

# PROBLEM 13-10N QUESTION

## Two Phase Problem Involving A Nuclear Power Plant

Consider a steam-cooled 170 MWe (electrical power output) power plant as shown in Fig. 1. The plant is heating the coolant (water) in two stages: the first stage is from waste heat supplied by an external boiler (located at the same site) through a heat exchanger; the second is through a nuclear reactor. The plant states are defined as follows:

Position	Quality (x)	Pressure (p)	State
1	•	5.0 MPa	saturated liquid
2	•	15.0 MPa	$h = 1168.86 \text{ kJ/kg}$
2	30%	15.0 MPa	•
3	75%	15.0 MPa	•
4	•	5.0 MPa	Two-phase mixture

Additional Information:

$\dot{Q}_{HX}$	=	1,000 MWt
Number of fuel pins	=	25,000
Number of channels	=	25,000
Square array with P/D	=	1.15
Diameter of rod	=	1.0 cm
Active core length	=	2 m

Assumptions:

Uniform flat radial power distribution over entire core  
 Cosine power shape axially with zero extrapolation length  
 HEM flow throughout  
For the pressure drop calculation assume:  
 Entrance and exit losses negligible  
 Liquid and vapor compressibility negligible  
 Gravitational losses negligible  
 $f_{2\phi} = f_{l0}$

QUESTIONS

- A . Draw the cycle T-s diagram.
- B . Compute reactor power and mass flowrate needed.
- C . Compute  $p_{acc}$  across the core.
- D . Indicate completely how to evaluate  $p_{fric}$  (but **do not** perform the integration).
- E . Compute the exit void fraction.

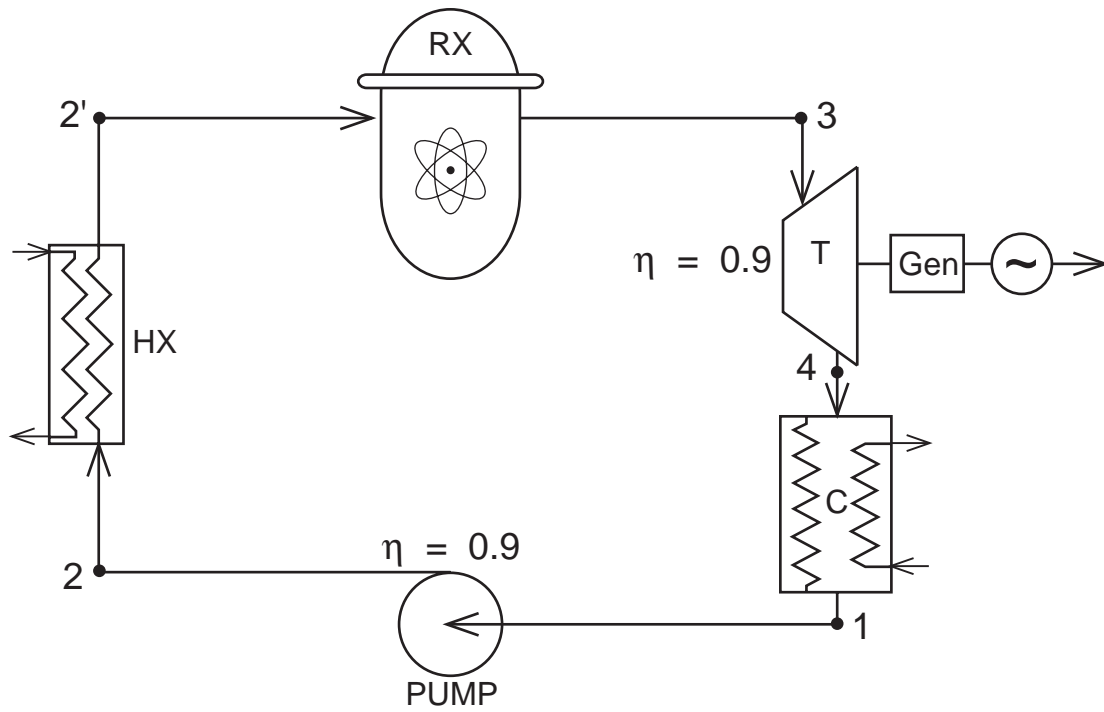


Figure 1