SNS COLLEGE OF TECHNOLOGY

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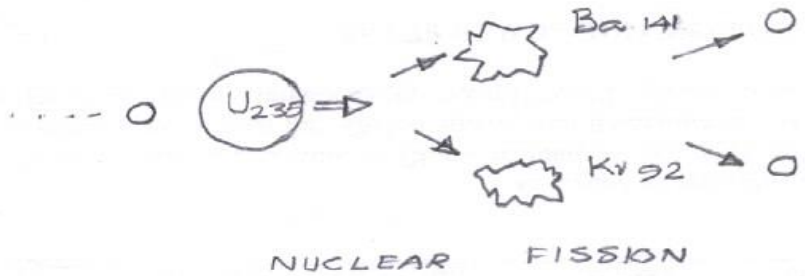
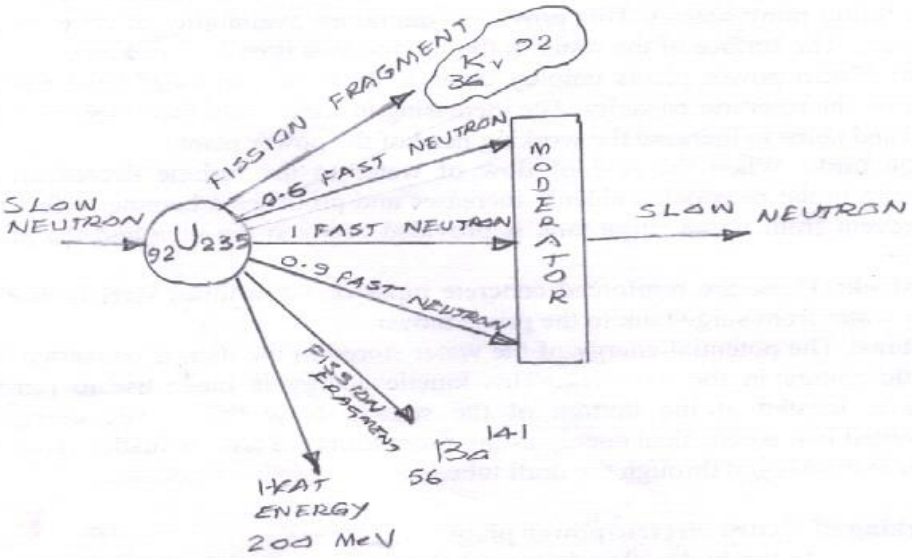
Department of Mechanical Engineering

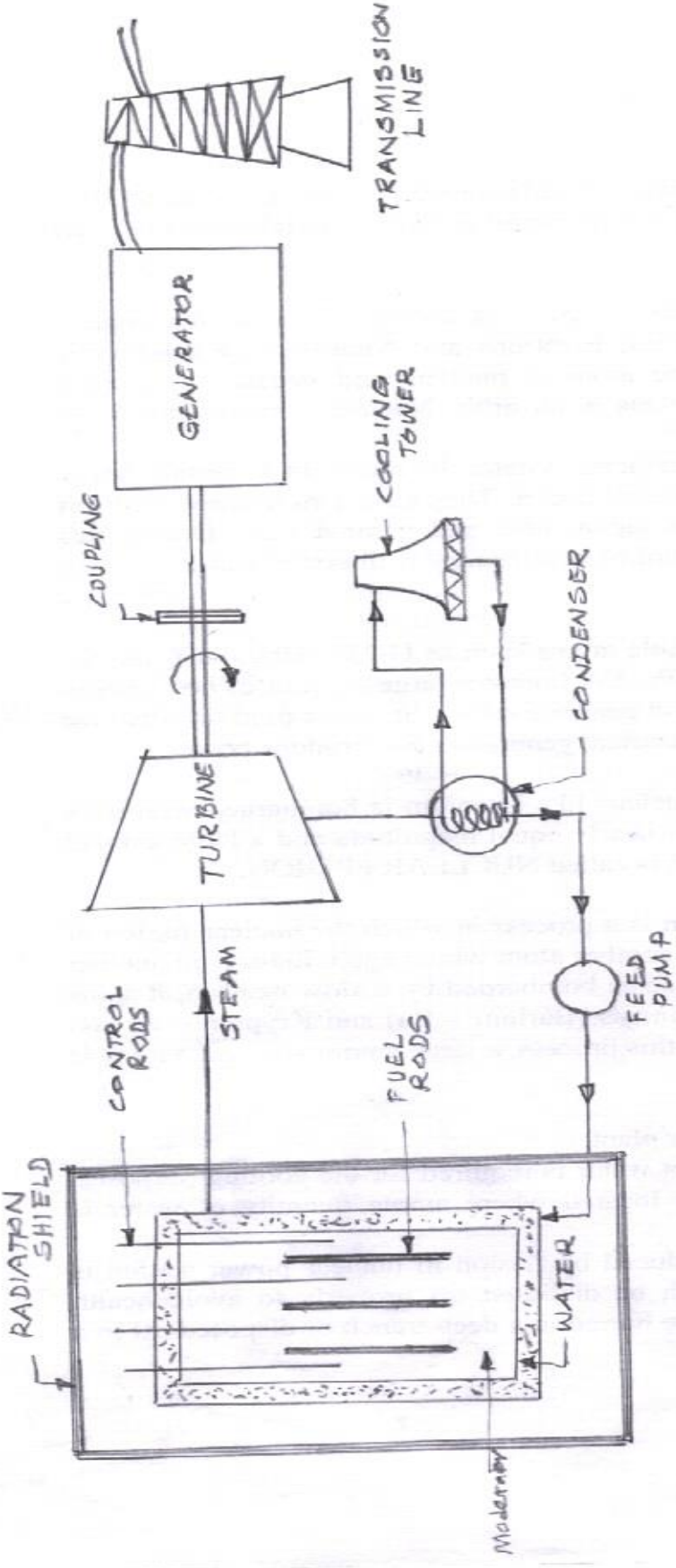
Nuclear of Power Plant



NUCLEAR FISSION



CHAIN REACTION



LAYOUT OF NUCLEAR POWER PLANT

NUCLEAR POWER PLANT

Worlds first nuclear power plant was commissioned in 1954 in USSR. In India the first nuclear power plant station was started at Tarapur (Maharashtra) in the year 1969.

