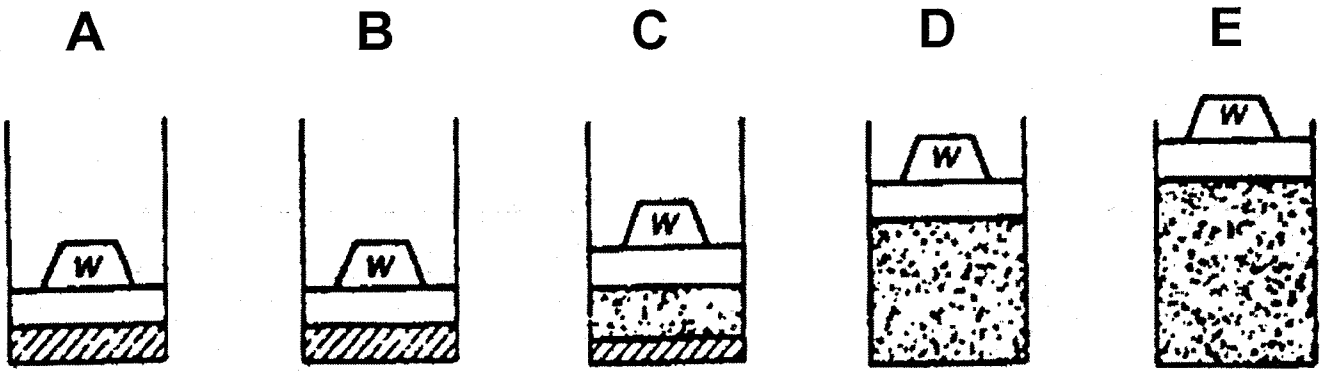
STEAM TABLES AND CHARTS

WATER AND STEAM CHARACTERISTICS

Heating water and steam at constant pressure.



