PROBLEM 6-14N QUESTION

BWR Operation At Supercritical Conditions

The BWR of Problem 6-3 is to be redesigned so as to operate at supercritical steam conditions. Hence, the cycle is modified as shown in Figure 1 by:

- the reactor core is redesigned to produce supercritical coolant at 23 MPa and 450°C.
- a second pump is added in series after the feed water pump to boost the reactor inlet to supercritical pressure conditions of 23 MPa. The isentropic efficiency of this pump is 90%.
- an additional turbine is added at the reactor outlet through which the steam passes and is returned exactly to State 1 of Problem 6-3.

See Table 1 for properties to avoid having to interpolate in the steam tables.

QUESTIONS

A. What is the new cycle thermodynamic effectiveness?

B. What is the new irreversibility of this reactor plant?

C. Identify what you think are the three most significant safety implications (positive or negative effects) of this new design.

Table 1

	kJ/kg K			kJ/kg		
	s_f	s_{fg}	s_g	h_f	h_{fg}	h_g
6.89 MPa	3.1111	2.7102	5.8213	1311.33	1462.20	2773.53
Specific volume of Stages 9 and 10s = 1.0089×10^{-3} m^3/kg						

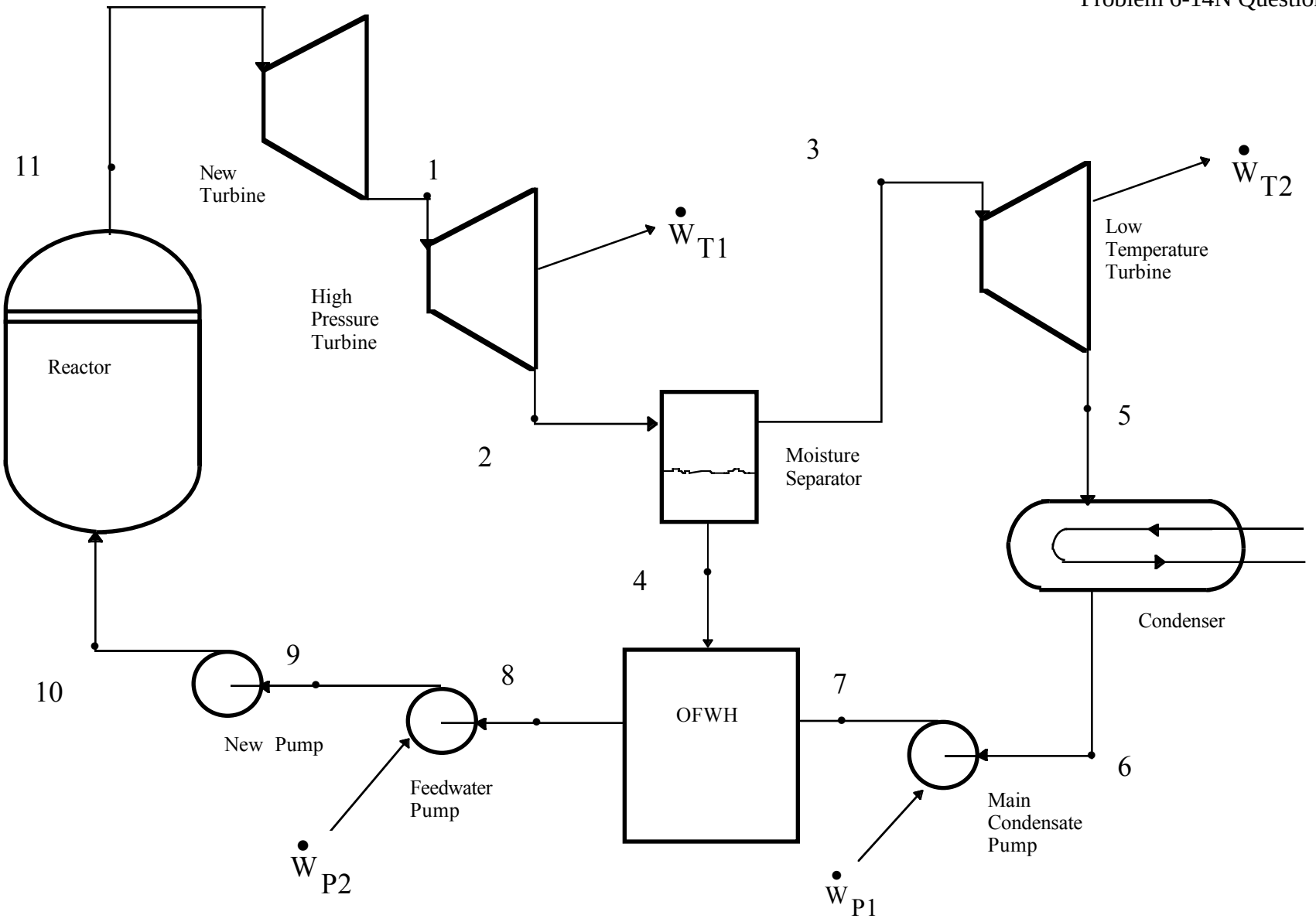
11
New
Turbine
1
3
$\dot{W}_{T2}$
$\dot{W}_{T1}$
High
Pressure
Turbine
Low
Temperature
Turbine
Reactor
2
Moisture
Separator
5
4
Condenser
9
10
8
7
OFWH
New Pump
Feedwater
Pump
6
Main
Condensate
Pump
$\dot{W}_{P2}$
$\dot{W}_{P1}$

Figure 1