Module 2

Work and Heat

We Concentrate On Two Categories Of Heat And Work

- Thermodynamic definition of work:

  Positive work is done by a system when the sole effect external to the system could be reduced to the rise of a weight.

- Thermodynamic definition of heat:

  It is the energy in transition between the system and the surroundings by virtue of the difference in temperature.

Traits of Engineers

- All our efforts are oriented towards how to convert heat to work or vice versa:

Heat to work ➡ Thermal power plant

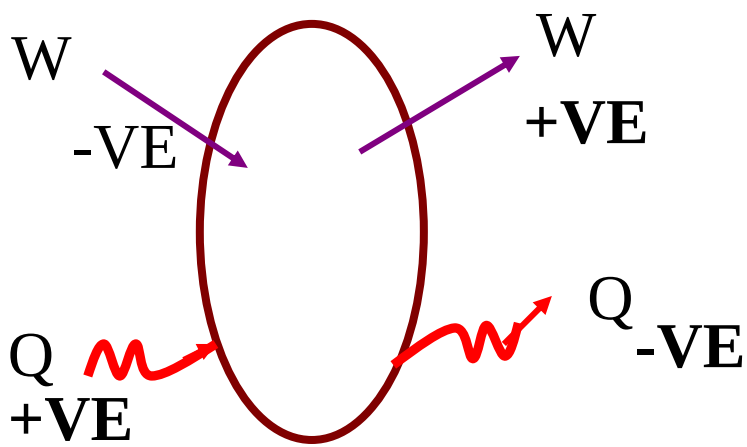
Work to heat ➡ Refrigeration

- Next, we have to do it in a sustained manner (we cant use fly by night techniques!!)

- We require a combination of processes.
- Sustainability is ensured from a cycle
- A system is said to have gone through a cycle if the initial state has been regained after a series of processes

Sign Conventions

- Work done BY the system is +ve
- Obviously work done ON the system is –ve
- Heat given TO the system is +ve
- Obviously Heat rejected by the system is -ve



Types of Work Interaction

Types of work interaction

- Expansion and compression work (displacement work)
- Work of a reversible chemical cell
- Work in stretching of a liquid surface
- Work done on elastic solids
- Work of polarization and magnetization

