Homework #2

Answers

1. Time	$\rho(t)$	$\dot{\rho}(t)$	$\tau(t)$	Power *
0^-	0 mbeta	0	∞	Steady
0^+	0 mbeta	20 mβ/s	50 s	Rising
10^-	200 mbeta	20 mβ/s	20 s	Rising
10^+	200 mbeta	0 mβ/s	40 s	Exponential Rise
50^-	200 mbeta	0 mβ/s	40 s	Exponential Rise
50^+	200 mbeta	-10 mβ/s	80 s	Still rising, but slowing
70^-	0 mbeta	-10 mβ/s	−100 s	Dropping
70^+	0 mbeta	0 mβ/s	∞	Steady

2. This problem is solved in two steps.

(a) Prompt-Jump:

$$P_f = P_i \frac{\bar{\beta}}{\bar{\beta}-\rho} = (1\ \text{kW})\left(\frac{1.0}{1.0-0.2}\right)$$

$$= 1.25\ \text{kW}$$

(b) Rise on Constant Period:

$$\tau = \frac{\bar{\beta}-\rho}{\dot{\rho}+\lambda_e\rho} = \frac{1.0-0.2}{0.0+(.1)(.2)}$$

$$= 40\ \text{s}$$

$$P = P_f e^{t/\tau} = 1.25\, e^{60/40}$$

$$= 5.6\ \text{kW}$$

3. The first effect will be decreased moderation because of the negative temperature coefficient of reactivity associated with the primary coolant. The second effect would be a negative reactivity insertion from the Doppler coefficient. For this to occur, the fuel would have to overheat. (The transient is too rapid for Xenon to have any effect.) If the transient were very rapid, the Doppler effect would occur before the moderator effect.

4. Steam is still being withdrawn by the turbine and the reactor is subcritical. So, the reactor cools off rapidly, the negative temperature coefficient of reactivity causes positive reactivity to be inserted and the reactor goes critical on a very short period.

5. The major sink for Xenon (burnup) is removed but the major source (decay of iodine) remains.

6. If the valve fails open during the repair, a slug of cool condensate will reach the steam generator and cause a power increase because of the negative reactivity coefficient associated with coolant temperature. So, first partially close an upstream manual valve. (Note: This problem may not exist depending on the preheater design.)