EEL4936/6936 – Power Plant Engineering

Homework #3: Steam Generators & Nuclear Power

Due: 02/16/09

#1. The law that states that any thermodynamic process is irreversible as the net entropy of a system and its surroundings always increases is ;

A. The first law of thermodynamics
B. The second law of thermodynamics
C. Ohms Law
D. Stuarts Law

#2. Using equation on page 2.76 (shown below), given that the needed volume of a fan application is 100,000 CFM and the pressure difference across the fan is 20 inches of water, the **air HP** of the fan is;

$$\text{Air hp} = \frac{VH}{6356}$$

Where;
V = Volumetric flow in cubic feet per minute
H = Pressure Difference in inches of water.

A. 210 Air HP
B. 315 Air HP
C. 385 Air HP
D. 410 Air HP

#3. Given the centrifugal fan laws on page 2.90 (also given at last page of this homework sheet), for a given fan size, system resistance and air density, as fan speed is reduced by a factor of two, fan power is reduced by a factor of;

A. Two
B. Four
C. Eight
D. Sixteen

#4. Given the following:
A saturated steam-water mixture with an inlet quality of 60% is flowing through a moisture separator. The moisture separator is 100% efficient for removing moisture. How much moisture will be removed by the moisture separator from 50 lbm of the steam-water mixture?
A. 10 lbm
B. 20 lbm
C. 30 lbm
D. 40 lbm

#5. A reactor coolant system is being maintained at 1000 psia. A pressurizer safety/relief valve is slowly discharging to a collection tank, which is maintained at 5 psig. Assuming 100% quality steam in the pressurizer vapor space, what is the approximate enthalpy of the fluid entering the tank?
A. 1,210 Btu/lbm
B. 1,193 Btu/lbm
C. 1,178 Btu/lbm
D. 1,156 Btu/lbm

#6. The thermodynamic cycle efficiency of a nuclear power plant can be increased by...
A. decreasing power from 100% to 25%.
B. removing a high-pressure feed water heater from service.
C. lowering condenser vacuum from 29 inches to 25 inches.
D. decreasing the amount of condensate depression (subcooling).

#7. To achieve maximum overall nuclear power plant thermal efficiency, feed water should enter the steam generator (S/G) _____ and the pressure difference between the S/G and the condenser should be as _____ as possible.
A. as subcooled as practical; great
B. as subcooled as practical; small
C. close to saturation; great
D. close to saturation; small

#8. A nuclear power plant is operating at 85% reactor power when the extraction steam to a high-pressure feedwater heater is isolated. After the transient, the operator returns reactor power to 85% and stabilizes the plant. Compared to conditions just prior to the transient, current main turbine generator output (MWe) is...
A. higher because increased steam flow is causing the turbine to operate at a higher speed.
B. lower because decreased steam flow is causing the turbine to operate at a lower speed.
C. higher because plant thermal efficiency has increased.
D. lower because plant thermal efficiency has decreased.

#9. A pressurizer is operating in a saturated condition at 636^{o}F. If a sudden pressurizer level decrease of 10% occurs, pressurizer pressure will _____ and pressurizer temperature will _____.
A. remain the same; decrease
B. remain the same; remain the same
C. decrease; decrease
D. decrease; remain the same

#10. Nuclear reactor fuel rods are normally charged with _____ gas to improve the heat transferred by _____ from the fuel pellets to the cladding.
A. helium; convection
B. helium; conduction
C. nitrogen; convection
D. nitrogen; conduction

#11. If a nuclear reactor is operated within core thermal limits, then...
A. plant thermal efficiency is optimized.
B. fuel cladding integrity is ensured.
C. pressurized thermal shock will be prevented.
D. reactor vessel thermal stresses will be minimized.

#12. Establishing natural circulation requires that a heat sink be _____ in elevation than a heat source and that a _____ difference exist between the heat sink and heat source.
A. lower; pressure
B. lower; temperature
C. higher; pressure
D. higher; temperature

#13. For a reactor operating in a “critical” state, the reactivity (p) is _____ and the neutron multiplication factor (k) is _____

A. $p > 1$, $k > 0$
B. $p < 0$, $k < 1$
C. $p = 0$, $k = 1$
D. $p = 1$, $k = 0$

#14. The primary purpose of the “Moderator” is;

A. Primary heat extraction
B. Lubrication
C. Slow neutrons produced by fission
D. Shielding

#15. What two types of reactor types utilize “light water” as both coolant and moderator?

A. BWR & PWR
B. PHWR & PTGR
C. GCR & LMFBR

#16. The purpose of a “pressurizer” in a PWR design is to;

A. To control primary loop temperature and pressure
B. To control secondary loop temperature and pressure
C. To control primary loop flow and pressure
D. To control secondary loop flow and pressure

#17. The reactor type whose design provides for online refueling is;

A. PWR
B. BWR
C. PHWR
D. HTGR

#18. What is the annual maximum permissible occupational radiation exposure in rem;

A. 1 rem
B. 5 rem
C. 10 rem
D. 15 rem

BONUS QUESTION:

Suppose you are given four radioactive cookies -- one an alpha emitter cookie, one a beta emitter cookie, one a gamma emitter cookie, and one neutron emitter cookie. You must eat one, hold one in your hand, put one in your pocket, and give the last one you throw away.

Which cookie do you eat, which cookie do you hold in your hand, which cookie do you put in your pocket and which cookie do you throw away to minimize your radiation exposure?

Eat the _____ Cookie
Hold the _____ Cookie in your hand
Put the _____ Cookie in your pocket
Throw away the _____ Cookie

Reference Material:

Fan Laws

1. For given size, R-sys, and density;
    1. When speed varies
        1. Flow varies directly with speed
        2. Pressure varies to square of speed
        3. Power varies to cube of speed
    2. When pressure varies
        1. Flow & speed vary as sqrt
        2. Power varies by 1.5

2. For constant pressure
    1. Speed, flow, power vary as sqrt of density (directly for pressure, inverse for temperature)

3. For constant flow & speed
    1. HP and pressure vary directly to density (directly for pressure, inverse for temperature)

4. For constant flow
    1. Capacity, speed, pressure vary inversely to density
    2. Power varies inversely as square of density