A Subcooled Water

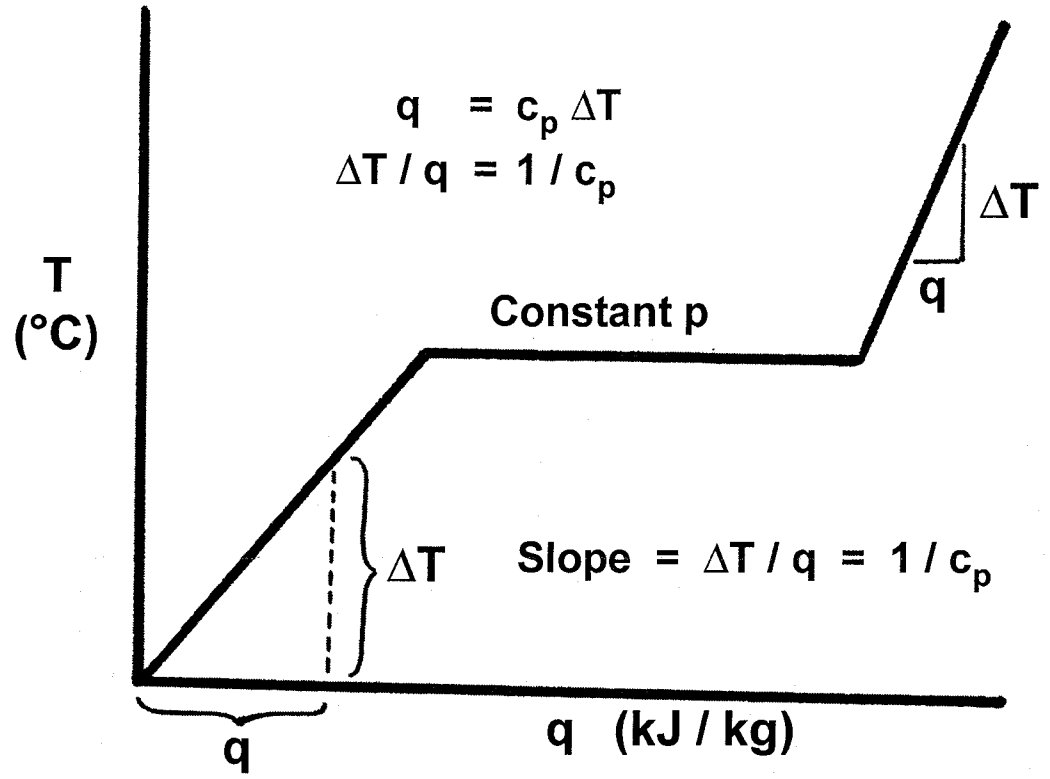
B Saturated Water Only

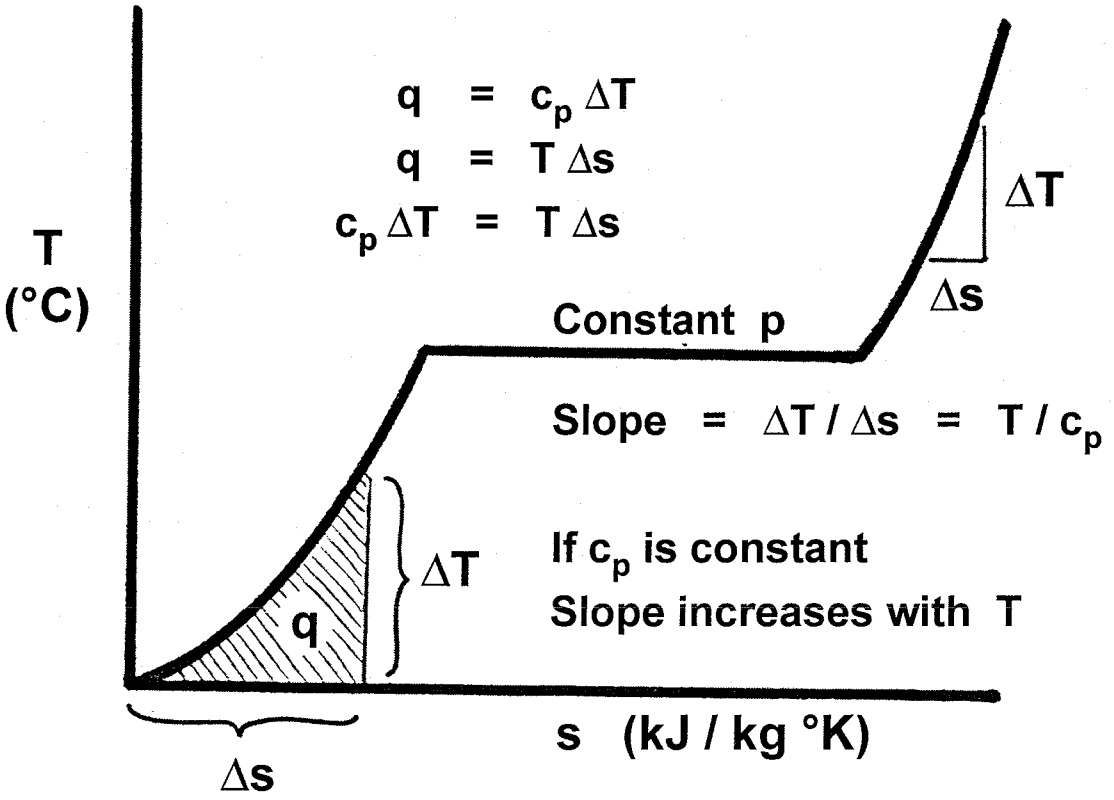
C Water and Steam Mixture

D Saturated Steam Only

E Superheated Steam

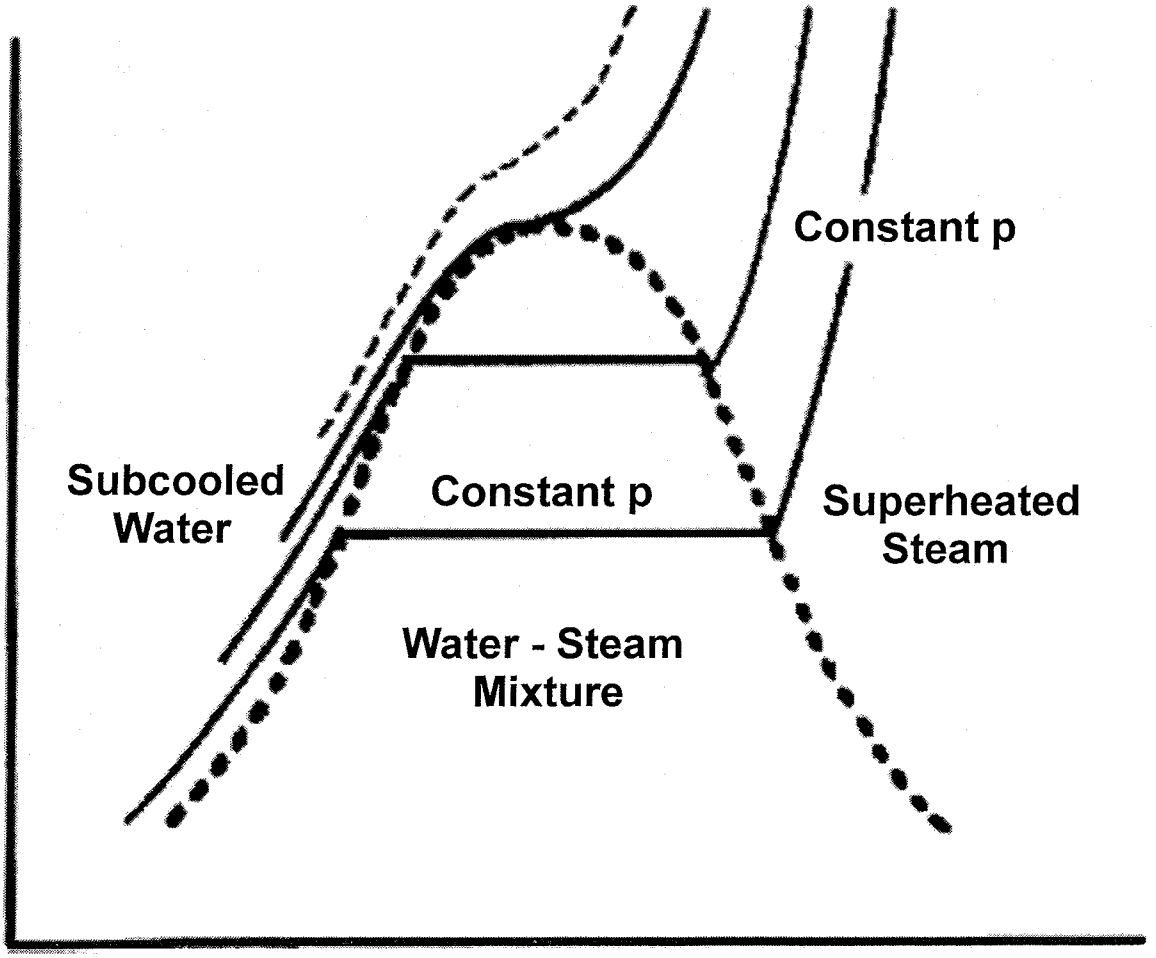
HEATING OF WATER



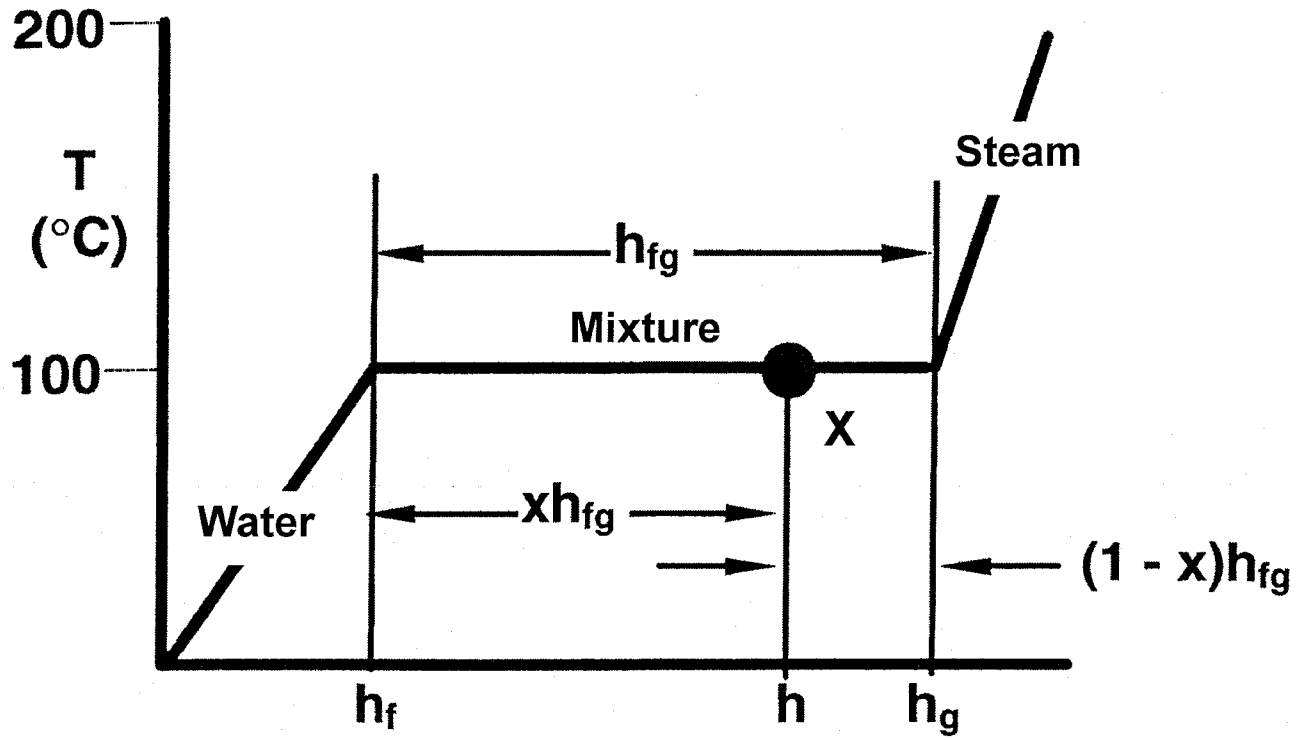


VARIATION OF PRESSURE

- When water boils its specific volume v increases
- As pressure increases v_f remains nearly constant
- As pressure increases v_g decreases due to compression
- At high pressure: $v_g \rightarrow v_f$
- At high pressure: Latent heat $h_{fg} \rightarrow 0$
- At high pressure: no liquid - vapour mixture



QUALITY AND MOISTURE



At point X for unit mass of mixture:

Mass of vapour = x Quality = x

Mass of liquid = (1 - x) Moisture = m = (1 - x)

