**-TWOMARKS.**

**UNIT-II NUCLEAR POWER PLANTS:**

**1.What is meant by radioactivity?**

It refers to the german name of Radio-Activitat. Radioactivity is the spontaneous disintegration of atomic nuclei. The nucleus emits particles or electromagnetic rays during this process.

**2.What is the unit of Radioactivity?**

1.Roentgen 2.RAD(Radiation Absorbed Dose)

3.RBE(Relative Biological Effectiveness) 4.REM(Roentgen Equivalent in Man)

5.Gray(GY)-100 rads 6.Sievert(SV)

**3.What are the types of Radioactive decay?**

1.Alpha decay 2.Beta decay

3.Gamma decay 4.Poistron emission(Beta positive decay)

5.Electron capture

**4.Define-Decay timing.**

The number of decay events – d N expected to occur in a small interval of time dt is proportional to the number of atoms present. If N is the number of atoms, then the probability of decay(-d N/N) is proportional to dt.

**5.What is Uranium enrichment?**

In most types of reactor, a higher concentration of uranium is used to make fuel rod. This produced by a process termed enrichment. The enriched uranium containing more than natural 0.7% U-235.

**6.What are the two ways of uranium enrichment?**

1.Gas centrifuge process

2. Gas diffusion

**7.What is the purpose of reprocessing of nuclear waste?**

The used fuel contains 96% uranium,1% plutonium and 3% radioactive wastes.

Reprocessing is used to separate the waste from the uranium and plutonium which can be recycled inti new fuel. The reprocessing effectively reduces the volume of waste and limits the need to mine new supplies of uranium, so that extending the time of resources.

**8.Define Nuclear Fission.**

An atom's nucleus can be split apart. When this is done a tremendous amount of

energy is released. The energy is both heat and light energy.This energy ,when let out slowly can be harnessed to generate electricity.

**9.Define Nuclear Fusion.**

Fusion means joining smaller nuclei to make a larger nucleus. The sun uses nuclear fusion of hydrogen atoms into helium atoms . This gives off heat and other radiation.

**10.What is Neutron life time?**

The prompt neutron lifetime, is the average time between the emission of neutrons and either their absorbtion in the system or their escape from the system. The term lifetime is used because the emission of a neutron is often considered its birth, and the subsequent absorption is considered its death.

**11.What is Uranium-235 chain Reactor?**

In a chain reaction, particles released by the splitting of the atom go off and strike other uranium atoms splitting those. Those particles given off split still other atoms in a chain reaction. If an least one neutron from U-235 fission strikes another nucleus and causes it to fission, Then the chain reaction will continue.

**12.What is four factor formula?**

The four factor formula is used in nuclear engineering to determine the multiplication of a nuclear chain reaction in an infinite medium. The formula is:

- Reproduction Factor
- The thermal utilization factor
- The resonance escape probability
- The fast fission factor



**13.List the four types of radiation associated with nuclear fission.**

1. Alpha radiation
2. Beta radiation
3. Gamma radiation
4. Neutron radiation

**14.Define Alpha radiation.**

This is basically the atomic nucleus of the element(He) consisting of two protons and two neutrons. It is not very penetrative and the danger to man arises if an alpha emitting element,such as plutonium,then the alpha radiation be very damaging.

**15.Define Beta radiation.**

Beta radiation consists of electrons or their positively charged counterparts. This can penetrate the skin, but not very far.

**16.Define Gamma radiation.**

Gamma radiation is penetrative in a manner similar to X-rays and has similar physical properties. It can be stopped only by thick shields of lead or concrete.

**17.Define Neutron radiation.**

Neutron radiation consists of the neutrons emitted during the fission process. Neutrons are also very penetrative, but less so then gamma-radiation.

**18.Define water as moderator.**

Neutrons from fission have very high speeds and must slowed greatly by water moderation to maintain the chain raction. The Uranium-235 is enriched to 2.5-3.5% to allow ordinary water to be the moderator. Enough spontaneous events occur to initiate a chain reaction if the proper moderation and fuel density is provided.

