h$

$P = 13600 \times 9.81 \times 0.76$

1 atm = 101.396 Pa

= 101.4 kPa

1 bar = 10^5 pa

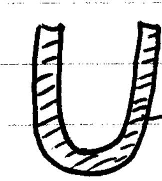


Pressure Measuring Device

Atm. → Barometer

Manometer → ΔP

piezoelectric transducer



* Example 1-10 (From textbook)

↳ $P_1 + \rho_{water} g h_1 + \rho_{oil} g h_2 - \rho_{merc} g h_3 = P_2 = P_{atm}$

$P_1 = P_{atm} + g(\rho_{hg} h_3 - \rho_{water} h_1 - \rho_{oil} h_2)$

$= 85.6\ kPa + (9.81\ m/s^2)\left[(13.600\ kg/m^3)(0.35m) \ldots\right]$

= 130 kPa (above atm. pressure)

* Example 1-111E (From textbook)

Sept. 14/17
THERMAL

Thermo Chap. 2: Energy, Energy Transfer + General Energy Analysis

Obj:
1) Introduce the concept of energy + it's various forms
2) Introduce the concept of the 1st law of thermodynamics
3) Define energy conversion efficiency
4) Discuss the implications of energy conversions on the environment.

Forms of Energy:

1) Thermal, mechanical, kinetic, potential, electric, magnetic, chemical, nuclear

E = total energy = sum of energies

specific energy → $e = \frac{E}{m}$

$E = kJ$

$e = kJ/kg$

Energy → Microscopic → U or u, H, h

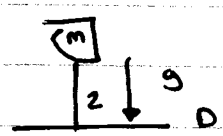
Energy → Macroscopic

$KE = \frac{1}{2} m v^2$

$ke = v^2/2$

$PE = mgz$

$pe = gz$



$E = U + KE + PE$

$E = H + KE + PE$

$e = u + ke + pe$

$= u + v^2/2 + gz$

$e = h + v^2/2 + gz$

$E = me$

$\dot{E} = \dot{m}e$

$\dot{E} = kW$

Mechanical Energy:

$E_{mech} = PE + KE + \text{Flow Energy}$

$e_{mech} = \frac{P}{\rho} + \frac{v^2}{2} + gz$

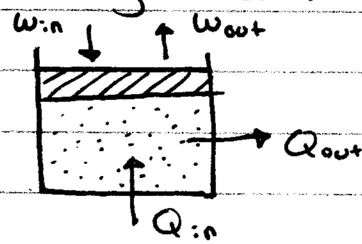
$h = u + (P\vartheta)$ → Flow energy → P/ρ

$\dot{E}_{mech} = \dot{m}\, e_{mech} = \dot{m}\left(\frac{P}{\rho} + \frac{v^2}{2} + gz\right)$ $\quad \vartheta = \frac{1}{\rho}$

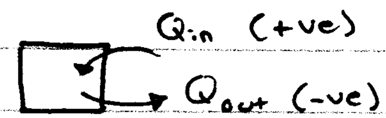
$\Delta e_{mech} = \dot{m}\left[\frac{P_2 - P_1}{\rho} + \frac{V_2^2 - V_1^2}{2} + g(z_2 - z_1)\right]$

Energy transfer:

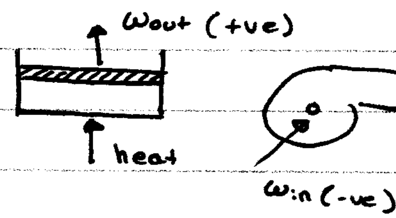
1) by heat } → closed system
2) by work }
3) by mass flow



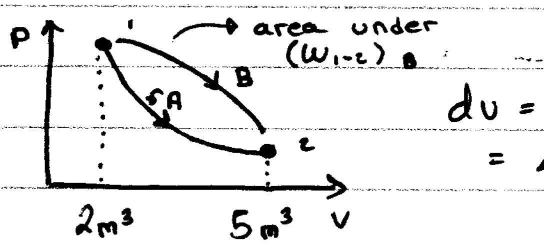
For heat:



For work:



1) Point Functions
2) Path Functions



$dV = V_2 - V_1$
$= \Delta V = 5 - 2$
$= 3\,m^3$

where: $W = Fs$

$(\Delta V)_A = 3\,m^3$

$(W_{1-2})_B > (W_{1-2})_A$ $\quad (\Delta V)_B = 3\,m^3$

heat + work → path finding $\quad (W_{1-2})_A$ = Area under 1A2

$\int_1^2 dV = V_2 - V_1 = \Delta V$

exact differential

$\int_1^2 \delta W = W_{12} = \Delta W$

↳ inexact differential

Electrical Energy

$P = VI$ → amp

P ↳ watt, V ↳ volt

Energy Balance:

$E_{in} - E_{out} = \Delta E_{system}$

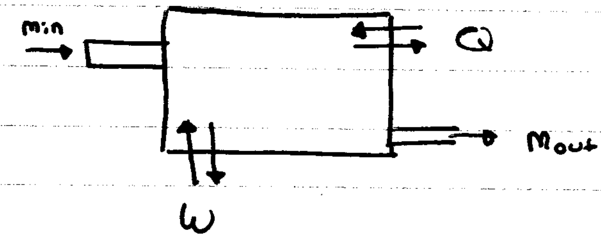
$\Delta E_{sys} = E_{final} - E_{initial}$

$\Delta E = \Delta U + \Delta KE + \Delta PE$

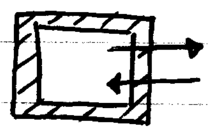
$\Delta U = m(U_2 - U_1)$

$\Delta KE = \frac{1}{2} m (V_2^2 - V_1^2)$

$\Delta PE = mg(Z_2 - Z_1)$



For adiabatic process
(no heat transfer) → $Q = 0$



Energy Balance:

$E_{in} - E_{out} = \Delta E_{sys}$

$(Q_{in} - Q_{out}) + (W_{in} - W_{out}) + \ldots$

$\ldots + (E_{mass\,in} - E_{mass\,out}) = \Delta E_{sys}$

For cyclic process

$E_{in} = E_{out}$

$Q_{in} + W_{in} = Q_{out} + W_{out}$

$(Q_{in} - Q_{out}) = (W_{out} - W_{in})$

↳ $Q_{net,in}$ ↳ $W_{net,out}$

Heating value of the fuel:

Calorie

Gasoline → 1) HHV/HCV (47,300 KJ/kg)

Gasoline → 2) LHV/LCV (44,000 KJ/kg)