Q 6 Air with pressure 2 MPa and density 10 kg/m^3 enters a turbine at a mass flow rate of 0.2 kg/s and a velocity of 300 m/s. The same mass flow rate leaves turbine at a velocity of 200 m/s with a pressure o.1 MPa and temperature of 400 K. If heat is lost from the turbine casing at a rate of 5 kW determine the mechanical power output. R = 287 J/kg K and c_p = 1004.5 J/kg K.

SOLUTION

$\Phi + P = \Delta H + \Delta KE$ ignoring potential energy.

$\Phi = -5$ kW

$\Delta KE = 0.2(200^2 - 300^2)/2 = -5000$W or -5kW

$T_2 = 400K$ $T_1 = pV/mR = p/\rho R = 2 \times 10^6/10 \times 287 = 696.9$ K

$\Delta H = mc_p\Delta T = 0.2 \times 1004.5 \times (400 - 696.9) = -59540$ W or -59.6 kW

$P = -5 - 59.56 + 5 = -59.6$ kW

Power output is 59.6 kW