Notes on Heat

- All temperature changes need not be due to heat alone

  eg: Friction

- All heat interaction need not result in changes in temperature

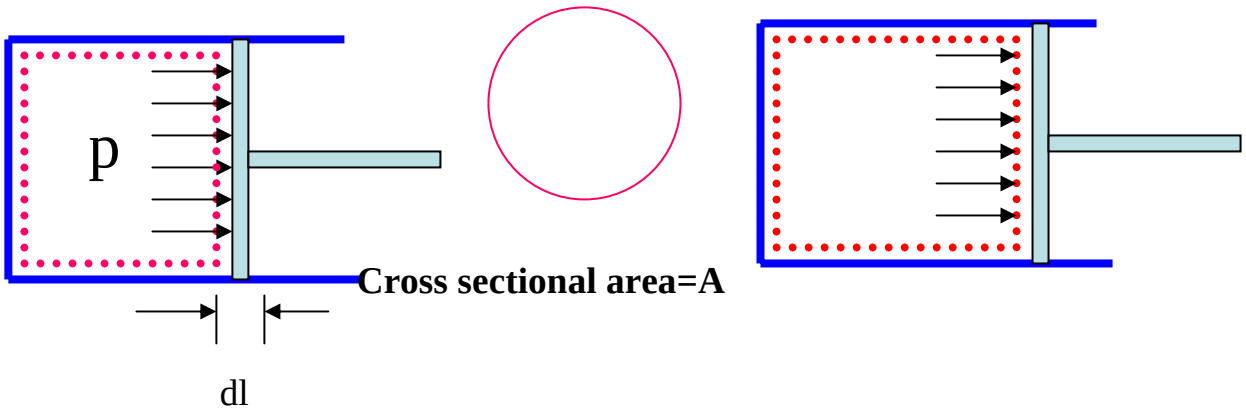
  eg: condensation or evaporation

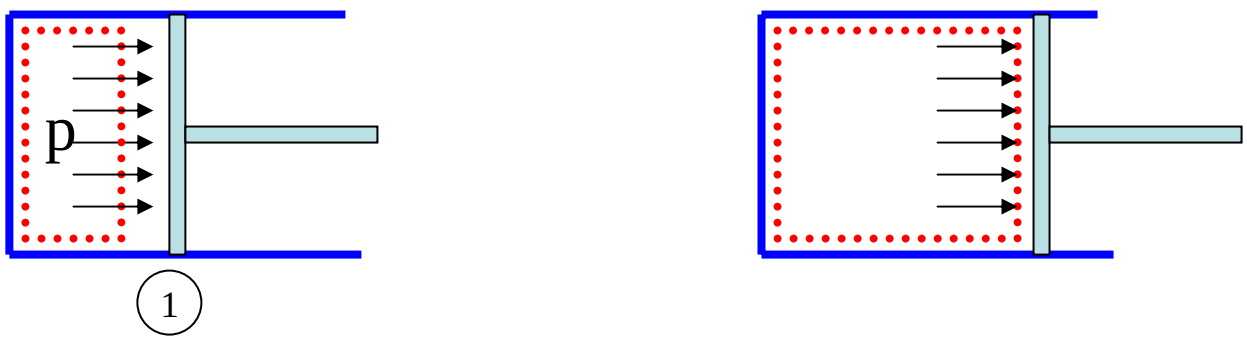
Various Types of Work

- Displacement work (pdV work)
- Force exerted, F= p. A
- Work done

  dW = F.dL = p. A dL = p.dV
- If the piston moves through a finite distance say 1-2,Then work done has to be evaluated by integrating $\delta W = \int pdV$

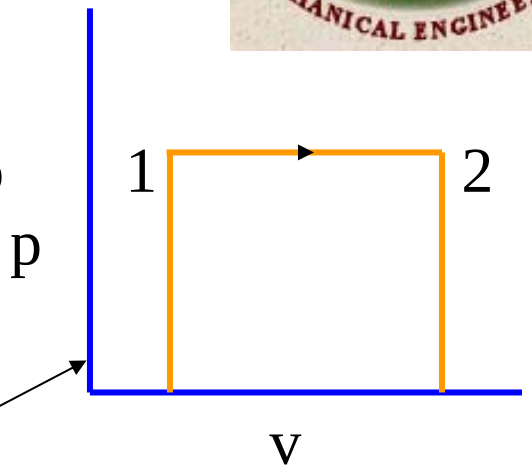
Work (Contd…)





Discussion on Work Calculation

The system (shown by the dotted line) has gone through a change of state from 1 to 2.We need to know how the pressure and volume change.



Possibilities:

- Pressure might have remained constant

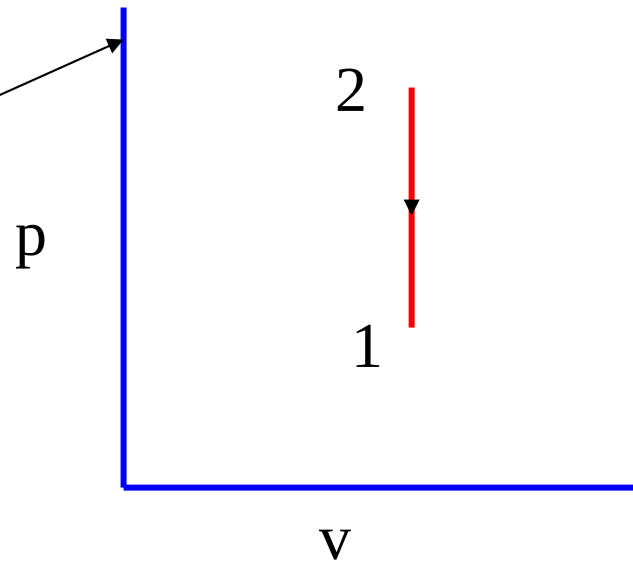
or

- It might have undergone a change as per a relation p (V)

