Science & Tech – Class-4

21/07/20

Nuclear Energy

Atom / Elements 118 < Natural – U, Th
Derived – Pu

$_6C^{12}$ → Atomic wt / Mass No / atomic mass = p + n

$12 = 6 + n$

$n = 6$

atomic number. = no. of e^- / p

$_6C^{14}$ — use for fossile life detection.

$_6C^{12} + {}_0n^1 \rightarrow {}_6C^{13}$

isotopes

Isotopes of Uranium – $_{92}U^{238}$, $_{92}U^{235}$, $_{92}U^{234}$, $_{92}U^{233}$

Isotopes of Plutonium – Pu^{239}, Pu^{240}

$_1H$ $_2He$ $_3Li$ $_4Be$ $_6C$ $_7N$ ---------- 82 | 83 ------ 118

83 onwards element → Radioactive element → Radioactivity property → Unstable element (Mad)

Uranium — present in → Pitchblende
Thorium → Monazite Soil

Rays → α, β, γ (Highest Penetration)

U, Th, Pu — large size of atoms

②

Nuclear fission

Large size of atom/ Nuclei —Break→ Small size of atom/ Nuclei + Heat/ Energy

$$_{92}U + {}_{0}n^{1} \longrightarrow {}_{56}Ba + {}_{36}Kr + 3\,{}_{0}n^{1} + \text{Heat/energy}$$

eg → Atom Bomb

Nuclear Energy Development Programme of India. based on Nuclear fission.

Nuclear Fusion

$$_{1}H^{1} + {}_{1}H^{2} \longrightarrow {}_{2}He^{4} + \text{Heat/Energy}$$

eg → • Hydrogen bomb, • Solar Energy, • ITER (Artificial Sun Experiment)

EPIM – VPSC

Nuclear fission	Nuclear fusion
→ It generates Less heat/ energy.	→ It generates more heat/ Energy
→ Nuclear waste generate those are issue for living	→ No nuclear waste
→ It can be controlled	→ Limitation → Uncontrolled Reaction

Nuclear Energy Development Programme of India

"H. J. Bhabha"

⇒ Bhabha developed three stages Nuclear energy development Programme of India.

First stage: fuel : Uranium(U)

Moderator, Coolant] – D_2O (Heavy water)

Reactor :- PHWR (Presswrised Heavy water Reactor)

Second stage:

fuel : Plutonium (Pu)

Moderator → Rearly Used

Coolant → Liquid Sodium (Na)

Reactor → Breeder Reactor / etc.

Third stage

fuel → Thorium (Th)

Moderator → Heavy Water

Coolant → Light water / Demineralised water

Reactor → Breeder Reactor / AHWR

④

Fuel

first stage:

In 1783, German Scientist – Martin Klaproth identified Uranium inside Pitchblende (6 isotopes of U).

$$\left({}_{92}U^{238} + U^{235} + U^{234} + \_\_ + \_\_ + \_\_ \right)$$

(99.2742%) (0.7204%) (0.0054%)

U^{235}

Enrichment → 3% – Electricity
→ 90% – Atom bomb

Second stage

$${}_{92}U + {}_{0}n^{1} \longrightarrow {}_{56}Ba + {}_{36}Kr + 3{}_{0}n^{1} + \text{Heat/Energy} + \text{Nuclear waste}$$

Pu^{239} → Highly Unstable → atom bomb

$Pu^{239} + {}_{0}n^{1} \rightarrow Pu^{240}$

Pu^{239} → Highly unstable → atombomb.

Pu^{240} → Less unstable → Electricity

Third stage

$Th \xrightarrow{+n,\ -\beta} U^{233}$ (Monozite)

Derived

Note

U vs Th

U^{235} Vs U^{233}

1st Atom bomb — Little boy & fat man — Pu^{239}

(U^{235}) (in Hirosima & Nagasaki)

Moderator

$$_{92}U + {}_0n^1 \longrightarrow {}_{56}Ba + {}_{36}Kr + 3\,{}_0n^1 + \text{Heat/Energy}$$

Speed slow

Speed fast

$_{92}U + {}_0n^1$ — reaction take place → n + Heat / Energy generates

Moderator

$U + {}_0n^1$ ← U breaks

D_2O & Graphite are good moderator. which slow down the rate of breakdown.

