AUIS ENGR 352 (Thermodynamics), Section 1, Course Assignment 1

Deadline:[1] September 24, 2017
Tutorial Discussion: October 8, 2017

1) Thermodynamic systems

Inside a perfectly thermally insulated room, a candle is burning. Assume that the volume of the candle, which is burning down very slowly, is approximately constant. Explain whether there are any interactions by heat transfer and/or by work between the system and the surroundings, if the system is defined as consisting of **a)** the room (including the candle), or **b)** only the candle.

2) Heat transfer

A bottle with m_{MeOH} = 220 g pure liquid methanol, initially at the temperature T_1 = 265 K, is placed inside a water bath (with m_{W} = 1.25 kg pure liquid water), initially at T_2 = 280 K. As a consequence, heat is transferred from the water to the methanol until thermal equilibrium is reached. How much heat is transferred during this process, and what is the final temperature?

Neglect heat transfer to the environment, etc., and only consider the water and the methanol. Assume constant molar isochoric heat capacities $c_{v,\mathrm{W}}$ = 75.8 J K^{-1} mol^{-1} (for water) as well as $c_{v,\mathrm{MeOH}}$ = 64 J K^{-1} mol^{-1} (for methanol). The molar masses are M_{W} = 18.02 g mol^{-1} for water and M_{MeOH} = 32.04 g mol^{-1} for methanol.

3) Atmospheric pressure

The average atmospheric pressure $p_{\mathrm{atm}}(z)$ as a function of the altitude z can be approximated by

$$p_{\mathrm{atm}}(z) = (1 - \alpha z)^{\beta}\, p_0,$$

where $\alpha = 2.2 \cdot 10^{-5}\,\mathrm{m}^{-1}$, β = 5.4, and p_0 = 101.3 kPa is the average pressure at sea level (z = 0). Using this equation, determine the average pressure difference between Sulaimani and Kirkuk.

A manometer indicates that the local pressure is $p_{\mathrm{atm}}(z)$ = 680 mmHg. Estimate the altitude z, using the correlation given above. Express the altitude in meters as well as in feet.

4) Kinetic energy

Wind is blowing steadily at a velocity of $\mathcal{V} = 8\,\mathrm{m\,s}^{-1}$ into a wind turbine with blades which have the radius r = 20 m. Determine the power generation potential, i.e., the power generated by a hypothetical, perfectly efficient wind turbine which uses the whole kinetic energy of the incoming air, assuming that the air has the density $\rho^{(\mathrm{m})}$ = 1.17 kg m^{-3}.

5) Compression work

How much work needs to be done to a system to expand it from V_1 = 5.20 m^3 to V_2 = 5.30 m^3 at constant pressure p = 101.3 kPa, assuming that the total mass of the system is m = 41 kg?

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1 *Joint submissions by two people as well as submissions by individual participants are allowed. As usual, collaborating on separate submissions, copying, etc., is not permitted. Unless otherwise stated, each problem contributes 0.5% to the overall grade. Please submit the results on paper, not digitally. Submissions can be handed in on Sunday, September 24, in class, or deposited in the mailbox in room B-F2-01 by Saturday, September 23.*