

NUCL 40200 Engineering of Nuclear Power Systems

Assignment 8

- (1) A BWR system with one stage of moisture separation is shown in Figure 6.38 below. The condition in Table 6.19 below may be used.

Turbine separation efficiency = 90%,

Pump isentropic efficiency = 85%

Environmental temperature = 30C

(a) Calculate the cycle thermal efficiency.

(b) Recalculate the thermal efficiency of the cycle assuming that the pumps and turbines have isentropic efficiency of 100%.

(c) Calculate the lost work due to the irreversibility of each component in the cycle and show numerically that the available work equals the sum of the lost work and the net work.

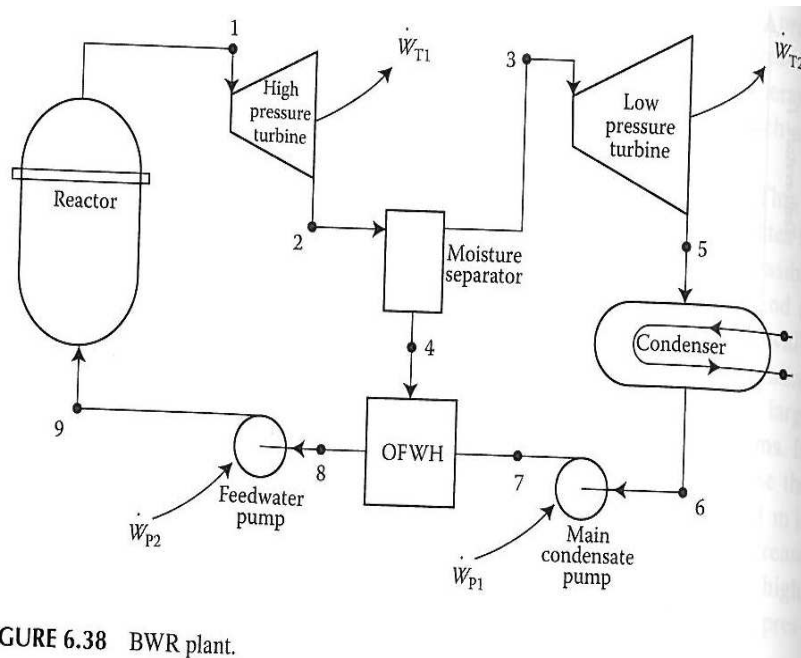


TABLE 6.19
State Conditions for Problem 6.3

Points	p (kPa)	Condition
1	6890	Saturated vapor
2	1380	
3	1380	Saturated vapor
4	1380	Saturated liquid
5	6.89	
6	6.89	Saturated liquid
7	1380	
8	1380	
9	6890	

FIGURE 6.38 BWR plant.

Ans:

(a) $\eta_{th} = 34.2\%$,

(b) $\eta_{th\ max} = 37.7\%$,

(c) $W_{u,\ max} = 2510.9\ \text{kJ/kg}$, $W_{NET} + I_{TOT} = 2510.9\ \text{kJ/kg}$,

(2) The Brayton cycle shown in Figure 6.41 operates using CO₂ as a working fluid with compressor and turbine isentropic efficiencies of 1.0. Calculate the thermal efficiency of this cycle when the working fluid is modeled as

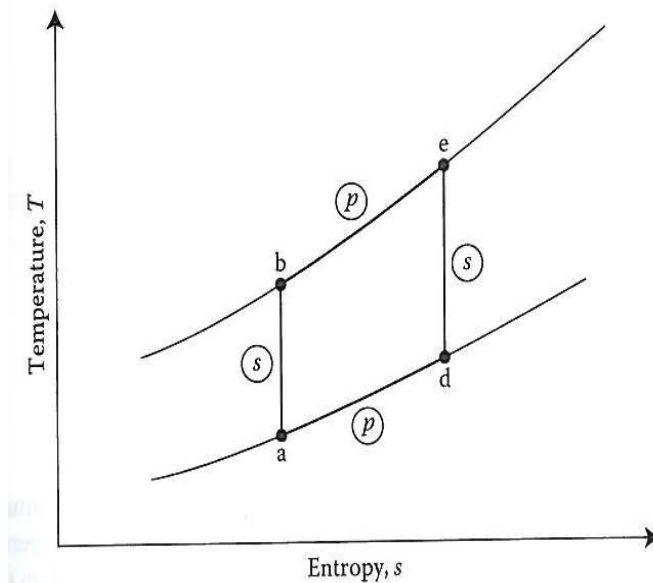
1. A perfect gas of $\gamma = 1.30$
2. A real fluid (see below for extracted values from Keenan and Kaye's gas tables).
3. A real fluid and the compressor and turbine both have isentropic efficiencies of 0.95

The parameters needed for a real fluid (from Keenan and Kaye's gas tables) are shown in Table 6.21, where T in C, p_r relative pressure, h enthalpy per mole kJ/kg-mole, The ration of pressures p_a

and p_b as tabulated for T_a and T_b . Thus $\left(\frac{p_a}{p_b}\right)_{s=\text{constant}} = \frac{p_{ra}}{p_{rb}}$

Table 6.21

Parameter	<i>a</i>	<i>b</i>	<i>c</i>	<i>d</i>
<i>T</i>	32.2		573.8	
<i>p</i>	137.9	689.5	689.5	137.9
<i>p_r</i>	0.16108	0.8054	31.5	6.3
<i>h</i>	9643.6	14513.8	33038.5	23439.1



Ans: Table

$\eta_{th} = 31.0\%$, 25.5% and 21.9% respectively.