Coolant

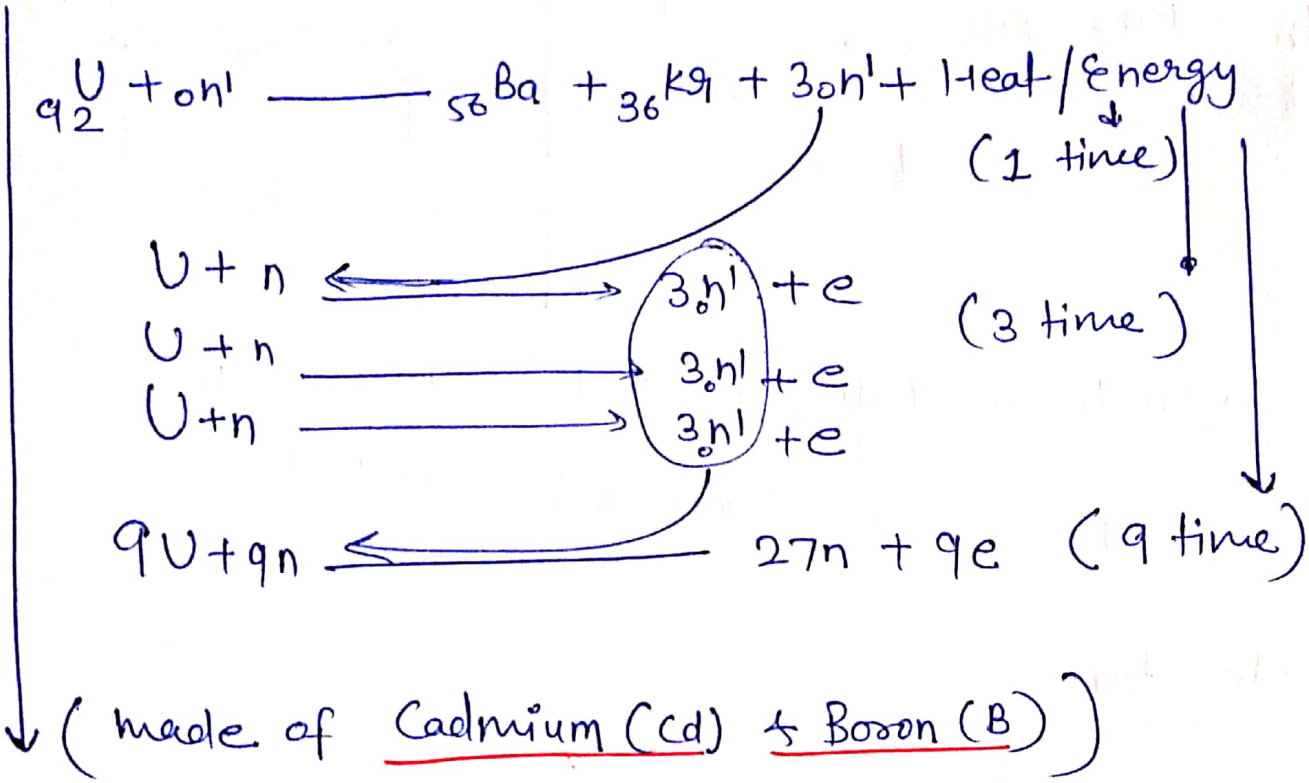
$$_{92}U + {}_0n^1 \longrightarrow {}_{56}Ba + {}_{36}Kr + 3\,{}_0n^1 + \text{Heat/Energy}$$

Exothermic Reaction

↓ (Heat ↑)

Nuclear Reaction is a exothermic Reaction, so Coolant used to maintaine the temperature inside the nuclear reactor.

Control Rod / Absorbant Rod



↓ (made of Cadmium (Cd) & Boron (B))

It absorb the extra neutron in the chemical reaction, in nuclear reactor. It controll the rate of reaction.

Reactor

It is a Nuclear furnance.

- PHWR – Pressurised Heavy Water Reactor
- Breeder Reactor

PHWR → we used Heavy water and maintain high pressure in this reactor. We used it in first stage acc to Bhabha.

Breeder Reactor → These reactor where efficiency of fuel increased for heat generation.