**19.List the types of Nuclear reactors.**

The reactors are classified based on the following:

1.Type of fuel used

2. Neutron flux spectrum

3. The coolant

**20.List the various widespread power plant reactor types.**

1.Pressurized water reactor(PWR)

2.Boling water reactor(BWR)

3. Pressurized Heavy water reactor(PHWR)

4. Liquid metal fast Breeder Reactors(LMFBR)

5. High temperature Gas cooled reactors(HTGCR)

**21.What is pressurized water reactors(PWR)?**

The PWR belongs to the lidht water type. The moderator and the coolant are both light water(H2O). The cooling water circulates in two loops, which are fully separated from one another. PWR keep water under pressure, so the water heats but does not boil even at the high operating temperature.

**22.What is boiling water reactor(BWR)?**

In a boiling water reactor, Light water plays the role of moderator and coolant as well. Part of the water boils away in the reactor pressure vessel, thus a mixture of water and steam leaves the reactor core.



**23.What is Molten Salt Reactor(MSR)?**

A molten salt reactor is a type of nuclear reactor where the primary coolant is a molten salt. Molten salt refers to a salt that is in the liquid phase that is normally a solid at standard temperature ionic liquid, although technically molten salts are a class of ionic liquids.

**24.Nuclear Powerplant safety.**

Radiation doses can be controlled through the following procedures:

1.The handling of equipment via remote in the core of the reactor

2. Physical shielding

3. Limit on the time a worker spends in areas with significant radiation levels

4. Monitoring of individual doses and of the working environment

5. Safety mechanism of a Nuclear power reactor

**25. List the Nuclear power plants in India.**

1. Kaiga(3*22MWPHWR), Karnataka

2. Kakrapar(2*22MWPHWR), Gujarat

3. Kudankulam(2*100MWPWR), Tamilnadu

4. Madras(2*17MWPHWR), Tamilnadu

**26.Define mean generation time.**

It is the average time from a neutron emission to a capture results in fission. The mean generation time is different from prompt neutron lifetime because the mean generation time only includes neutron absorption that leads to fission reaction.

**REVIEW QUESTIONS:**

1. Explain in detail about the nuclear radioactivity and its effects.

2. Derive the expression of the radioactivity decay rate

3. With relevant diagram explain the nuclear life cycle

4. Explain the nuclear fission and nuclear fusion

5. List out the various components of nuclear power plant and explain briefly

6. What is the purpose of nuclear power reactor? List the types of nuclear power reactor and explain any one in detail.

7. Explain the following:

    1.Pressurized water reactor

    2.Boiling water reactor

    3.Gas-cooled, Graphite moderated reactor

8. Comparison of nuclear power reactors

9. Explain the nuclear power plant challenges.

10. List out the advantages and disadvantages of the nuclear power plant.

Unit - II Nuclear Power Plant

1) Explain with neat diagram the various parts of Nuclear Power Plant:

Diagram of Main components of Nuclear Power Plant.

Main components of Power Plant are

→ Fuel Rods → control Rods → Reactor
→ Heat Exchanger → steam line → Pump
→ Generator → Turbine → containment
→ cooling water Tower

Fuel Rods:-

Primary important in nuclear Power plant how the operators is able to control the energy given off by enriched uranium. Enriched uranium is typically formed Pellets, each with approximately inch long (2.5cm-long)

Moderator:-

This is the material which slows down the neutrons released from Fission water as moderator:-

Neutron from Fission have very high speed & must be slowed greatly by water moderation. Diagram of water moderation

Control rods

Fuel rods are submerged in water inside a pressure level.

2) Explain the construction & working of CANDU reactor

CANDU :-

* This type of reactor designed by Canada.

99.8% $D_2O$ is used as moderator & coolant as well as neutron reflector

* Natural uranium is used as fuel in this reactor

CANDU reactor Diagram

Coolant Pass through Pressurised Fuel tube

* heat up by nuclear Fission

Diagram of CANDU.

Advantages:-

1. No need of enriched Fuel
2. cost of reactor is less for construction of nuclear reactor
3. No control rods required
4. Construction Period shorter
5. Heavy water used as moderator.

Disadvantages:-

1. Heavy water costly
2. Leakage of water is major problem
3. Low Power density (9.7 kW/litre)
4. Very high standard are required.

