## FE-Style Questions

**33-FE1:** Superheated steam enters a turbine at 1 MPa and 500 °C. Steam leaves the turbine at 9.59 kPa and a quality of 98%. The turbine has an isentropic efficiency of 85.7%. Most nearly, what is the ideal turbine specific work?

1. 650 kJ/kg
2. 810 kJ/kg
3. 940 kJ/kg
4. 1100 kJ/kg

**33-FE2:** For the turbine in the previous problem, what mass flow rate [kg/hr] of steam passing through the turbine would be required to generate 1 MW of power?

1. 1900 kg/hr
2. 3100 kg/hr
3. 3800 kg/hr
4. 4500 kg/hr

## Practice Problems

**33-1:** A chemical processing facility produces exhaust gases with composition 46% N2, 43% CO2, and 11% SO2 by volume. The total pressure is .320 MPa and the temperature is 1000 °C. It is proposed that energy be recovered from this gas by expanding it through a turbine to atmospheric pressure. Assuming ideal gas behavior, determine the maximum possible power output per unit mass flow for this system.

**33-2** A mixture of air and water vapor at 20 C and .101 MPa has a relative humidity of 100%.  
 Determine the following using data about the composition of air in Example 12.2:  
 (a) molar composition (yi’s)

(b) effective molecular mass of the mixture  
 (c) mass concentration (wi’s)

(d) effective gas constant of the mixture

## Answers

**33-FE1:** The real state 2 has specific enthalpy of 2535 kJ/kg, and state 1 has a specific enthalpy of 3479 kJ/kg. The ideal specific work would then be wreal/eta, so wideal = 1100 kJ/kg

**33-FE2:** Wdot\_real = mdot\*(h1-h2), so mdot = 3817 kg/hr

**33-1:** maximum specific work would be ~275 kJ/kg

**33-2:**

1. molar composition of wet mixture:
   1. y(H2) = 0.023
   2. y(N2) = 0.763
   3. y(O2) = 0.205
   4. y(Ar) = 0.009
   5. y(CO2) = 0.0003

(b) effective molecular mass of the mixture ~ 28.7 kg/kmol

(d) effective gas constant of the mixture ~ 0.29 kJ/kg-K