Removal of Heavy Metals from Water

Why in News

Recently, a research team at the Indian Institute of Technology (IIT) Mandi has developed a **new method** for efficient removal of heavy metals from water**.**

Key Points

- **Background:**
  - Several methods like chemical precipitation, ion exchange, **adsorption**, membrane filtration, reverse osmosis, solvent extraction, and electrochemical treatment have been used to remove heavy metals from contaminated water.
  - Many of these methods suffer from **high capital and operational costs.**
  - Therefore, **adsorption is one of the best-suited methods**, due to its high efficiency, low-cost, and ease of operation.
- **About the Research:**
  - A research team has developed a fibrous membrane filter using a **biopolymer-based material** that helps to separate out the heavy metals from water samples.
    - These membranes contain adsorbents materials that attract and hold the metals.
    - These adsorbents contain a large amount of a biopolymer, Chitosan, derived from crab shells that is mixed with a well-known polymer, Nylon.
  - **Funding of Research:**The study was funded by the **Ministry of Mines, Government of India.**
- **Process Used:**
  - The researchers have used a process called **“solution blowing”**, while regular fibre-based adsorbents are produced through a method called **“melt blowing”**.
  - **Melt Blowing:**
    - It is a special technique for manufacturing material with **very fine fibers, down to 0.5 µm (in range of micrometers).**
    - The fibers are elongated by blowing hot air at high speed concentrically along the fibers.
  - **Solution Blowing:**
    - It starts from dissolving the polymer in solvent, e.g. cellulose in ionic liquid.
    - The solution is pumped through a spin nozzle where air is blown at high speed concentrically.
    - Solution blowing produces fibres that are **nanometres in diameter**, a hundred thousand times thinner than a single human hair. Finer than those produced through the process of Melt Blowing. This **increases the surface area** of fibers tremendously, resulting in better adsorption of heavy metals.
    - This method also enables **blending of higher concentration of natural polymers** like chitosan and lignin with synthetic polymers like Nylon.

- **Advantages:**
    - **Higher Metal Removal Efficiency:** The normal absorbent fibres bind to the target metal only at their surface, in their nanofiber membranes.
        - The biopolymer-based material adsorption was seen to happen at the sub-surface scale as well, which translates to higher metal removal efficiency.
    - **Reuse of Membrane:** The membranes could be reused at least eight times before there was considerable reduction in the efficiency of metal adsorption.
    - **Recovery of Adsorbed Metal:** The adsorbed metal in a metal-hydroxyl nitrate form can be easily recovered. It is a value-addition to the membrane filter.
    - **Industrial Production:** The researchers have provided a method to produce fibre-based adsorbents at large scale for handling larger volumes of metal-contaminated water.
    - **Environmentally Efficient:** Using the solution blowing technique could replace the synthetic polymers with natural polymers.
        - It will be a welcome move in this era of environmental consciousness.

Heavy Metals

- **About:**
    - The term heavy metal refers to any metallic chemical element that has a relatively **high density (> 5 g/cm 3)** and is toxic or poisonous at low concentrations.
    - **Examples of heavy metals** include mercury (Hg), cadmium (Cd), arsenic (As), chromium (Cr), thallium (Tl), and lead (Pb)
- **Source of Heavy Metals:**
    - Heavy metals are introduced into the environment either by **natural means** or by **human activities.**
    - **Natural Sources:**
        - Geographical phenomena like volcanic eruptions, weathering of rocks, leaching into rivers, lakes and oceans due to action of water.
    - **Anthropogenic Sources:**
        - These metals are released into the water through anthropogenic activities such as mining, manufacturing, electroplating, electronics, discharge from auto exhaust, domestic waste, agricultural waste and fertilizer production.
        - The **Central Water Commission (CWC)** has reported that the samples from **two-thirds of the water quality stations** spanning India's major rivers are contaminated by one or more heavy metals, exceeding safe limits set by the **Bureau of Indian Standards.**
        - Several villagers in **West Bengal** are suffering from sores and ulcers due to **arsenic poisoning** from drinking water. According to a recent report, the number of arsenic-affected habitations in India has **increased by 145% in the last five years (2015-20).**
- **Effect of Heavy Metals on Human:**
    - There are some **essential heavy metals** which the human body requires in trace amounts such as Cobalt, copper, zinc, and manganese but in the excessive amount, it can be detrimental to health.
    - The heavy metals found in drinking water such as **lead, mercury,** arsenic**, and cadmium** have no beneficial effects on our body.
        - In fact, their accumulation inside the body can cause severe health problems.

Metals	Disease

Mercury	Minamata disease
Cadmium	Itai Itai
Lead	Anaemia
Arsenic	Black foot disease
Nitrates	Blue Baby Syndrome

Source: DTE