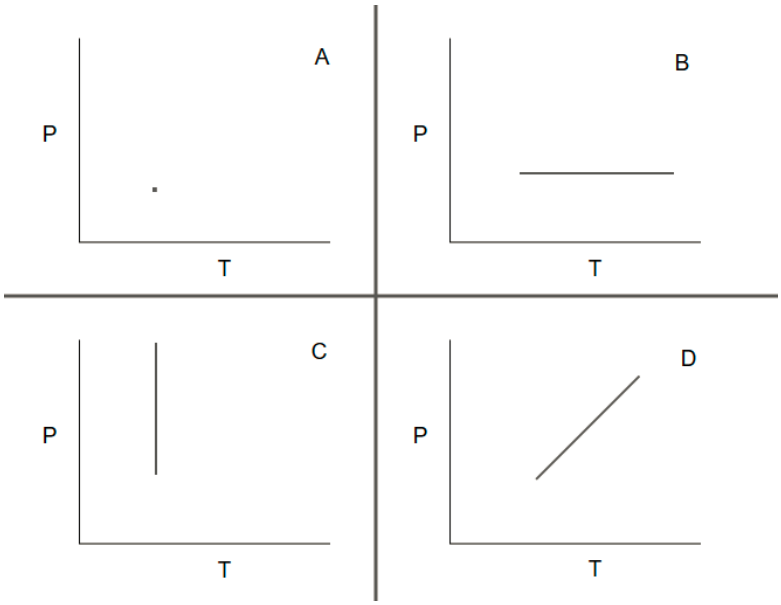
Explanation Chapter 3

3.1 Heat is added to water at a constant pressure of P = 25000 kPa. A phase transition takes place. From a saturated liquid (x = 0), the water is heated to a point where it becomes a saturated vapor (x = 1). What image in the P-T diagram corresponds to this process?

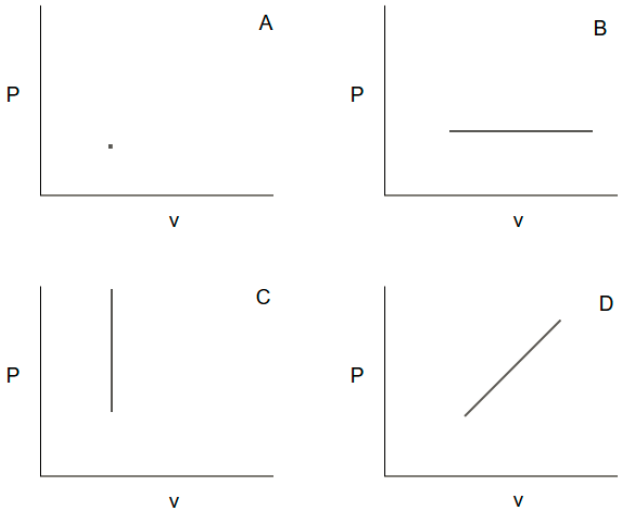
a) Image A
b) Image B
c) Image C
d) Image D



Ans: A. Under the liquid vapor dome both the temperature and pressure are constants. Option A thus gives the best visual representation of this process in a P-T diagram.

3.2 Heat is added to water at a constant pressure of P = 25000kPa. A phase transition takes place. From a saturated liquid (x = 0), state 1, the water is heated to a point where it becomes a saturated vapor (x = 1), state 2. What image in the P-v diagram corresponds to this process?

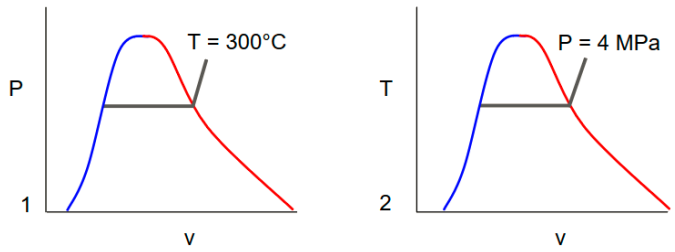
a) Image A
b) Image B
c) Image C
d) Image D



Ans: B. The process takes place at a constant pressure. When transitioning from a saturated liquid to a saturated vapor, the specific volume increases. You can check this in table 4 and 5.