or

- The volume might have remained constant

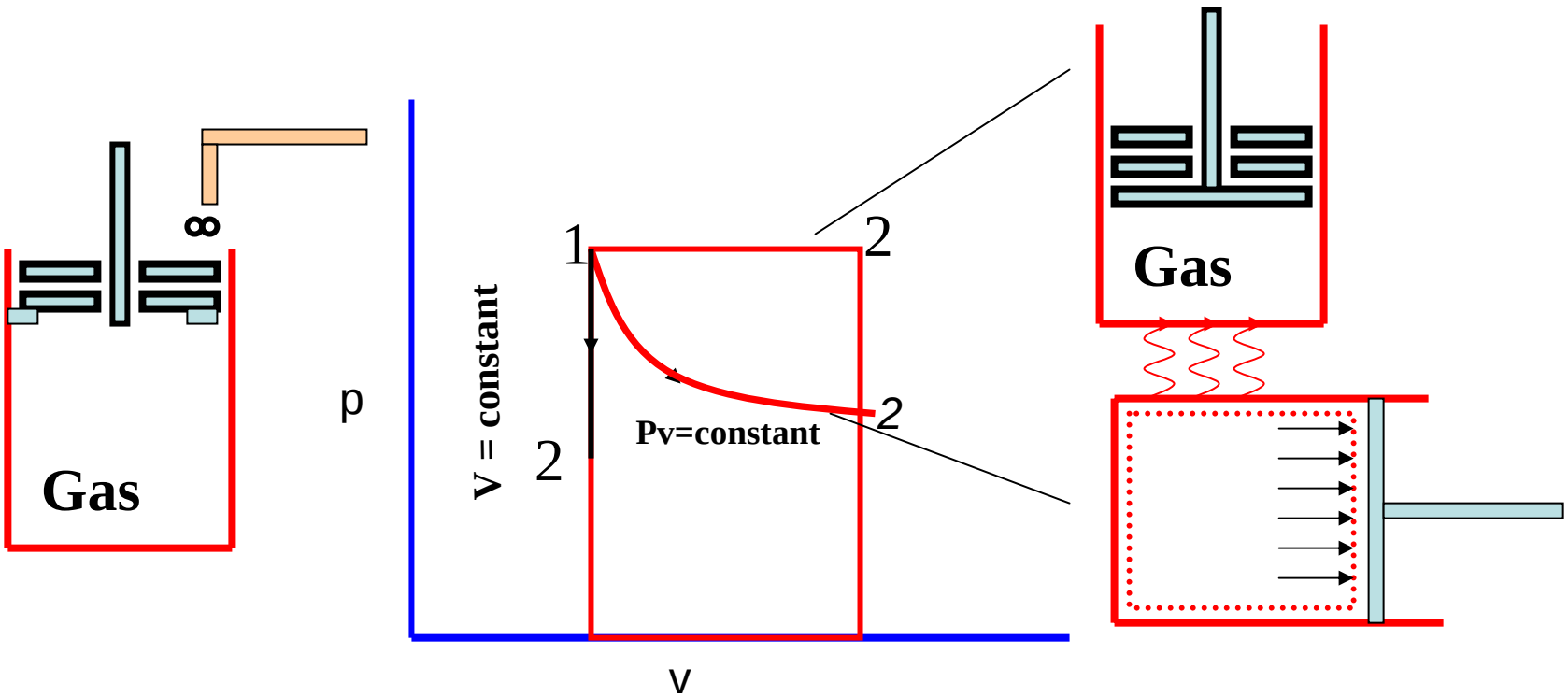
In general the area under the process on p-V plane gives the work