Enthalpy of vapour = xh_g

Enthalpy of liquid = $(1 - x)h_f$

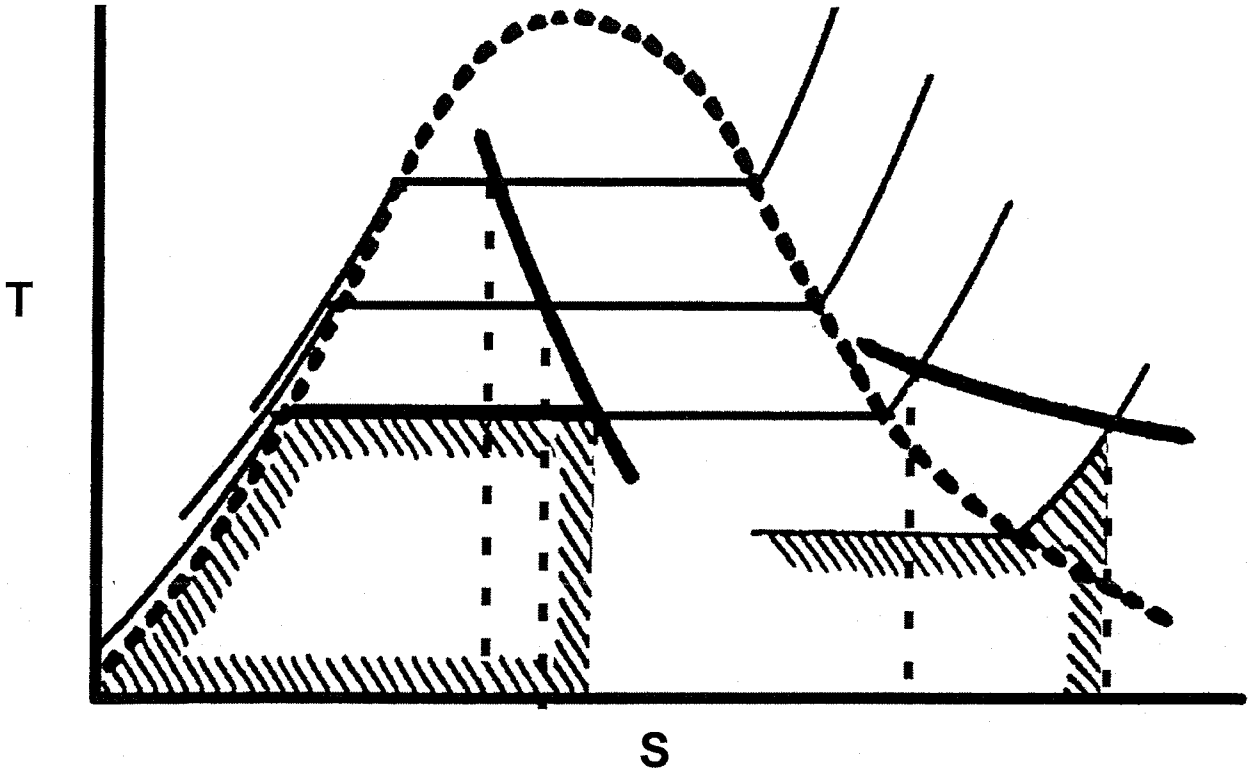
Total enthalpy: $h = xh_g + (1 - x)h_f$

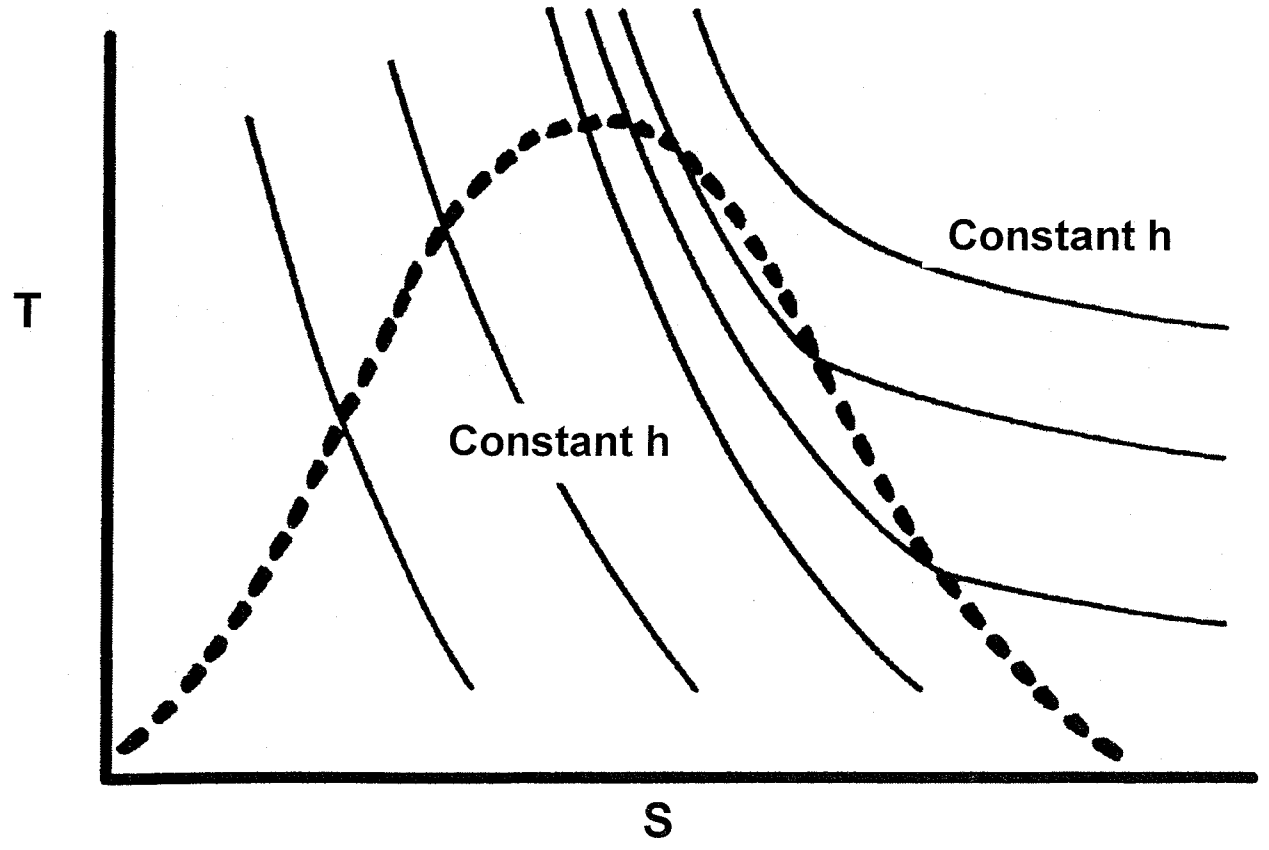
$= xh_g + h_f - xh_f$

$= h_f + x(h_g - h_f)$

$= h_f + xh_{fg}$

VARIATION OF ENTHALPY



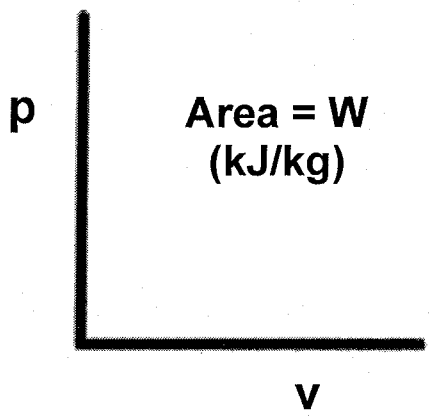


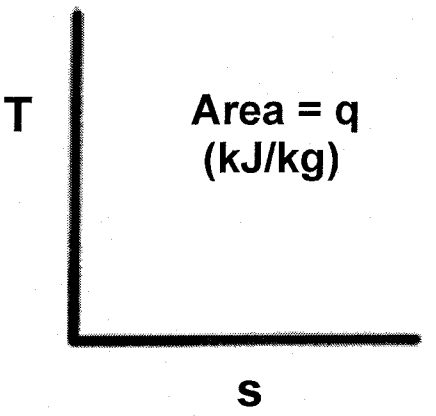
WHAT IS ENTROPY?

