## Practice Problems

**22-1:** A steam turbine is limited to a maximum inlet temperature of 800 °C. The exhaust pressure  
 is .01 MPa and the maximum allowable liquid passing through the turbine is 9%. Use EES along  
 with an array table to find the following:  
  
 a) What is the maximum allowable turbine inlet pressure if the flow is adiabatic  
 and reversible (aka isentropic)?  
 b) What is the specific work output given conditions of isentropic (ideal) turbine?  
 c) Starting with the same initial conditions, what are the actual outlet conditions if this  
 turbine has an isentropic efficiency of 85%?  
 d) What is the specific work output of this (real) turbine?  
 e) Display the ideal and real expansion processes on an EES Ts property diagram.

**22-2:** A refrigeration compressor receives saturated R-134a vapor at 0 °F and delivers it at  
 150 psia and 135 °F. The compression process is adiabatic. Use EES along with an array  
 table to find the following:   
   
 a) What is the specific work input for the real process?  
 b) What is the specific work input for an ideal, reversible process?  
 c) What is the isentropic efficiency of this compressor?  
 d) What is the outlet temperature for this ideal process?   
 e) Display the ideal and real compression processes on an EES Ts property diagram.

## Preparatory Reading Questions

1. Supply equations for the isentropic efficiency of the following devices. Sketch ideal and real performance on a Ts diagram.  
    - turbine  
    - compressor  
    - pump  
    - nozzle  
    - diffuser
2. Why is there no device efficiency defined for a valve?

## Answers

1. P\_1 max ~ 8700 kPa,   
   specific work (ideal) ~ 1750 kJ/kg  
   Actual outlet conditions: T\_2 = 70.55 °C, p\_2 = 10 kPa (independent because not 2-phase)  
   specific work (real) ~ 1500 kJ/kg (needs to be lower than ideal work)  
   Ideal process should be vertical on T-s diagram, and real process should have increase entropy
2. specific work (real) = -21.5 Btu/lbm  
   specific work (ideal) = -17.56 Btu/lbm  
   Isentropic efficiency ~ 81.6 %  
   Outlet temp (ideal) ~120 °F  
   Ideal process should be vertical on T-s diagram, and real process should have increase entropy