Matter consists of minute particles known as atoms. These atoms contain enormous 'binding energy'. Protons, Electrons and Neutrons are sub-atomic particles. The central part of the atom is nucleus and negatively charged electrons revolve around this nucleus in an orbit. Nucleus contains positively charged protons and neutrons.

When a slow moving neutron is induced to enter the nuclei of a certain heavy atom, they will fission into two smaller nuclei. They eject two or three neutrons and fragments emit rays such as alpha, beta and gamma rays. During this process of fission, enormous amount of heat energy is liberated and it is called "Nuclear energy".

Controlled fission of heavier unstable atoms such as U-235 (Uranium), Th-232 (Thorium) and artificial elements Pu-239 liberates large amount of heat energy which can be used to heat water and generate steam. Steam is used to drive the turbines which when coupled to electrical generators and produce power.

Fission Reaction: When heavy nucleus like Uranium is bombarded with slow neutron, it splits into two nuclei of nearly equal magnitude and a large amount of energy is produced. This process is called NUCLEAR FISSION.

Chain Reaction: The chain reaction is a process in which the nuclear fission of an atom induces nuclear fission in another atom which again induces in another and so on. When a nucleus 92U-235 is bombarded by a slow neutron, it splits into two approximately equal fragments (Barium – Ba) and Krypton – Kr and about 2.5 neutrons are released. In this process, a large amount of heat energy is also released.

Selecting the site for Nuclear power plant:

Availability of water: As sufficient water is required for the cooling purposes, therefore the plant site should be located where ample quantity of water is available.

Disposal of waste: The waste produced by fission in nuclear power station is generally radio active which much be disposed off properly to avoid health hazards. The waste should either be buried in a deep trench or disposed off in a sea quite away from the sea shore.

Distance from the populated areas: The site selected for a nuclear power plant should be quite away from the populated areas as there is a danger of presence of radio activity in the atmosphere near the plant.

Main parts of the Nuclear reactor (power plant):

The main components of a reactor are 1.Fuel rods, 2.Moderators, 3.Control rods, 4.Radiation shield, 5.Coolant.

Fuel Rods: The fissionable material used in the reactor is called fuel. The common fuels are Uranium 233, Uranium-235, Plutonium-239 and Thorium-232. The fuel material is sealed in aluminium cylinders.

Moderators: The slow down the fast neutrons produced during the fission process, a substance called moderator is used. Heavy water, Beryllium, Carbon in the form of pure graphite are generally used as moderators. The purpose of the moderator is to reduce the energy of neutron and at the same time it should not absorb neutrons.

Control Rods: These rods absorb the neutrons and stop the chain reaction to proceed further. Cadmium or Boron rods are generally used as control rods. It is used to prevent it from becoming violent.

Radiation shield: During nuclear fission alpha, beta and gamma particles and neutrons are produced. They are harmful to human life. Therefore it is necessary to shield the reactor with thick layers of lead or concrete walls of thickness 10m. to protect both the operating personnel as well as the environment from the radiation hazards.

Coolant: The substance used to absorb heat generated in the reactor is called coolant. Mercury, Sodium and Heavy water are used as coolant.

Working of a Nuclear power plant:

The figure shows a schematic diagram of a nuclear power plant. Its working is as follows.

Uranium fuel is subjected to a nuclear fission which produces lot of heat energy in the reactor.

Water surrounding the reactor absorbs this heat and evaporates into steam. Reactor surrounded by a biological shield which reduces the radiation intensity.

Steam is passed to the turbine where it expands over rotor blades doing mechanical work. Turbine runs at higher speed and is coupled to an electrical generator (Alternator) which produces electrical power. Exhaust steam which is sufficiently hot is passed to a condenser.

In the condenser cold circulating water absorbs the heat from the exhaust steam, forming the condensate and then leaves the condenser to a hot well from where it is pumped by feed pump to reactor chamber. Cycle of working is repeated.

Nuclear reactor is a principal component in the process of nuclear power generation. It is the main unit in which heat is generated and transferred to cooling medium like water. Then steam is produced, which in turn is used to run turbine. Turbine coupled to electrical alternator produces electrical power.

Advantages of Nuclear power plants:

1.Greater Nuclear power production leads to conservation of coal.
2.Fuel required in small quantity, hence no problems of transport and storage.
3.Requires less space.
4.No emission of smoke and dust.
5.There is increased reliability of operation.
6.It is suitable for large power generations.
7.It does not require large quantity of water.

Disadvantages:

1.Not suitable for variable loads.
2.Initial cost of the plant is very high.
3.Maintenance cost of the plant is high.
4.Radioactive wastes, if not disposed carefully may have bad effect on the health of workers and other population.
5.It requires skilled persons to handle nuclear power plants.