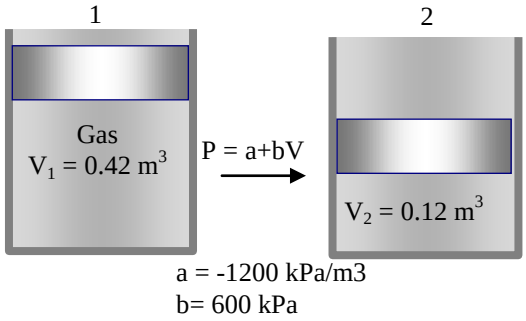
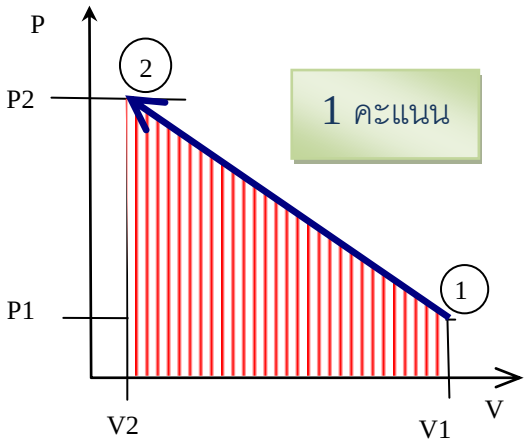
Thermodynamics I Section 1 *Test 2 Saturday 24 July 2010 Time 10:30-11:30*

เลขที่..... ID..... ....Name.....

1) A gas is compressed from the initial volume of 0.42 m^3 to the final volume of 0.12 m^3.During the quasi-equilibrium, the pressure change with the volume according to the relation P = aV + b, where V is in m^3. The a = -1200 kPa/m^3 and b = 600 kPa.
   a) and volumes.
   b) What is the meaning of area under the P-V relation?
   c) Using integration method, calculate the amount of work during this compression process.

1 คะแนน





1 คะแนน

System: gas, Closed system

Assumption: Ideal Gas, neglect ΔKE, ΔPE

1 คะแนน

Solution

(b) Boundary work: $W = \int P dV$

Therefore, Area under P-V diagram represent the work $_1W_2$ occurs during the process 1→2

Answer

1 คะแนน

(c) $_1W_2 = \int_1^2 P dV = \int_1^2 (aV + b) dV$

$= \frac{a}{2}[V_2^2 - V_1^2] + b[V_2 - V_1]$

$\frac{a}{2}[V_2^2 - V_1^2] = [(-1200\ kPa/m^3)/2] \times [0.12^2 - 0.42^2] = 97.2\ kJ$

$b[V_2 - V_1] = (600\ kPa)(0.12 - 0.42)\ m^3 = -180\ kJ$

$_1W_2 = 97.2\ kJ - 180\ kJ = -82.8\ kJ$ Answer

5 คะแนน

เป็นระบบ-ระเบียบ-สะอาด 1 คะแนน

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เลขที่..... ID..... ....Name.....

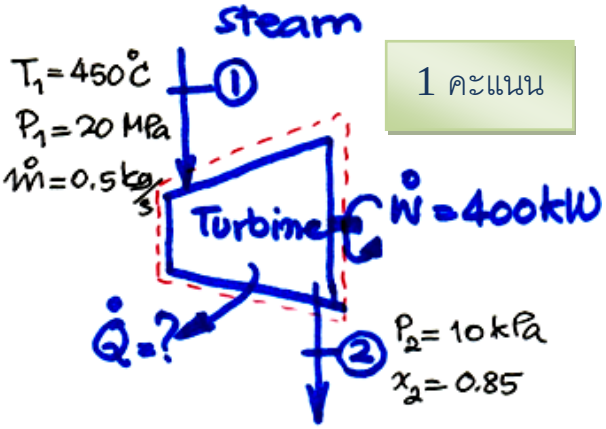
2. *Steam enters a turbine at 450°C and 20 MPa with a mass flow rate of 0.5 kg/s and leaves at 10 kPa and 85% quality. The power produces by the turbine is 400 kW. Assume changes in kinetic energy and potential energy are negligible, determine the rate of heat loss from the turbine. (10 marks)*

1 คะแนน

System: Steam, open system

Assumption: SSSF process

neglect ΔKE, ΔPE



1 คะแนน

Analysis: Control volume turbine

2 คะแนน

1st law: $q + h_1 = w + h_2$

$$q = w + (h_2 - h_1) \quad \text{——} (1)$$

$$\dot{Q}_{cv.} = \dot{m} q \quad \text{——} (2)$$

Solution:

State (1) 20 MPa, 450°C ⇒ Superheated vapor, using Table A-6

$$h_1 = 3060.1 \text{ kJ/kg}$$

State (2) 10 kPa, $x_2 = 0.85$ ⇒ Mixture, using Table A-5

$$h_{f_2} = 191.83 \frac{kJ}{kg} \text{ and } h_{fg_2} = 2,392.8 \text{ kJ/kg}$$

$$h_2 = h_{f_2} + x_2 h_{fg_2}$$

$$= (191.83 \frac{kJ}{kg}) + (0.85)(2,392.8 \frac{kJ}{kg}) = 2,225.4 \frac{kJ}{kg}$$

2 คะแนน

Therefore, $h_2 - h_1 = (2,225.4 \frac{kJ}{kg}) - (3060.1 \frac{kJ}{kg}) = -834.4 \frac{kJ}{kg}$

1 คะแนน

and $w = \frac{\dot{W}_{cv.}}{\dot{m}} = \frac{400 \text{ kW}}{0.5 \text{ kg/s}} = 800 \frac{kJ}{kg}$

Substitute in eqn (1)

$$q = (800 \frac{kJ}{kg}) + (-834.4 \frac{kJ}{kg}) = -34.4 \frac{kJ}{kg}$$

$$\dot{Q} = \dot{m} q = (0.5 \frac{kg}{s})(-34.4 \frac{kJ}{kg}) = -17.2 \text{ kW}$$

2 คะแนน

The rate of heat loss from the turbine is 17.2 kW Answer.

เป็นระบบ-ระเบียบ-สะอาด 1 คะแนน