ESO 201A Thermodynamics

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Tutorial 3

[2-68]The water in a large lake is to be used to generateelectricity by the installation of a hydraulic turbine-generatorat a location where the depth of the water is 50 m (Fig.2-62). Water is to be supplied at a rate of 5000 kg/s. If theelectric power generated is measured to be 1862 kW and the generator efficiency is 95 percent, determine (a) the overallefficiency of the turbine—generator, (b) the mechanical efficiency of the turbine, and (c) the shaft power supplied by theturbine to the generator.

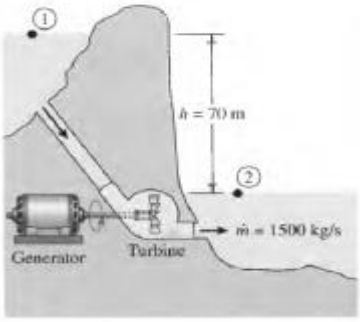

FIGURE 2–62
Schematic for Example 2–16.

[2-71]Water is pumped from a lake to a storage tank20 m above at a rate of 70 L/s while consuming 20.4 kWof electric power. Disregarding any frictional losses in the pipes and any changes in kinetic energy, determine(a) the overall efficiency of the pump-motor unit and (b) the pressure difference between the inlet and the exitof the pump.

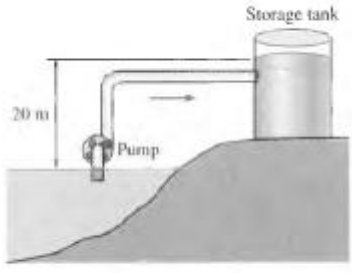

FIGURE P2–71

[2-78]A wind turbine is rotating at 15 rpm under steadywinds flowing through the turbine at a rate of 42,000 kg/s.The tip velocity of the turbine blade is measured to be 250 km/h. If 180 kW power is produced by the turbine, determine(a) the average velocity of the air and (b) the conversionefficiency of the turbine. Take the density of air to be 1.31 kg/m^3.

Additional Homework Problems (Tutorial 3)

[2-69]At a certain location, wind is blowing steadily at7 m/s. Determine the mechanical energy of air per unit massand the power generation potential of a wind turbine with 80-m-diameter blades at that location. Also determine theactual electric power generation assuming an overall efficiencyof 30 percent. Take the air density to be 1.25 kg/m^3.

[2-72]Large wind turbines with blade span diameters ofover 100 m are available for electric power generation. Considera wind turbine with a blade span diameter of 100 m installed at a site subjected to steady winds at 8 m/s. Takingthe overall efficiency of the wind turbine to be 32 percent and the air density to be 1.25 kg/m^3, determine the electric powergenerated by this wind turbine. Also, assuming steady winds of 8 m/s during a 24-hour period, determine the amount ofelectric energy and the revenue generated per day for a unitprice of $0.06/kWh for electricity.

[2-76]An oil pump is drawing 35 kW of electric powerwhile pumping oil with ρ= 860 kg/m^3 at a rate of 0.1 m^3/s.The inlet and outlet diameters of the pipe are 8 cm and 12cm, respectively. If the pressure rise of oil in the pump ismeasured to be 400 kPa and the motor efficiency is 90 percent,determine the mechanical efficiency of the pump.

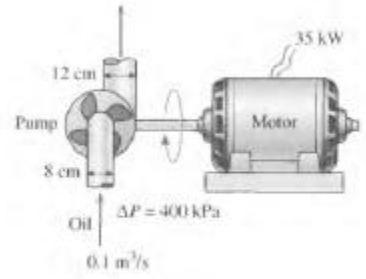

FIGURE P2–76

[2-85]When a hydrocarbon fuel is burned, almost all of thecarbon in the fuel burns completely to form CO_2 (carbondioxide), which is the principal gas causing the greenhouse effect and thus global climate change. On average, 0.59 kg of CO_2 is produced for each kWh of electricity generated from a power plant that burns natural gas. A typical new householdrefrigerator uses about 700 kWh of electricity per year. Determine the amount of CO_2 production that is due to therefrigerators in a city with 300,000 households.