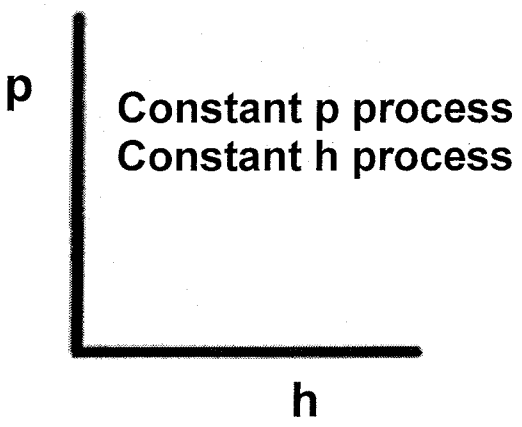
- Entropy is a property of a fluid as is enthalpy. It cannot be measured directly but is derived.
- Entropy enables work and heat to be shown on a diagram of a thermodynamic cycle.
- Entropy increase without heat addition is a measure of the irreversibility in a thermodynamic process.

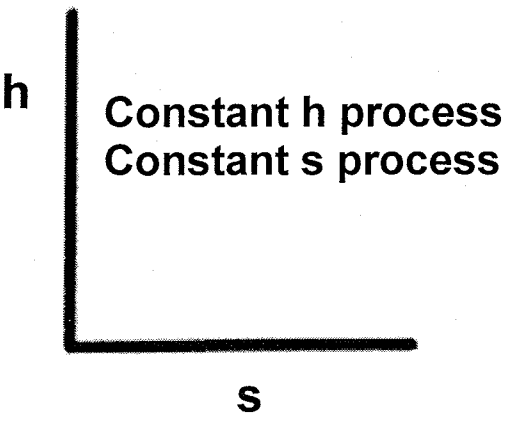
PROPERTIES AND CHARTS

Pressure	p
Temperature	T
Specific Volume	v
Internal Energy	u
Enthalpy	h
Entropy	s





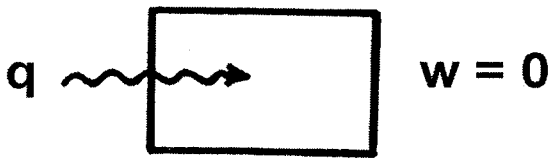


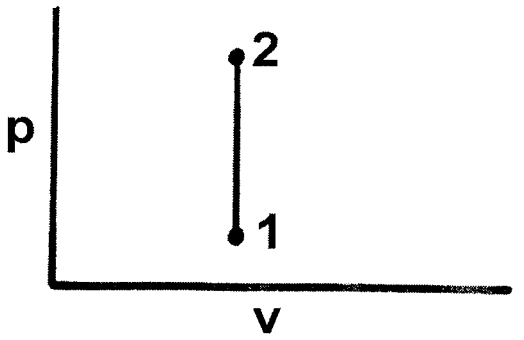


NON-FLOW PROCESS

CONSTANT VOLUME

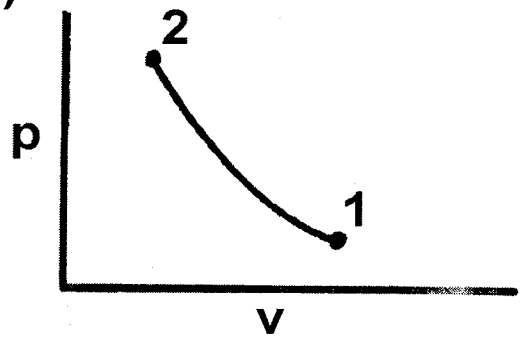
$q = u_2 - u_1 = \Delta u$





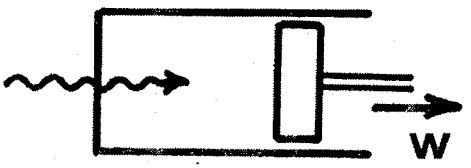
CONSTANT HEAT (ADIABATIC)

