Thorium properties

- Density: 11.7 gm/cm³, Silvery color, softer than steel,
- Low (strength & corrosion resistance).
- Th+Mg alloys → High mechanical properties and creep resistance at high temp.
- Production of ceramics & Deoxidizer.
- Most important application in nuclear energy production.

Ores

- Monazite: this is the most important ore which is (Ce, La, Nd, Th)PO₄ contain 3-5% thorium as a form of Thoria (ThO₂).

Extraction of Thorium

I. Acid Digestion: ground Monazite sand is digested at ~ 150°C with high conc. H₂SO₄ at cast iron containers using mechanical stirrer to convert the content to soluble pieces after complicated series of reactions as in flow chart below.

After that complex procedure will done to get pure Th.
II. **Alkaline Digestion**

Using conc. NaOH at temp. of 140°C, the insoluble compound in the Monazite will be dissolved and solid (ThO₂) will produce as in flow chart below.

![Flowchart](image)

And after complex procedure reactions will done to get Thorium metal.

III. **Reduction by Sodium or Calcium**

\[ \text{ThCl}_4 + \text{Na} \rightarrow 4\text{NaCl} + \text{Th} \]

- After that heating to 900°C to remove Na compounds at vacuum for 16 hrs.
- Sponges Thorium will forge to rods then melt in Electric arc furnace to produce Thorium solid metal.

IV. **Electrolysis**

- Carbon (Graphite) as anode, Molybdenum as cathode, and electrolyte of NaCl with (KCl, ThCl₃) at temp. of (750-850)°C to produce Thorium (similar to the electrolysis of Copper).
Rare earth metal extraction

- Rare earth metals (Lanthanide series): Metals with atomic number (57-71) + Scandium and yttrium.
- Used in advanced engineering applications as in plasma TV screens, ceramics, strong magnets and nuclear applications.

![Diagram of the rare earth metal extraction process]

1. Monazite
2. Crushing
3. +100 mesh
4. Classifying
5. Digestion at 150°C
6. Washing
7. Leaching
8. Washing
9. Leaching
10. Paste
11. NaoH + H2O steam
12. Paste
13. Acid Digestion
14. Acid Digestion
15. Filteration
16. Liquid
17. Concentration
18. Collection of rare earth metals chloride

H2O → Paste

HCl → Acid Digestion