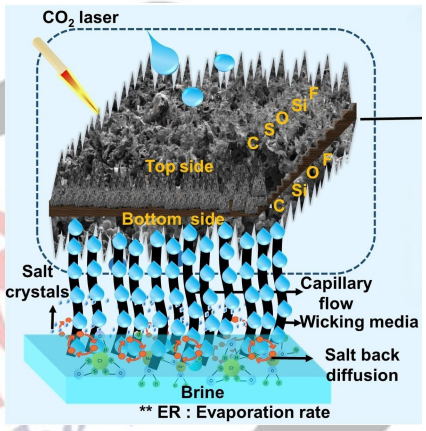
Solar Water Desalination

Why in News?

Indian Institutes of Technology (IIT)- Bombay scientists have developed a new material to **enable water desalination** and address **global freshwater scarcity.**

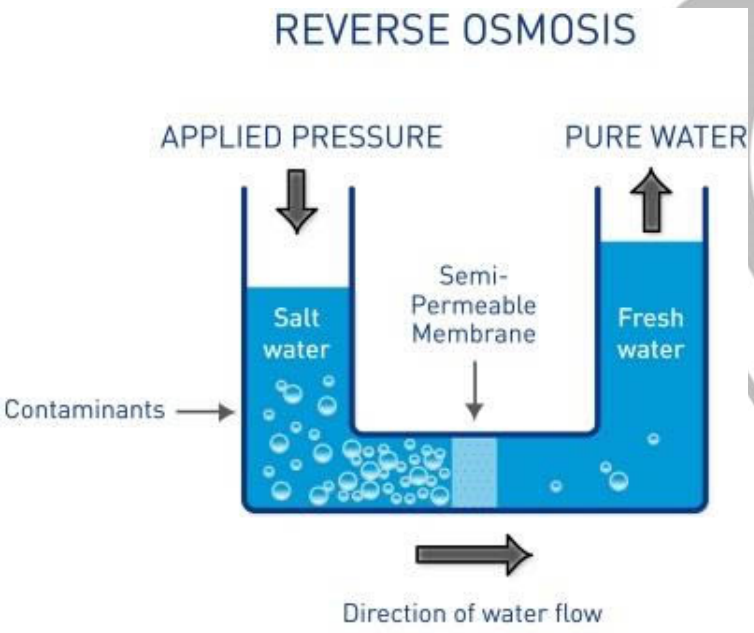


Key Points

- **About the Innovation:**
  - Researchers have developed a **Dual-Sided Superhydrophobic Laser-Induced Graphene (DSLIG) evaporator.**
  - The DSLIG **addresses limitations of traditional evaporators** and shows promise for large-scale desalination and wastewater treatment.
  - **The Freshwater Challenge:**
    - Only **3% of Earth's water is freshwater,** and **less than 0.05% is easily accessible.**
    - **Desalination of seawater** and brackish water is a **key solution** to this scarcity.
    - However, desalination produces **brine, a concentrated salt byproduct,** which poses **disposal challenges**, especially in landlocked areas.
    - Industries now aim for **zero liquid discharge systems** to avoid environmental harm.
- **Solar Desalination:**
  - Solar energy-based desalination offers a **low-carbon solution.**
    - Yet, sunlight variability and poor light absorption reduce efficiency.
  - Interfacial evaporation systems help by **heating a thin surface layer of water instead of the whole volume**, enhancing efficiency.
  - **Challenges in Interfacial Evaporation:**
    - **Cloud cover** and fluctuating **solar intensity** hamper consistent performance.
    - Evaporation peaks around 2 pm, when solar radiation is highest.
    - Salt deposition on the evaporator surface blocks water contact, reducing long-term efficiency.
  - **DSLIG Overcomes the Challenges:**
    - DSLIG allows **dual heating—solar and Joule heating (electric)**—ensuring performance even in low sunlight.

        - **Superhydrophobic properties (lotus effect)** prevent salt from sticking to the evaporator surface.
- **Fabrication of DSLIG:**
    - Researchers coated **PVDF (polyvinylidene fluoride)** on one side of **PES (polyether sulfone) polymer.**
        - PDVF are **polymers** that can generate electric charges on the surface under pressure/strain thus **converting mechanical energy into electrical energy.**
        - PES is a thermoplastic polymer known for its high **thermal stability, excellent chemical resistance, and biocompatibility.**
    - They used l**aser engraving to inscribe graphene** onto the PVDF layer.
        - PES ensures mechanical strength, while PVDF contributes to dual-sided water repellency.
    - The result is a durable, superhydrophobic surface effective in both electric and solar modes.
    - **Applications:**
        - It is suitable for **treating industrial wastewater and brine** from desalination plants.
        - Researchers observed **improved performance by stacking multiple evaporators.**
        - DSLIG is l**ow-cost, non-toxic, and sustainable,** making it ideal for large-scale applications.

Desalination



- A **desalination plant** turns salt water into water that is fit to drink.
    - **Desalination** is the process of **removing salts from water** to produce water that meets the quality (salinity) requirements of different human uses.
- The most commonly used **technology** for the process is **reverse osmosis.**
    - An external pressure is applied to push solvents from an area of high-solute concentration to an area of low-solute concentration through a semi-permeable membrane.
    - The **microscopic pores** in the membranes allow water molecules through but leave salt and most other impurities behind, releasing clean water from the other side.
- These plants are mostly set up in areas that have access to **sea water.**