
PROBLEM 6-17N QUESTION

Power Cycle for a Simplified BWR

The power cycle of a simplified BWR is shown in Figure 1a. Steam at 10% quality exits the core. The steam is separated from the water in a steam separator, and then is directed to the turbine, then completely condensed and pumped back to the reactor. The separated water is mixed with the feedwater coming from the pump, and recirculated to the core inlet.

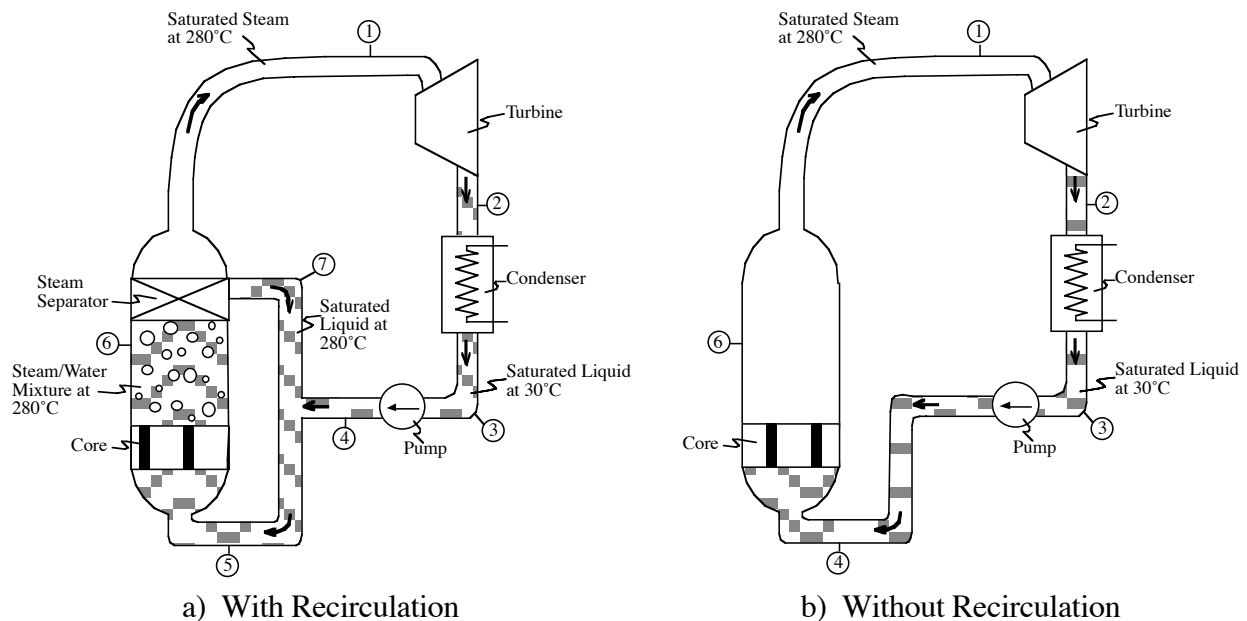


Figure 1. Schematic of a Simplified BWR Plant.

QUESTIONS

- Sketch the T-s diagram for the cycle of Figure 1a. Make sure to include the effect of recirculation.
- Using the data below, calculate the cycle thermal efficiency.
- Consider now the same cycle but **without recirculation**, i.e., the feedwater from the pump goes directly to the core, the steam quality at the core outlet is 100%, and there is no steam separator (Figure 1b). Sketch the T-s diagram and calculate the thermal efficiency for this cycle. How does the thermal efficiency compare to that of the cycle with recirculation?
- Given the results in 1.c., what are the advantages/disadvantages of using the cycle with recirculation?

Assumptions:

- Assume perfect steam/water separation in the steam separator.
- Assume ideal turbine and pump.
- Assume constant water density in the pump.
- Neglect kinetic and gravitational terms.

Data for Saturated Water:

T (°C)	P (bar)	v_f (m ³ /kg)	v_g (m ³ /kg)	h_f (kJ/kg)	h_g (kJ/kg)	s_f (kJ/kg·K)	s_g (kJ/kg·K)
30	0.04	1.0×10^{-3}	32.9	126	2556	0.4	8.4
280	64	1.3×10^{-3}	0.03	1236	2780	3.1	5.9