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SELF STUDY MODULE

Heat and work under different constraints

Objective

Balances around a piston and cylinder assembly. Learning how to use the steam tables.

Vocabulary

Heat: Energy in transit due to a temperature difference. Heat is transferred to bring objects to a thermal equilibrium.

Work: Energy in transit due to motion, due to a pressure difference. Mechanical equilibrium is reached through work.

Conservation Laws

The general mass conservation law $\frac{dm}{dt} = \sum_{in} m_i - \sum_{out} m_j$

The general conservation of energy or the first law of thermodynamics

$$\frac{dU}{dt} = \sum_{in} m_i h_i - \sum_{out} m_j h_j + \dot{Q} + \dot{W} - P\frac{dv}{dt}$$

Calculate

1. A gas in piston and cylinder assembly is heated at constant volume from T_1 to T_2.
    a. Derive the equation that will allow you to determine the amount of the heat needed for this process.
    b. How much heat is transferred to a monoatomic ideal gas?
    c. How much heat is transferred to a diatomic ideal gas?

2. A gas in piston and cylinder assembly is heated at constant pressure from T_1 to T_2.
    a. Derive the equation that will allow you to determine the amount of the heat needed for this process.
    b. How much heat is transferred to a monoatomic ideal gas?
    c. How much heat is transferred to a diatomic ideal gas?
3. This is a variation of an example in Sandler. A gas in a piston and cylinder assembly is used to generate work. Compare the amount of work you can obtain from this system if you carry out this process
    a. Rapidly. For this, imagine a weight supporting the piston is lifted and the system does work on the environment.
    b. At an intermediate speed: For this imagine you have the weight lifted in two installments.
    c. Slowly: for this imagine the weight is in the form of pebbles and you remove the weight pebble by pebble.

Bibliography

S. Sandler Chemical Biochemical and Engineering thermodynamics, 4th edition, Wiley

M. Koretsky, Engineering and Chemical Thermodynamics, 2nd edition, Wiley, 2013, NY.

M.J. Moran, H. N. Shapiro, D.D. Boettner, M.B. Bailey, Principles of Engineering Thermodynamics, 7th edition, John Wiley and Sons, 2012, NY.