$-w = u_2 - u_1 = \Delta u$

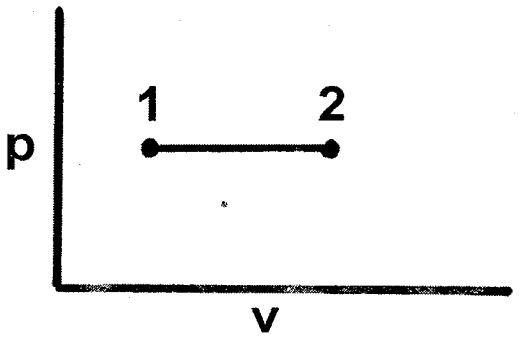


CONSTANT PRESSURE

$q = h_2 - h_1 = \Delta h$



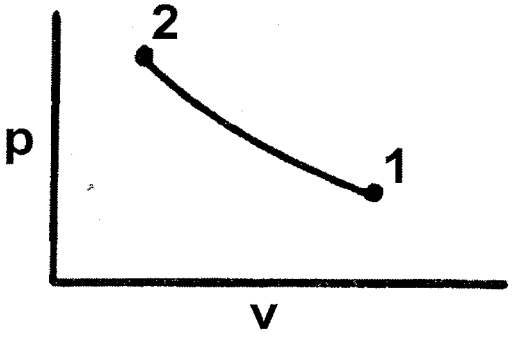
$\Delta u = \Delta h - q$



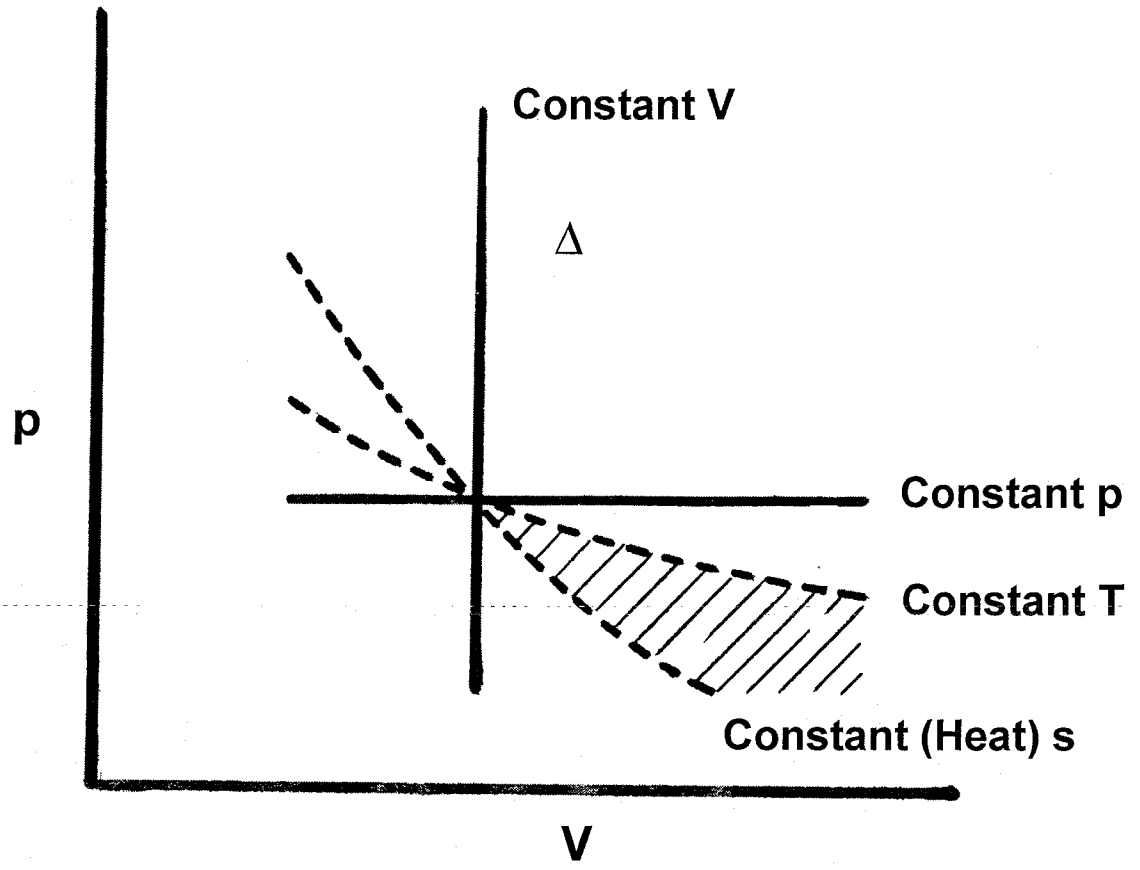
CONSTANT TEMPERATURE

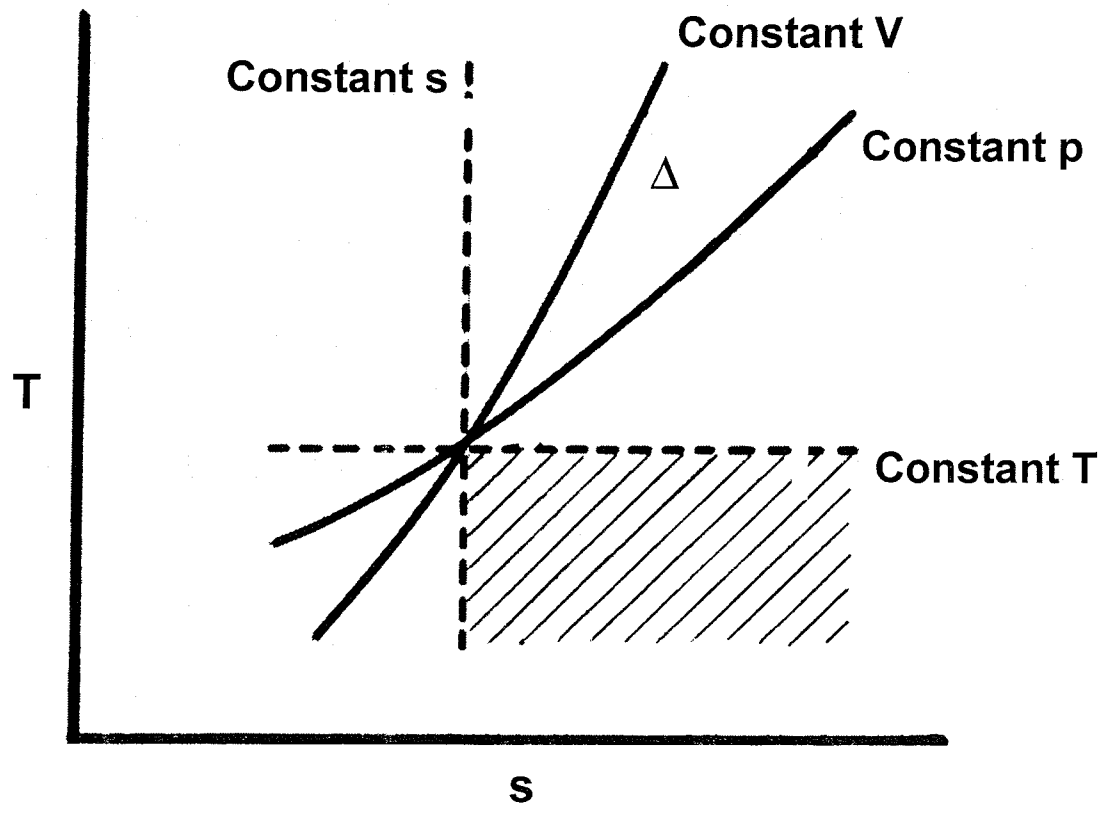
$p_1 v_1 = p_2 v_2$

$\Delta u = 0$ $\quad w = q$

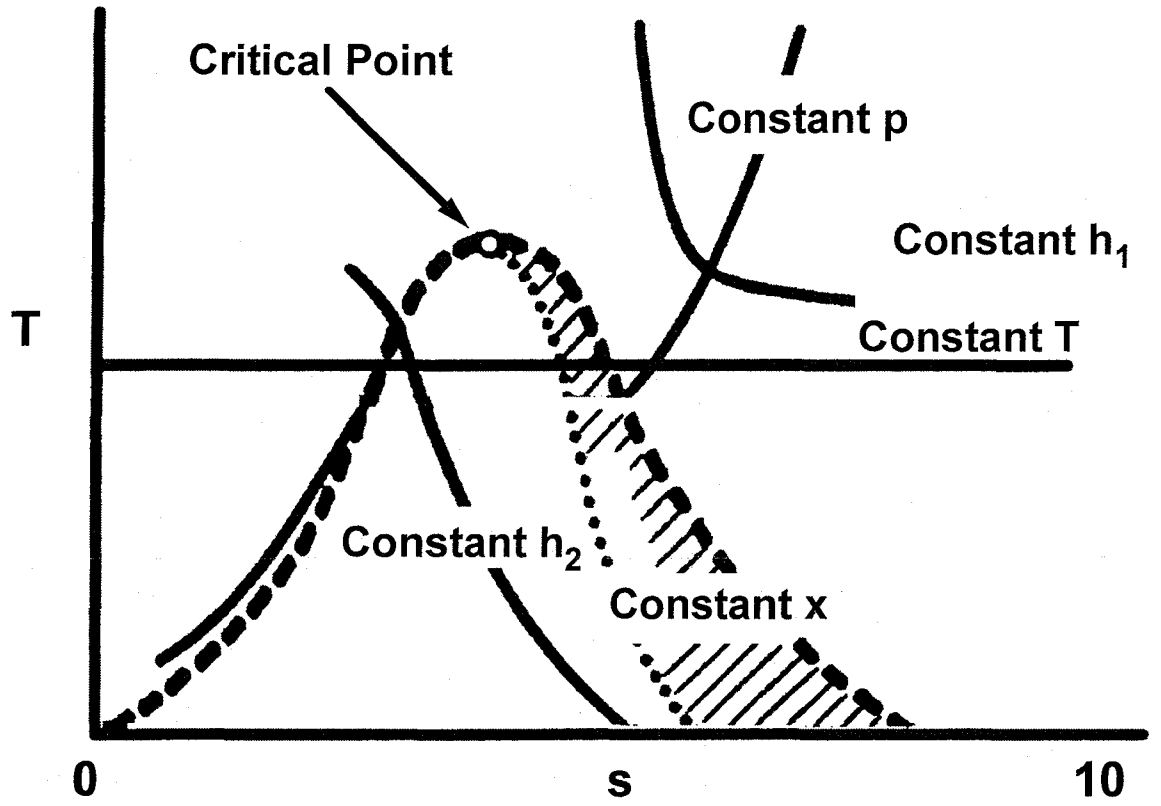


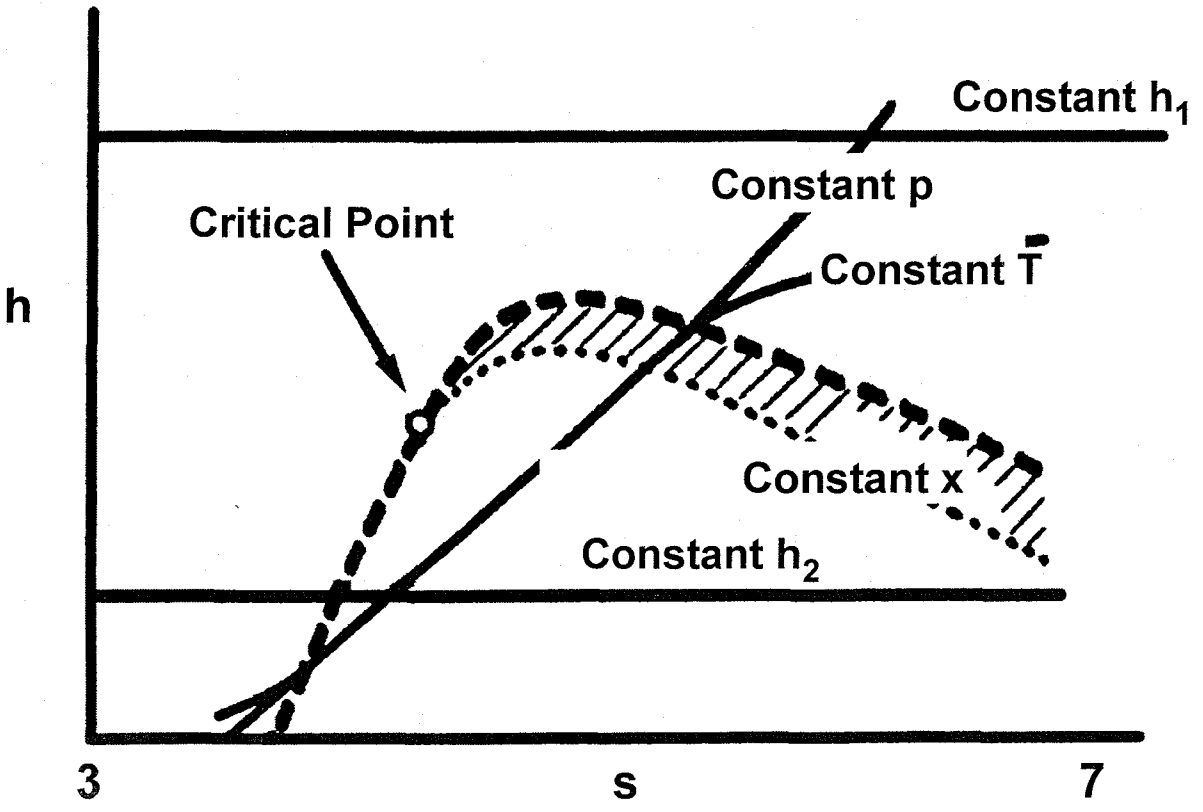
p - V AND T - s DIAGRAMS





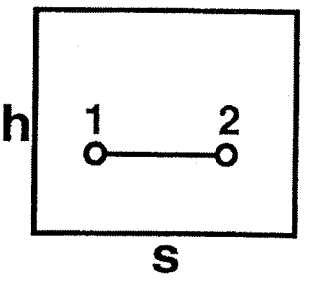
T - s AND h - s DIAGRAMS



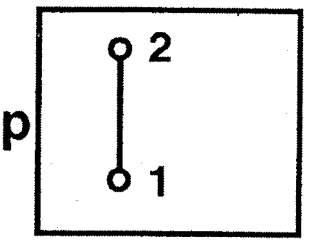


