## Practice Problems

1. Air at 70 °F, 30 psia, and velocity of 3.00 ft/s enters an insulated steady state nozzle. The inlet area of the nozzle is .05 m2. The nozzle contains a 1500 W electrical heater. The air exits the nozzle at 14.7 psia and 300 ft/s. Determine the temperature of the air at the exit of the nozzle.
   1. Solve this assuming isobaric specific heat remains constant at 0.240 Btu/lbm-R
   2. Solve this using the air tables (with built-in variation in specific heat)
2. The quality of wet steam in a pipe can be estimated by diverting a small portion of the steam through an orifice (an isenthalpic valve) and then expanding it through a calorimeter (small volume next to the pipe). The orifice can be sized such that the temperature and pressure under expected operating conditions will place the thermodynamic state in the superheated vapor region. Calculate the quality of the steam in a pipe that is at 200 psia if you know the properties inside the adjacent calorimeter are: T = 300 °F, and a p = 20 psia.
3. Refrigerant R-22 is flowing steadily through a refrigerator throttling valve at the rate of 10 lbm/min. At the inlet, R-22 is a saturated liquid at 80.0 °F. At the valve outlet, the pressure is 31.162 psia. Assuming that the process is aergonic, adiabatic, and with no change in kinetic or potential energy, find the quality at the valve outlet.

## Answers

1. Air temperature after heated nozzle
   1. Assuming constant specific heat capacity 🡪 86.9 °F
   2. Using air tables with variable specific heat capacity 🡪 86.9 °F
   3. Using EES (not required for your assignment) 🡪 86.52 °F
2. Quality in pipe would be 0.9914
3. Quality at valve outlet would be 0.265 (by hand)  
   Quality at valve outlet would be 0.2674 (with EES)