Indian Institute of Technology Kanpur
ESO 201 A: Thermodynamics
Instructor: Dr. Jayant K. Singh
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Tutorial- 4

Q 3-68

A 0.3 m^3 rigid vessel initially contains saturated liquid-vapor mixture of water at 150°C. The water is now heated until it reaches the critical state. Determine the mass of the liquid water and the volume occupied by the liquid at the initial state.

Q 3-87

Determine the specific volume of superheated water vapor at 15 MPa and 350°C, using **(a)** the ideal-gas equation, **(b)** the generalized compressibility chart, and **(c)** the steam tables. Also determine the error involved in the first two cases.

Q 4-7

A piston-cylinder device initially contains 0.07 m^3 of nitrogen gas at 130 kPa and 120°C. The nitrogen is now expanded polytropically to a state of 100 kPa and 100°C. Determine the boundary work done during this process.

Q 4-26

1.5-kg water that is initially at 1 MPa and 30 percent quality occupies a spring-loaded piston-cylinder device. This device is now cooled until the water is a saturated liquid at 100°C. Calculate the total work produced during this process, in kJ.

Additional Homework Problems

Q 4-11

A frictionless piston-cylinder device initially contains 50 L of saturated liquid refrigerant-134a. The piston is free to move, and its mass is such that it maintains a pressure of 500 kPa on the refrigerant. The refrigerant is now heated until its temperature rises to 70°C. Calculate the work done during this process.

FIGURE P4–11

Q 4-21

Carbon dioxide contained in a piston-cylinder device is compressed from 0.3 to 0.1 m^3. During the process, the pressure and volume are related by $P = aV^{-2}$, where a = 8 kPa-m^6. Calculate the work done on the carbon dioxide during this process.

Q 4-22

During an expansion process, the pressure of a gas changes from 100 to 700 kPa according to the relation P= aV+b, where a = 1220 kPa/m^3 and b is a constant. If the initial volume of the gas is 0.2 m^3, calculate the work done during the process.

Q 4-24

A piston-cylinder device contains 0.15 kg of air initially at 2 MPa and 350°C. The air is first expanded isothermally to 500 kPa, then compressed polytropically with a polytropic exponent of 1.2 to the initial pressure, and finally compressed at the constant pressure to the initial state. Determine the boundary work for each process and the net work of the cycle.