FLOW PROCESSES

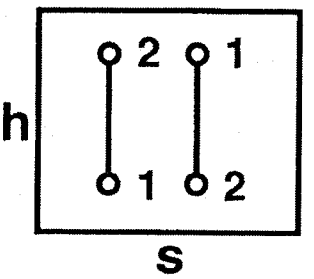
Constant Enthalpy (Irreversible Adiabatic)
(Isenthalpic)
Applications: Throttle (Depressurisation)



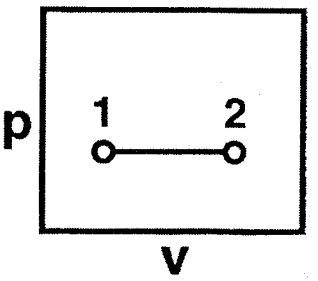
Constant Volume (Isometric)
Applications: Tank (Heating)
Pump (Pressurisation)



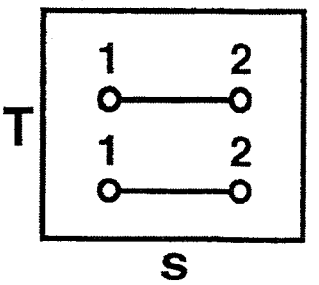
Constant Entropy (Reversible Adiabatic)
(Isentropic)
Applications: Turbine (Expansion)
Compressor (Compression)
Pump (Pressurisation)



Constant Pressure (Isobaric)
Applications: Gas Turbine (Combustion)
Boiler (Heating)



