Homework #1

MEMS 0051 - Introduction to Thermodynamics

Assigned May 8th, 2018
Due: May 14th, 2018

Problem #1

Use the phase diagram of water (Fig. 3.7 on page 54 of Sonntag 7e) to determine the *phase* of water at the following conditions. Sketch the phase diagram, including axis and region labels, and indicate where points (a)-(f) lie.

(a) 100 °C, 101.3 [kPa]
(b) 180 °C, 2,000 [kPa]
(c) 160 °C, 400 [kPa]
(d) 400 °C, 200 [kPa]
(e) 133.5 °C, 300 [kPa]
(f) 100 °C, 800 [kPa]

Problem #2

Water vapor at 200 [kPa], which has a specific volume of 0.88573 [m^3/kg], is contained in a piston-cylinder device. At this initial state, the piston is 0.1 [m] from the bottom of the cylinder. The water vapor is then cooled in a constant pressure process such that final volume occupies half the initial. Determine:

(a) the final specific volume;
(b) the final mass;
(c) specify if this system is a open or closed, a control mass and/or isolated.

Problem #3

There exists a container with a volume of 10 [m^3]. This container is filled with 8 [m^3] of coarse stone, which has a density of 1,600 [kg/m^3], 1 [m^3] of sand, which has a density of 1,442 [kg/m^3], and the rest is filled with water, which has a density of 998 [kg/m^3]. Determine:

(a) the average specific volume;
(b) the average density.

Problem #4

Using the phase diagram of water (Fig. 3.7 on page 54 of Sonntag 7e), indicate which of the following processes occur (melting, solidification, vaporization, condensation, sublimation and/or deposition) when going from the specified initial to final state. Sketch the phase diagram, including axis and region labels, and indicate the initial and final states connected by a straight line for parts (a)-(g).

(a) 225 [K] and 1 [MPa] → 400 [K] and 1 [MPa]
(b) 225 [K] and 0.0001 [MPa] → 400 [K] and 0.0001 [MPa]
(c) 500 [K] and 10,000 [MPa] → 500 [K] and 100 [MPa]
(d) 500 [K] and 0.1 [MPa] → 350 [K] and 10 [MPa]
(e) 225 [K] and 0.01 [MPa] → 400 [K] and 0.1 [MPa]
(f) 525 [K] and 100 [MPa] → 525 [K] and 10,000 [MPa]
(g) 300 [K] and 0.0001 [MPa] → 225 [K] and 0.0001 [MPa]