In Session Practice Problems – Thermodynamics (EGN 3343)

February 2024

Hello everyone,

These are some problems that, in my experience, provide students with a wider understanding of the topics covered in the first third of the semester. I will go over these and other problems during my sessions. I highly recommend that you attend these sessions to solve any doubts.

Disclaimer: There is no guarantee that any of these problems will be included in any exam, so the best way to approach these problems is like practice problems that will help you familiarize yourself with important concepts learned during the semester. Finally, do not use this guide as your ONLY study resource for the exams.

<u>Important Note:</u> All problems and diagrams presented here were extracted from Cengel, Yunus, et al. Thermodynamics: An Engineering Approach. Available from: Yuzu Reader, (9th Edition). McGraw-Hill Higher Education (US), 2018.

6-58 Refrigerant-134a enters the evaporator coils placed at the back of the freezer section of a household refrigerator at 100 kPa with a quality of 20 percent and leaves at 100 kPa and -26°C. If the compressor consumes 600 W of power and the COP of the refrigerator is 1.2, determine (a) the mass flow rate of the refrigerant and (b) the rate of heat rejected to the kitchen air. Answers: (a) 0.00414 kg/s, (b) 1320 W
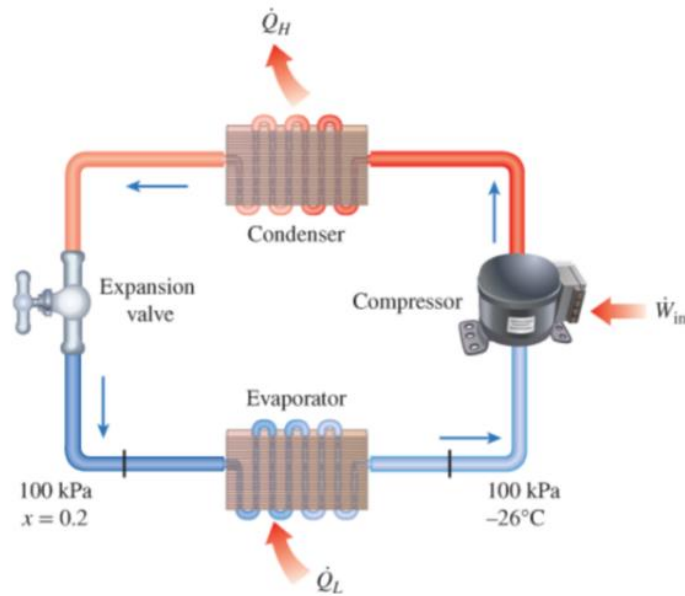

FIGURE P6–58

6-111 A Carnot heat pump is to be used to heat a house and maintain it at 25°C in winter. On a day when the average outdoor temperature remains at about 2°C, the house is estimated to lose heat at a rate of 55,000 kJ/h. If the heat pump consumes 4.8 kW of power while operating, determine (a) how long the heat pump ran on that day; (b) the total heating costs, assuming an average price of $0.11/kWh for electricity; and (c) the heating cost for the same day if resistance heating is used instead of a heat pump. Answers: (a) 5.90 h. (b) $3.11, (c) $40.3
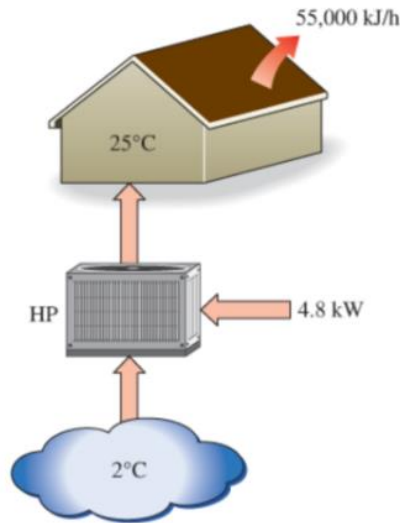

