Sustainable Production of Nickel

Prelims – General issues on Environmental ecology, Bio-diversity and Climate Change.

Mains – *General Studies-III* (Conservation, environmental pollution and degradation, environmental impact assessment)

Why in news?

A recent study by researchers at the Max Planck Institute for Sustainable Materials, Germany, has introduced a new, carbon-free method of extracting nickel using hydrogen plasma, offering a cleaner and faster alternative to traditional methods.

- **Nickel** – Nickel (Ni) is a silvery-white metal used in various industries.
- It is the fifth most common element on earth and occurs extensively in the earth's crust and core.
- Nickel, along with iron, is also a common element in meteorites.
- Nickel occurs naturally in soil and water.
- It is also an essential nutrient for plants.

Significance of Nickel

- **Electric Vehicles (EVs)** – Nickel is a key component in lithium-ion batteries, which power EVs.
- As the world transitions to cleaner transportation, the demand for nickel in this sector is skyrocketing.
- **Renewable Energy** – It is used in various renewable energy technologies, including solar panels and wind turbines.
- **Stainless Steel and Alloys** – Nickel is a primary alloying element in stainless steel, providing enhanced durability and corrosion resistance.
- It is also used in other specialized alloys.
- **Gadgets and Electronics** – From smartphones to laptops, nickel finds its way into numerous electronic devices.

Conventional Extraction Process of Nickel

- **Calcination** – Heating the ore to remove moisture and other impurities.
- **Smelting** – Melting the ore at high temperatures, often using carbon as a reducing agent.
- **Reduction** – Further reactions with carbon to separate nickel from its oxides.
- **Refining** – Purifying the nickel to achieve the desired grade.

New Hydrogen Plasma Method

- This new approach offers a one-step, carbon-free process.
- **Replacing Carbon with Hydrogen** – Instead of using carbon as a reducing agent, this method utilizes hydrogen (H2) gas.
- **Hydrogen Plasma** – The key innovation lies in using hydrogen plasma. When hydrogen gas is subjected to high-energy electrons in an electric arc, it transforms into a plasma state, an extremely hot and reactive "fourth state of matter."
- **Rapid Reduction** – This highly reactive hydrogen plasma rapidly reduces metal oxides in the ore.
- **Carbon-Free Process** – The reaction of hydrogen with oxygen in the ore produces water (H2O) as a byproduct, rather than carbon dioxide.
- **Energy and Time Efficient** – The proposed method is significantly more energy-efficient (up to 18% savings) and faster than traditional methods, while cutting direct CO2emissions by up to 84%.
- **Utilizing Low-Grade Ores** – Crucially, this technology efficiently extracts nickel from laterite ores, which are abundant but difficult to process with conventional methods.
- Laterite ores are formed in hot, tropical regions and are becoming increasingly important as higher-grade sulphide ores deplete.

Reference

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