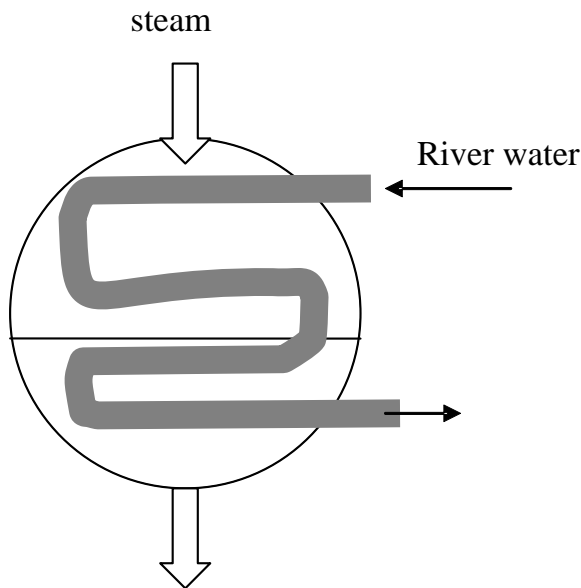


**Homework #7 Due Thursday, October 25**

1. Saturated liquid-vapor mixture of steam at 2 MPa is throttled to a final state of 100 kPa and 120 °C. **What is the quality of the influent steam?**
2. During a throttling process, the temperature of a fluid drops from 30 to – 20 oC. Can this process be adiabatic? If so, under what condition(s)? If not, why not?
3. Refrigerant, R-134a, at 700 kPa, 70 °C, and 8 kg/min is cooled by water in a condenser heat exchanger until the refrigerant becomes a saturated liquid at the same pressure (700 kPa). The cooling water enters the condenser at 300 kPa and 15 °C and leaves at 25 °C at the same pressure (300 kPa). **Determine the mass flow rate of the cooling water required to cool the refrigerant.**
4. Steam enters the condenser of a steam power plant at 20 kPa and a quality of 95% with a mass flow rate of 20,000 kg/hr. The steam flows through the pipe in a heat exchanger and is cooled by water from a nearby river circulated around the steam pipes in the condenser. The steam going in leaves the condenser as saturated liquid at 20 kPa. To prevent fish kills in the river, the temperature of the river water cannot increase by more than 10 °C. **Determine the mass flow rate of river water required to cool the steam.**



5. A stream of refrigerant (R-134a) at 1 MPa and 12 °C is mixed with another stream of R-124a at 1 MPa and 60 °C. If the mass flow rate of the cold stream is twice that of the hot one, **determine the temperature and quality of the exit steam.**
6. An adiabatic feedwater heater in a power plant is used to mix 0.2 kg/s steam at 100 kPa and 160 °C with 10 kg/s cool feedwater at 100 kPa and 50 °C to produce warm feedwater at 100 kPa and 60 °C at the outlet. **Find the outlet mass flow rate and the outlet velocity if the outlet pipe diameter is 0.03 m.**
7. Hot exhaust gases of an internal combustion engine are to be used to produce saturated water vapor at 2 MPa. The gases enter the heat exchanger at 400 °C and a mass flow rate of 32 kg/min. The water enters at 15 °C. The heat exchanger is not well insulated, and it is estimated that 10% of the heat given up by the exhaust gases is lost to the surroundings. If the mass flow rate of the exhaust gases is 15 times that of the water. Determine:
  - a. **The temperature of the exhaust gases at the heat exchanger outlet**
  - b. **The rate of heat transfer from the gases to the water. Assume that the  $C_p$  value for the exhaust gases is constant and the same as for air.**

#### EXTRA CREDIT

- EC1. (5 points) A glass bottle washing facility uses a well mixed hot water bath at 55 °C. The bottles enter the bath at 20 °C at a rate of 800 per minute and leave at 55 °C. Each bottle has a mass of 150 g and a specific heat of 0.8 kJ/kgK. Each bottle leaving the bath carries 0.2 g water with it. Make-up water at a temperature of 15 °C is added to keep the bath water volume constant. Assuming that there are no heat losses from the bath to the surroundings. Determine:
- a. **The rate of water make-up added**
  - b. **The heat added to maintain steady operation.**