
PROBLEM 7-17N QUESTION

Containment Sizing for a Gas-Cooled Reactor with Passive Emergency Cooling

An advanced helium-cooled graphite-moderated reactor generates a nominal thermal power of 300 MW. To prevent air ingress in the core during a Loss Of Coolant Accident (LOCA), the reactor containment is filled with helium at atmospheric pressure and room temperature (Figure 1a). The reactor also features an emergency cooling system to remove the decay heat from the containment during a LOCA. To function properly, this system, which is passive and based on natural circulation of helium inside the containment, requires a minimum containment pressure of 1.3 MPa.

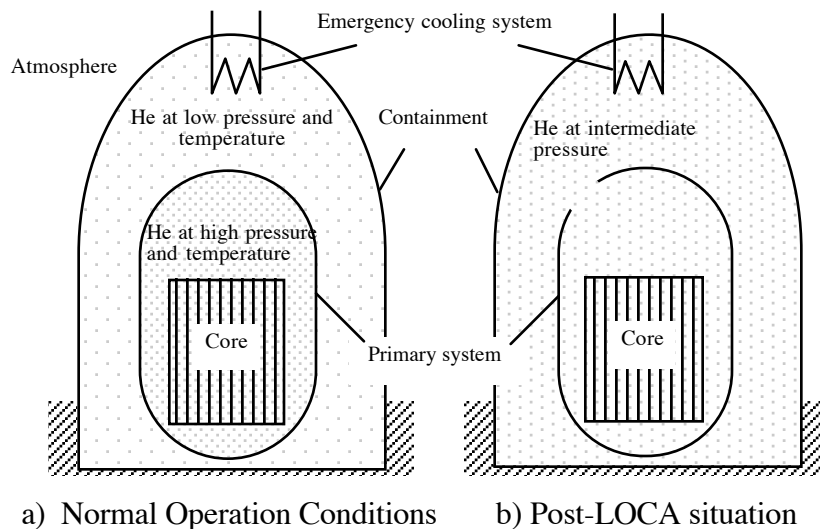


Figure 1. Helium-Cooled Reactor with Helium-Filled Containment.

QUESTIONS

- Find the containment volume, so that the pressure in the containment is 1.3 MPa immediately after a large-break LOCA occurs (Figure 1b). (Assume that thermodynamic equilibrium within the containment is achieved instantaneously after the break)
- Assuming that the emergency cooling system removes 2% of the nominal reactor thermal power, calculate at what time the pressure in the containment reaches its peak value after the LOCA. (Calculate the decay heat rate assuming infinite operation time)
- To reduce the peak pressure in the containment, a nuclear engineer suggests venting the containment gas to the atmosphere through a filter. What would be the advantages and disadvantages of this approach?

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Assumptions: □

- □ Treat helium as an ideal gas.
- □ Neglect the heat contribution from fission and chemical reactions.
- □ Neglect the thermal capacity of the structures.

Data: □

Gas volume in the primary system: 200 m^3

Initial primary system temperature and pressure: 673 K , 7.0 MPa

Initial containment temperature and pressure: 300 K , 0.1 MPa

Helium specific heat at constant volume: $c_v = 12.5 \text{ J}/(\text{mol}\cdot\text{K})$

Helium atomic weight: $A = 0.004 \text{ kg}/\text{mol}$

Gas constant: $R = 8.31 \text{ J}/(\text{mol}\cdot\text{K})$