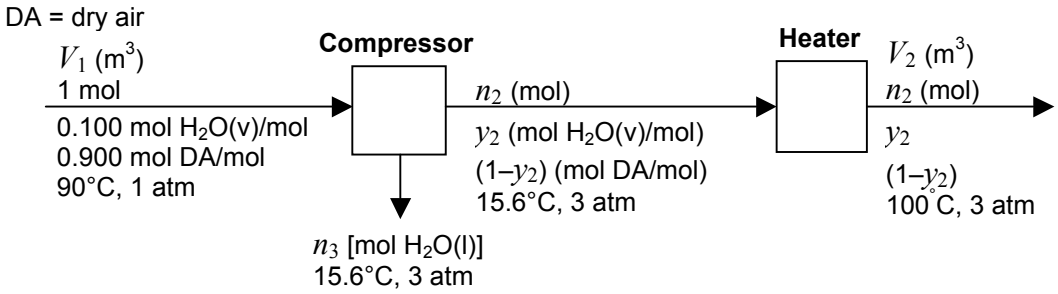
PROBLEM 6.18

Air at 90°C and 1.00 atm (absolute) contains 10.0 mole% water. A continuous stream of this air enters a compressor-condenser, in which the temperature is lowered to 15.6°C and the pressure is raised to 3.00 atm. The air leaving the condenser is then heated isobarically to 100°C. Calculate the fraction of water that is condensed from the air, the relative humidity of the air at 100°C, and the ratio m^3 outlet air @ 100°C /m^3 feed air @ 90°C.

Solution

Basis: 1 mol feed. Since the problem statement asks us to calculate the ratio of the volumes of feed air and exit air, we will label both volumes on the flowchart.



DEGREE-OF-FREEDOM ANALYSIS ON COMPRESSOR		
UNKNOWNS AND INFORMATION		JUSTIFICATION/CONCLUSION
+ 4 unknowns	(V_1, n_1, n_2, y_2)	
– 2 balances	_____ , _____	
– 1 gas law at inlet		
1 DOF		Problem is unsolvable

Since we have more unknowns than equations, unless we can come up with another relationship among the compressor variables we're stuck. (If you do the DOF analyses for the overall system and the heater you'll run into the same problem—try it.) Fortunately, there is another relationship. Can you state what it is and justify your claim? (*Hint*: What do you know about the two streams leaving the compressor?)

(6.18-2)

The solution strategy is straightforward.