NUCL 40200 Engineering of Nuclear Power Systems

Assignment 6

(Problems are from Todreas and Kazimi book Edition 2)

(1) A typical primary system pump in a three loop PWR operates at a head of 100 m and flow rate of 7500 kg/s. How much power is required for the pump in steady state if the pump efficiency η is 85%. What percent is pump power with respect to power produced by plant? Assume plant power of 1000 MWe.

Ans :
$8.7x10^6$ W

(2) Minimum CPR in BWR:
Calculate the minimum CPR for atypical 1062 MWe BWR operating at 100% power using data in Appendix K. Assume that:

1. Axial linear power shape can be expressed as
$q'(z)= q'_{ref} exp\ (-\alpha z/L) sin \pi z/L$
where α=1.96. determine q'_{ref} such that q'_{max} = 47.24 kW/m

2. The critical bundle power is 9319 kW.

Ans:
q'_{ref} =104.75 kW/m
MCPR =1.28

(3) Primary system cooling for a PWR reactor:
Calculate the pumping power under steady state operating conditions for typical PWR reactor coolant system using only the following operating conditions:

Core power = 3411 MW th
ΔT_{core} = 33.7 C
T_{IN} = 293C
P = 15.5 MPa
Reactor coolant system pressure drop =778 kPa
Pump efficnecy = 85%.

Ans:
Pumping power = 21.8 MWe

(4) Using Equation 3.70c or 3.70d, evaluate the energy generated in a 3411 MWth PWR after the reactor shuts down. The reactor operated for 1 year at the equivalent of 75% of total power.
Consider the following time periods after shutdown:
(a) 1 h, (b) 1 day, (c) 1 month and (d) 1 year

Ans:
(a) 0.128 TJ (1tJ = 10^{12} J), (b) 1.42 TJ, (c) 14.8 TJ.