3) Explain with neat sketch the construction & working of Pressurized water reactor

→ Light water cooled & moderated reactor

5.

having an unusual core design using both natural & highly enriched Fuel.

Diagram of Pressurised water reactor

Main components are:

(i) Reactor
(ii) Pressuriser
(iii) Heat exchanger
(iv) Coolant Pump

Components of Secondary circuit of Pressurized water plant are similar to those in normal steam station.

Coolant in primary circuit is pumped to reactor core coolant absorb heat energy which liberated during nuclear Fission in reactor core.

Advantages:-

For coolant, moderator & reflector
- water which is cheaply available in plenty is used
- No of control rod is less
- Easily available natural uranium
- steam is not contaminated by radiation

Disadvantages:-

High Pressure req stronger reactor vessel.
Thermal efficiency of plant is low
Fuel element Fabrication is expensive
Reprocessing of Fuel is difficult
Necessary to shut down reactor

4) Explain with neat sketch BWR Boiling water reactor

→ Reactor also enriched uranium is used as Fuel & water is used as moderator, coolant and reflector in PWR. only difference b/w PWR & BWR is BWR steam generated in reactor itself.

Diagram of BWR

→ Exhaust steam from turbine pass through condenser & condensed.

Advantages:-

→ Reactor vessel is much lighter than PWR
→ No heat exchanger Pressurizer, circuating pump.
→ Thermal efficiency of BWR is more than PWR.
→ Metal temp remain is 0
→ BWR is more stable.

Disadvantage:-

→ Steam entering the turbine is slightly radioactive
→ wastage of steam result in lower of thermal efficiency.
→ low Power density & larger in size.
→ Power demand fluctuation cannot met
→ Specific Power of reactor is less.
→ Safety must be provided against melt-down
→ Neutron flux is high at center of cor
→ Handling of sodium is major problem.

5) Explain in brief about nuclear life cycle:-

- Nuclear Fuel begins when uranium is mined, enriched & manufactured in to nuclear fuel which is deliver to Power Plant.

Diagram of nuclear life cycle

Uranium enriched can be done by 2 ways.

1. Gas centrifuge process 2. Gas diffusion

The enriched uranium hexafluoride convert in to uranium oxide as i/p for fuel production. Fuel load to nuclear reactors undergoes fission of uranium 235 atoms. During operation of reactors a proportion of uranium atom is transform in to other elements

Nuclear Energy - Fission & Fussion.

$E = mc^2$

E - energy, m - mass c - stands for velocity.

Nuclear Fission:- Atoms can split apart.

control:- Keep nuclear reaction from drying out

safety :- If some thing goes wrong it can be contained.

Refueling:- Adding more nuclear fuel.

waste production - by product must be manageable.

6) Explain in brief about the radio activity

XII is a 1975 concept album by Kraft werk. also released under German name Radio - Aktivital.

spontaneous disintegration of atomic nuclei.

Units of Radio activity:-

Roentgen (R):- Amount of ionizing radiation which produces $2.08 \times 10^9$ ion pairs

*RAD Radiation Absorbed Dose:-

A rad is the amount of radiation that puts $10^{-2}$ J/kg of energy.

* RBE:- The biological risk of α, β, γ radiation diffa.

* REM:- Product of amount of rad × RBE factor

Gray (Gy) - 100 rads

Sievert - 100 rem.

Biological Effects:-

→ Physical damage to cells & DNA.

→ High dose of radiation death occur

Radio active decay

↓ Mass number

$^{238}_{92}U$ ← Element

↑ charge


5 different types of radio active decay.

→ α decay α Beta -ve decay → Gamma decay.

1) Difference b/w Nuclear fission & fusion:-

on the laws of universe is matter & energy can't be created nor destroyed.

$E = mc^2$

E - energy m - mass c - velocity

Fission:- Atoms split apart tremendous amount of energy released (light & heat energy)

control keep nuclear reaction from dying out

Safely:- Some thing goes wrong

$^{235}U$ + neutron → Fission fragments + 2.4 neutron + 192.9 mev

Diagram of Uranium 235 - fission

Neutron life time:-

Avg time b/w emit of neutron &

either absorption.