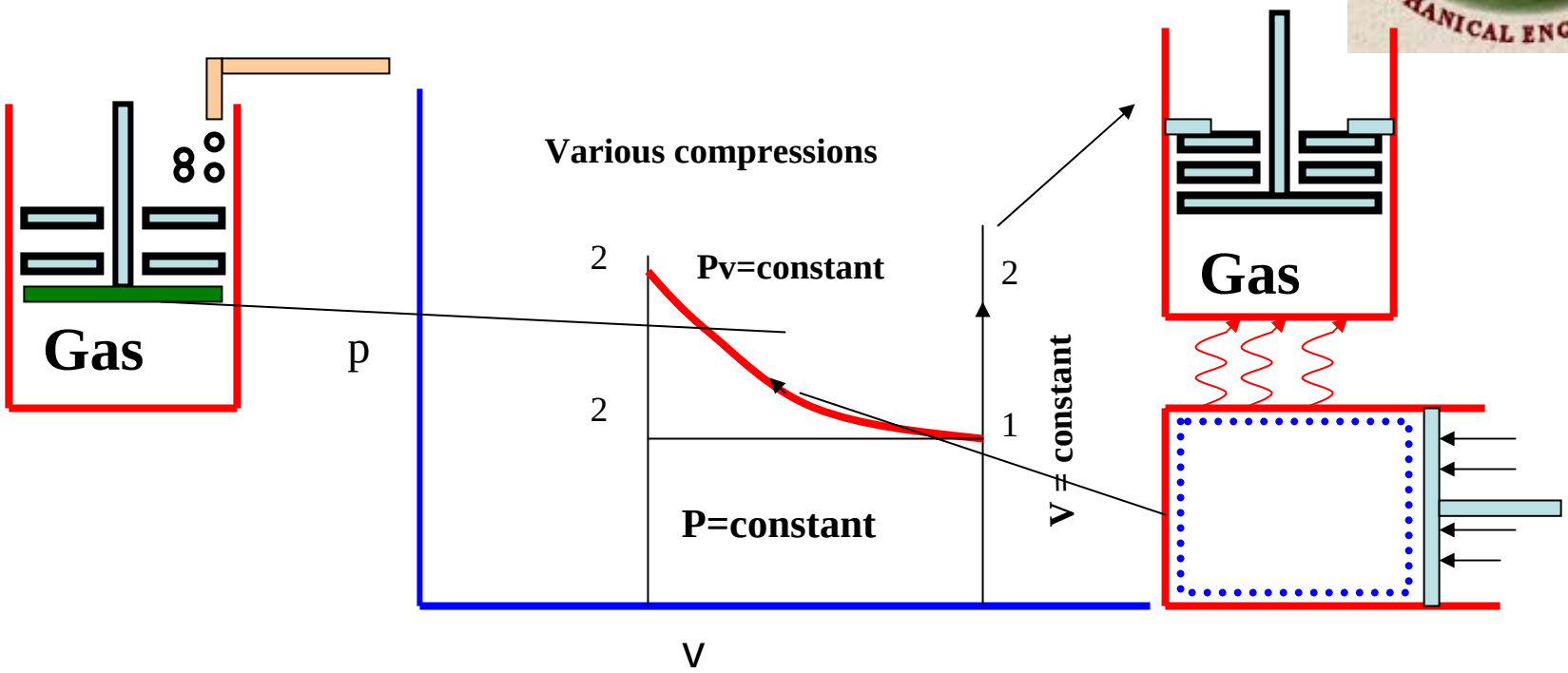


Other Possible Process

- pv=constant (it will be a rectangular hyperbola)
- In general pv^n= constant

IMPORTANT: always show the states by numbers/alphabet and indicate the direction.





- n= 0 Constant pressure ($V_2 > V_1$ - expansion)
- n=1 pv=constant ($p_2 < p_1$; $V_2 > V_1$ - expansion)
- n= ∞ Constant volume ($p_2 < p_1$ - cooling)

Others Forms Of Work

❖ Stretching of a wire:

Let a wire be stretched by dL due to an application of a force F

Work is done on the system. Therefore dW=-FdL

❖ Electrical Energy:

Flowing in or out is always deemed to be work

dW= -EdC= -EIdt

❖ Work due to stretching of a liquid film due to surface tension:

Let us say a soap film is stretched through an area dA

dW= -σdA

where σ is the surface tension.