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