14/20

MAE91 Summer 2004 – Quiz 6
Dr. H. Susan Zhou

Closed book and notes – 20 minutes

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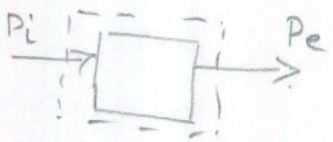
6/10

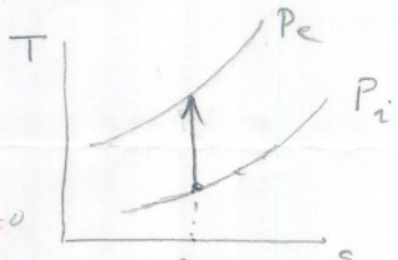
1. (10 points)
1). A reversible adiabatic flow of liquid water in a pump has increasing P. What happens to T? Why?
2). A reversible adiabatic flow of air in a compressor has increasing P. What happens to T? Why?

① statment
Assumptions C.V.
$Q_2 = 0$ ∵ adiabatic
$S_{sen} = 0$ ∵ reversible.
steps



$P_e > P_i$ - 3

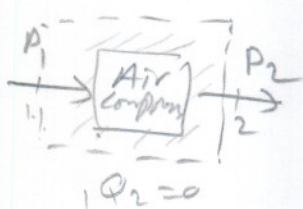
T increases
From T-s diagram



$$0 = m_i s_i - m_e s_e + \int \frac{\delta Q}{T} + S_{sen}$$ (=0, =0)

so $s_i = s_e$

② Assumptions steady state. $m_2 = m_1$ - 3
Laws $PV = mRT$
$v = \frac{V}{m}$
steps



$$T_2 = \frac{P_2 V_2}{mR} \quad \text{but} \quad m_1 = \frac{P_1 V_1}{RT_1}, \quad m_2 = m_1$$

$$\text{so } T_2 = \frac{P_2 V_2}{R} \frac{RT_1}{P_1 V_1} = T_1 \frac{P_2}{P_1} \frac{V_2}{V_1}$$

$$\text{or } \frac{T_2}{T_1} = \frac{P_2}{P_1} \frac{v_2}{v_1}$$

$v_2 < v_1$

So T decreases

$v = \frac{V}{m}$

10/10 2. (10 points) The shaft work in a pump to increase the pressure is larger or smaller compared to the shaft work in an air compressor for the same pressure increase? Why?

Statment

Assumptions

water pump.

Laws

$$_1w_2 = -\int v\,dp \qquad \text{shaft work.}$$

$$v = \frac{V}{m}$$

Steps

since water has smaller v compared to air, then for same ΔP, shaft work in air compressor is Larger than in water pump from $_1w_2 = \int v\,dp$

smaller for water compared to air.
Can be considered constant also for water.