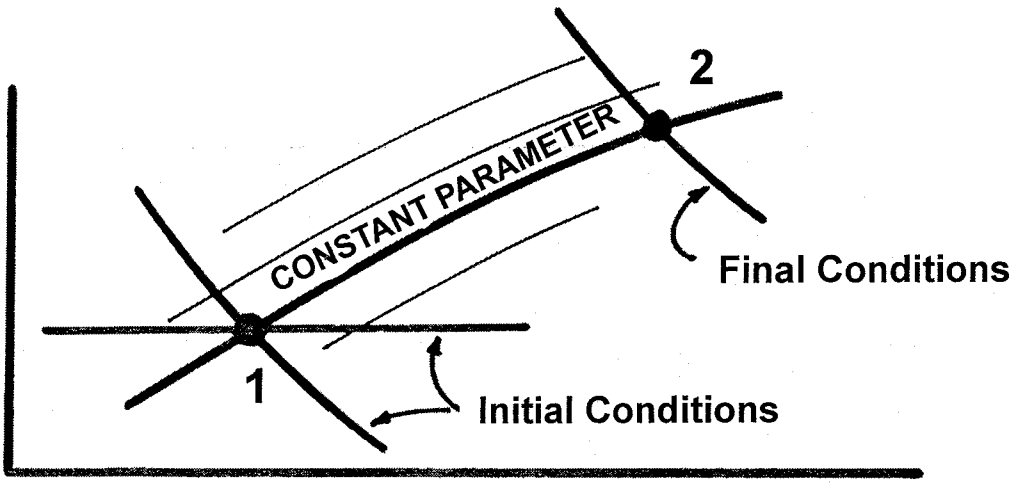
Constant Temperature (Isothermal)
Applications: Boiler (Boiling)
Condenser (Condensation)



CALCULATION STRATEGY

PROCESS IDENTIFICATION

- Write Energy Equation
- Make appropriate assumptions
- Derive process equation



PROCESS SOLUTION

- Write initial and final conditions
- Two parameters define starting point
- Process equation defines constant parameter
- Constant parameter is same at start and finish
- Process line through start and finish is fixed
- Intersection with final conditions gives finishing point