3.3 Two diagrams of a liquid vapor dome are shown. A process takes place in which a saturated liquid with P= 4 MPa is heated to a state where T = 300°C and P = 4 MPa. Which diagram(s) are correct?

a) None of the diagrams
b) Only diagram 1
c) Only diagram 2
d) Both of the diagrams



Ans: C.
Only diagram 2 is correct. In the T-v diagram the correct process and the matching isobar are displayed. Diagram 1 shows a P-v diagram, and the isotherm is wrong, the line should go down after exiting the liquid-vapor dome. Also, the liquid vapor dome should be a little different.

3.4 In which phase is water at T=210°C and P=2 MPa?
a) Compressed liquid
b) Saturated liquid
c) Saturated mixture
d) Saturated vapor
e) Superheated vapor
Ans: A. At 2 MPa (2000 kPa) the saturation temperature (the temperature at which the water starts to boil) is 212.38 degree Celsius. 210 degree Celsius is lower so the water is still in the compressed liquid phase.

3.5 A rigid container of volume 0.5 m^3 contains 1 kg of water at 120°C (vf = 0.00106 m^3/kg, vg= 0.8908 m^3/kg). The state of water is:
a) Compressed liquid
b) Saturated liquid
c) A mixture of saturated liquid and saturated vapor
d) Superheated vapor
Ans: C. The specific volume of water during constant pressure will remain:

$$\vartheta = (Volume\ of\ water)/(mass\ of\ water) = 0.5/1 = 0.5\ m3/kg$$

Since specific volume of water lies between vg & vf at 120°C, therefore the state of water is wet state i.e. a mixture of saturated liquid and saturated vapor.

3.6 For an amount of water is given: T = 180 degree Celsius and h = 2000 kJ/kg. What is the phase of the water?

a) Compressed liquid
b) Saturated liquid
c) Saturated mixture
d) Saturated vapor
e) Superheated vapor

Ans: C. At 180°C, the enthalpy of the saturated liquid id 763 kJ/kg and of the saturated vapor it is 2777 kJ/kg. 2000 kJ/kg is in between, so the water is still in the compressed liquid phase.

3.7 For an amount of water is given: P = 300 kPa and h = 2724.9 kJ/kg. What is the phase of the water?

a) Compressed liquid
b) Saturated liquid
c) Saturated mixture
d) Saturated vapor
e) Superheated vapor

Ans: D. At 300 kPa the enthalpy of the saturated vapor is 2724.9 kJ/kg (table A-5 Cengel and boles, 7th edition). Other tables can give a slightly different number.

3.8 For an amount of water is given: T = 50 degree Celsius and P = 12.352 kPa. What is the phase of the water?

a) Compressed liquid
b) Saturated liquid
c) Saturated mixture
d) Saturated vapor
e) You cannot determine this from the given information

Ans: E. At 50 degrees Celsius the saturation pressure (the pressure at which the water starts to boil) is 12.352 kPa (table A-4 Cengel and boles, 7th edition, other tables can give a slightly different number). So, the water can be saturated liquid, saturated vapor or a mixture. You need more info to determine which of the three it is. Although two properties are given it does not provide enough information. These two properties are not independent. You need two independent properties. Besides the temperature or pressure, you need for example the mass fraction, the enthalpy or the volume.

3.9 Is it possible to have a pressure of 5 kPa in a condenser that is placed near a river and cooled by the water of the river that has a temperature of 10°C? And in a condenser that is placed in the dessert and cooled with outside air of 35°C?

a) Yes, for both it is
b) No, for both it is not
c) Only for the one near the river
d) Only for the one in the dessert

Ans: C. Only for the one near the river, because the saturation temperature of steam at 5 kPa is 32.87°C, which is much higher than the temperature of the cooling water, but lower than the temperature of the air in the desert. So, the condenser cannot reject heat to the environment in the dessert.

3.10 What is the total volume of the mixture liquid-vapor of 10 kg of water at 90℃ when 8kg are in liquid state and the other 2 in vapor stare?

a) 4.73 m^3
b) 23.593 m^3
c) 1 m^3
d) 8.23 m^3
e) 1.001 m^3

Ans: A. Look at the example 3-4 in the book page 126.

3.11 What is the quality of the mixture liquid-vapor of water at T=120℃ knowing that enthalpy h=1800kJ/kg?

a) 69%
b) 73%
c) 48.5%
d) 64.2 %
e) 59%

Ans: E. Using table 4 you can find h_f and h_g and derive x.