FIGURE P6–111

6-152 A heat pump with refrigerant-134a as the working fluid is used to keep a space at 25°C by absorbing heat from geothermal water that enters the evaporator at 60°C at a rate of 0.065 kg/s and leaves at 40°C. Refrigerant enters the evaporator at 12°C with a quality of 15 percent and leaves at the same pressure as saturated vapor. If the compressor consumes 1.6 kW of power, determine (a) the mass flow rate of the refrigerant, (b) the rate of heat supply, (c) the COP, and (d) the minimum power input to the compressor for the same rate of heat supply. Answers: (a) 0.0338 kg/s, (b) 7.04 kW, (c) 4,40, (c) 0.740 kW
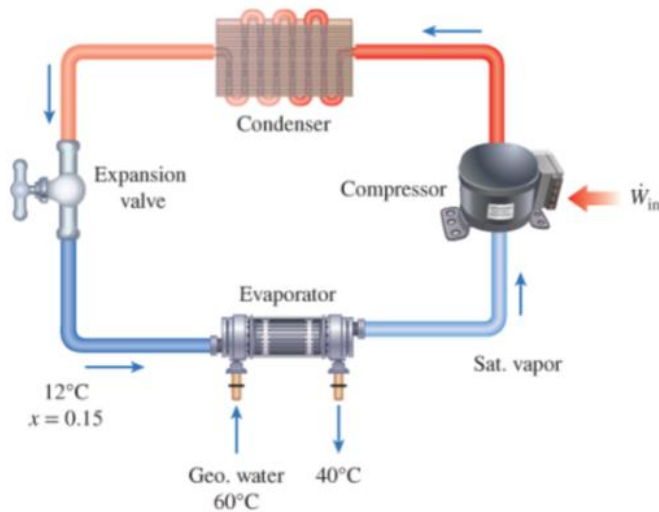

FIGURE P6–152

7-32 A well-insulated rigid tank contains 3 kg of a saturated liquid-vapor mixture of water at 200 kPa. Initially, three-quarters of the mass is in the liquid phase. An electric resistance heater placed in the tank is now turned on and kept on until all the liquid in the tank is vaporized. Determine the entropy change of the steam during this process. Answer: 11.1 kJ/K
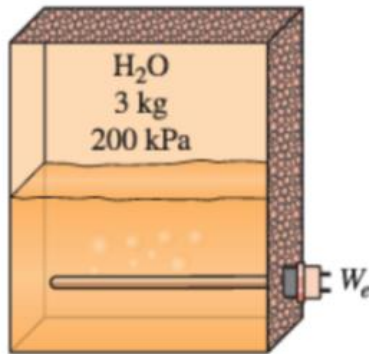

FIGURE P7–32

7-153 Steam expands in a turbine steadily at a rate of 40,000 kg/h, entering at 8 MPa and 500°C and leaving at 40 kPa as saturated vapor. If the power generated by the turbine is 8.2 MW, determine the rate of entropy generation for this process. Assume the surrounding medium is at 25°C. Answer: 11.4 kW/K
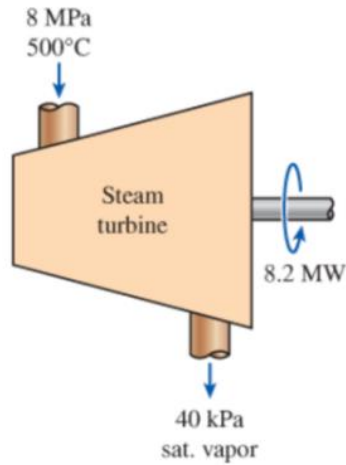
8 MPa
500°C

Steam
turbine

8.2 MW

40 kPa
sat. vapor

FIGURE P7–153

7-190 Air enters a two-stage compressor at 100 kPa and 27°C and is compressed to 625 kPa. The pressure ratio across each stage is the same, and the air is cooled to the initial temperature between the two stages. Assuming the compression process to be isentropic, determine the power input to the compressor for a mass flow rate of 0.15 kg/s. What would your answer be if only one stage of compression were used? Answers: 27.1 kW, 31.1 kW
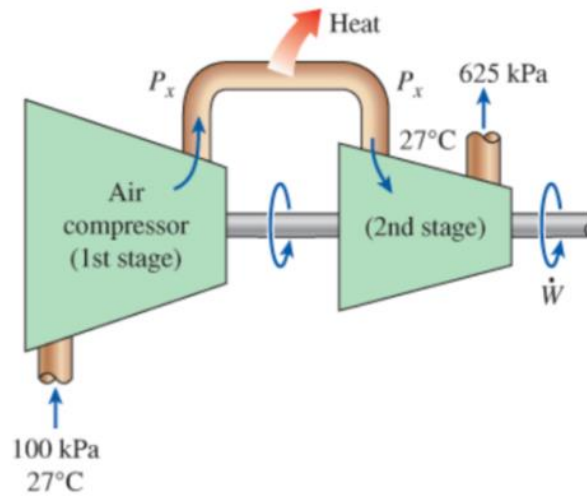

FIGURE P7–190