Types of Breeder Reactor

- FBR (Fast Breeder Reactor)
  - → Speed of neutron fast
  - → Rarely Moderator use
- TBR (Thermal Breeder Reactor)
  - → Inside the reactor high temprature is required.

Comparison between Uranium and Thorium

U_2^{235} — Uranium

U^{233} — Thorium

Uranium	Thorium
1. Amount / Reserve — Less	— More
2. → Less efficient for heat generation.	→ More efficient for heat generation
3. → More amount of nuclear waste generate	→ Less amount of nuclear waste generate
	Limitation: FBR ← Costly, Technology Demonstration

* Alternative Energy source
  1- Renewable
  2- Biofuel
  3- Nuclear Energy - 3%

Note

Reprocessing plant
1. 1964 - Trombay (Maha.)
2. Kalpakkam (TN)
3. Tarapore (Maha.)

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Nuclear Reactor

- Tarapur (M.H)
- Narosa (UP)
- Kalpakkam (TN)
- Kakrapara (Guj)
- Rawatbhata (Raj)

3%

New Reactor (future Reactor)

- Mithivirdi (Guj)
- Kovvada (A.P)
- Jaitapur (Maharashtra)
- Kundankulam (TN)
- Haripur (W.B)
- Kumharia/ Gorekhpur (Haryana)
- Chennai (Madras)
- Mahi Banswara (Raj)

Nuclear Vision

3% Power Generation

NV - 2020 - 20,000MW

NV - 2032 - 63,000 MW

NV - 2000 - 25%

- 70% → (U + Pu)
- 30% → (Th alone)

Thorium Vision

Imp

↓

220MW

IGCNR — Kalpakkam (TN)

Prototype fast Breeder Reactor

Experimental

Jaitapur Nuclear Power Plant (MH)

↓

France → Areva Company

6 Reactors = 9900 MW

Largest Nuclear Reactor in the world (Production)

Protest :→ Western Ghat → Endemic species.

Kudankulam Nuclear Power Plant

↓

Russia → VVER - Voda-Voda Energo Reactor

1000 MW — At Present

(9600 MW) — (In future)

Facts Corner :

- Maxm power generation by Nuclear energy in the world
  → France (Two Quarter — 70%)
- Most of European countries + Japan — 30% power generation by nuclear energy.
- Maxm Thorium in India in Andhra Pradesh.
- Maxm Uranium in worldwide → 1. Australia 1/3
  2. Kazakistan 12% → Exporting maxm Uranium
  3. Canada 9%

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ITER (Artificial Sun Experiment)

(International Thermo nuclear Experimental Reactor)

(Nuclear fusion Reactor)

∞ heat/Energy

2006 — 7 ITER member — 2016

Problem — Uncontrolled Reaction.

2016 Electricity Crisis Reduces

Delay 2020-2021

7 ITER member (Place — Cadarache (S. France))

1. US — 10%
2. Russia — 10%
3. Japan — 10%
4. China — 10%
5. S. Korea — 10%
6. India — 10% Contribution
7. EU — 40%

Involve in Research in ITER

BARC
National Plasma Research Centre
Pune & Ahmedabad)

Biofuel

Derived from

Living organism

Plant + Animal + Microorganism

1. Primary Biofuel

Direct source of Biofuel

eg - Biomass, Biogas

2. Secondary Biofuel

Not direct source of Biofuel

eg → Sugarcane, Maize crop

Sugarcane, Maize → Juice
Carbohydrate. } fermentation → Ethanal (fuel)

Biodiesal plant (Jatropha & Pongamia) → Juice (Lipid Material) → Transesterification (TE) Process → Biodiesal

Generation of Biofuel

1- first Generation → Biomass, Biogas, Sugarcane, Maize

2. Second Generation → Jatropha & Pongamia
   - (Non edible product are used) → Cellulosic material, Byproduct of maize
   - → Neem seed, Biomass

3. Third Generation → Algoil (Algae + oil)
   (2nd P)
   - aquatic — fresh
   - Saline

Algae { Botryococcus, Schiochytrium } → 70% by weight Lipid Compound → (TE) → Biodiesal

- No Competition with food Crops.
- fastest growing plant in the nature
- 10 to 100 time more biodiesal production in comparision to Jatropha.
- Wastage of algae — good source of protein — fodder.

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Fourth Generation Biofuel

- → Genetically Modified Plant
- → Microbio fuel Cells