



Removal of Heavy Metal Ions from Wastewater

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ABSTRACT:

The present study reviews, various sources of heavy metals and their ill effects on mankind. Need for removal of heavy metals from wastewater. Different techniques available for the removal of heavy metals from polluted and wastewater. Adsorption a most convenient technique for small scale industries. Low cost easily available adsorbents. Acid and alkali treated adsorbents and their effects on rate of adsorption. Factors affecting rate of adsorption. Applications of adsorption.

KEYWORDS: Polluted water, Adsorbents, Heavy Metals, Adsorption, Low-Cost Adsorbents.

INTRODUCTION:

Water is very important for all living things including plants, microorganisms, human being and various industries. The rainwater which is purest form of water become impure during its downward journey towards earth due to contamination of suspended matter, biological matter, dissolved gases, dissolved salts, colloidal matter etc. This impure water becomes inconvenient for domestic use and industrial use. Due to discharge of wastewater from various chemical, processing etc. industries and contact with various rocks the water become polluted and may contain heavy metal ions along with other impurities and pollutants. Such water is not convenient for drinking, washing, cleaning and other processes in industries. So it is very essential to remove these impurities particularly heavy metal ions from industrial waste water. These heavy metals can be removed by various methods like membrane separation, coagulation, chemical precipitation, solvent extraction, adsorption, ion exchange etc. Adsorption, reverse osmosis and ion exchange methods can be used for dilute concentrations of the metals.¹

HEAVY METALS:

Heavy metals when discharged into water bodies through wastes also affects the aquatic life and destroy their self-purification power². So it is very essential to remove these heavy metals from the industrial discharge. Researchers are working on different technologies to remove such metals from water completely or to reduce their concentration below tolerance limit. Some important heavy metals are discussed below in Table-I:

Heavy metal	Source	MPL (mg L ⁻¹)	Adverse effects
Hg ³	Pesticides, batteries, Paints, pharmaceuticals, fertilizers, pulp and paper, cosmetics, oil refining industries.	0.1	Chestpain, genetic defects, cerebral palsy and convulsions, mental retardation
As ⁴	Dyes, glasswares, pesticides, ceramic, detergents, metallurgical, fertilizers industries.	0.06	Cancer, diarrhea, black foot disease, vomiting.
Cr ⁵	Dyeing, textile, tanning, electroplating, Leather industries	0.05	Edema, liver damage, Carcinogenic, ulcer, skin irritation

Ni ^{6,7}	Metal finishing and forging, mining, batteries manufacturing, electroplating	0.1	Skin dermatitis, damage to lungs, vomiting, diarrhoea, kidneys
Cu ⁸	PCB designing, Electroplating	2	Accumulation in the kidneys, brain, skin, heart, gastrointestinal problems, hemochromatosis, carcinogenic
Pb ⁹	Glass industries, printing, batteries manufacturing, lead paint	0.05	Headache, anemia, destruction in kidney, reproductive system, liver, brain and central nervous system

TECHNIQUES TO REMOVE HEAVY METALS:

Various techniques which are used for removal of heavy metals are electrochemical, Reverse Osmosis, Chemical precipitation, Electrodialysis, Evaporation, Ion exchange, Chemical oxidation/reduction etc. But these techniques have certain advantages and disadvantages like most of them are expensive, generates sludge, difficult separations, simple, metal recovery possible etc. So adsorption method seem to be convenient to remove the heavy metals from the industrial wastewater.

ADSORPTION:

Adsorption technique seem to be convenient as compared to other various techniques because it requires simple equipment and less space. It is easy to operate, low cost and high efficiency technique. It produces high quality treated water. Cheap and eco-friendly natural adsorbents are used. It is non-sensitive to toxic pollutants. No biological or chemical sludge is formed.

ADSORBENTS:

Various researchers utilised different adsorbents to remove heavy metals from industrial wastewater. Easily and abundantly available, low cost adsorbents should be used to make this method more economic. Literature survey indicates that various researchers utilised different materials as adsorbents. These materials are by-products from different industries, biological materials, waste building materials, plant material etc. These plant materials are Jambhool, Prosopis spicigera, Apple Pomace, Potato husk, Almond husk, Cassia Siamea, Tea waste, Ratrani leaf, green tea, Jute stick, Ashoka leaf, Cashew nut shells, Algae, Syzygium cumini, Jute, Sunnhemp, Coffee, Coconut husk, Date tree leaves etc.

Other materials are albumin, ores, wool, feathers, hairs, activated red mud, waste rubber, Hydroxides of aluminium and iron, activated carbon, bagasse etc.

Acid and alkali treated adsorbents i.e. pre-treated adsorbents are also used by the researchers to increase the adsorption efficiency of the various adsorbents. Researchers tried acids like HCl, H₂SO₄, HNO₃, H₃PO₄ and alkalies like NaOH, KOH, Ca(OH)₂ etc. for the pre-treatment of adsorbents.

FACTORS AFFECTING ADSORPTION:

Following factors affect the adsorption,

- 1. Adsorbent dose:** Increase in the amount of adsorbent increases the removal efficiency.
- 2. Initial concentration of adsorbate:** The adsorption of metal ions onto the surface of adsorbent is found rapid initially, slows down later and then shows equilibrium.
- 3. pH:** As the pH increases the adsorption decreases.
- 4. Contact Time:** The percentage of adsorption increases with the increase in contact time.
- 5. Temperature:** Generally, adsorption increases with increase in temperature.

APPLICATIONS OF ADSORPTION:

1. For softening of hard water
2. For heavy metal removal from wastewater
3. In drying gases, decolourisation and purification¹⁰
4. Removal of dyes from industrial wastewater¹¹
5. Purification of enzymes¹²
6. Recovery of dyes from dilute solution¹³
7. For gas mixture separation.

CONCLUSION:

Among all methods adsorption is a very economical alternative for the heavy metals removal from the water.

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