ADSORPTION OF CHROMIUM(VI) FROM WASTEWATER USING CHITOSAN GRAFTED WITH GRAPHENE OXIDE

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Introduction:

Hexavalent Chromium i.e Cr (VI) has been in special attention due to its high toxicity, its potential to bioaccumulate, and its persistence in the environment. Various technologies have been explored to remove Cr (VI) from aqueous solutions, such as cyanide treatment, electrochemical precipitation, reverse osmosis, and ion exchange [1-2].

However, each of these methods has limitations when it comes to wastewater treatment. For example, precipitation is inefficient and results in large quantities of sludge that require careful management; chemical reduction/oxidation requires extra chemicals which may cause secondary pollution; and electrochemical treatment incurs relatively high operating costs[3-4].

For these reasons, adsorption of Cr (VI) on various adsorbents is considered to be the most promising treatment method due to its prominent advantages that include cost-efficiency, flexibility, simplicity of design, ease of operation, insensitivity to toxic pollutants and the absence of secondary pollution.

Chitosan (CS), a basic polysaccharide polymer with active functional groups, Chitosan is easily obtained due to the widespread natural occurrence of its source – chitin – which is found in the shells of crustaceans, e.g., crabs, prawns, shrimps and insects. Further, chitin is easily converted to CS, the desired end product, through deacetylation GO is the oxidation product of graphene and contains various oxygen functional groups, e.g., hydroxyl, epoxy and carboxyl groups, which promote the interfacial interaction between adsorbate and GO, while improving the hydrophilicity of GO. These oxygen-containing functional groups have strong binding ability to metal ions in water through the formation of metal ions complexes.

Objectives:

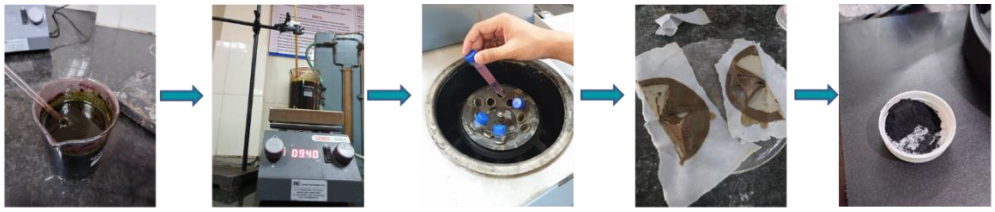
1. Synthesis Chitosan grafted graphene oxide.
2. Characterization of CG-GO.
3. Study the parameters (pH, conc., time, dosage) effecting adsorption of Chromium (VI).

Methodology:

Materials Used

The graphite powder (100 microns), Potassium dichromate, Potassium permanganate, Chitosan Powder, Conc. Sulphuric acid (90%), Hydrogen Peroxide (30%), Phosphoric Acid (35%), Ethanol, Sodium borohydride.

Preparation of Graphene Oxide (GO):



Graphite Powder + KMnO4 + con. H2SO4 + H3PO4

Initial (Dark Green)

After 6 hours 920 - 950 RP at 50 *C

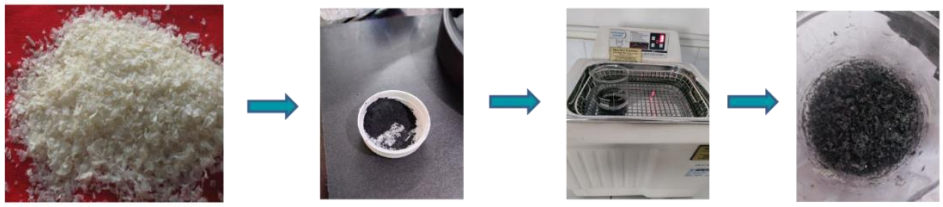
Final (Chocolate Brown)

Centrifugation

Graphene Oxide (Slurry)

Graphene Oxide (Dried Powder)

Preparation of Chitosan Graphene Oxide Composite (CS-GO):



Chitosan Flakes

Graphene Oxide

Sonication

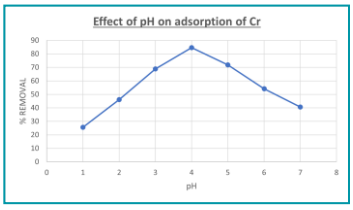
CS-GO

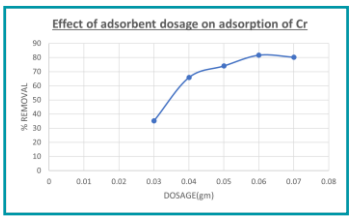
Result and Conclusion:

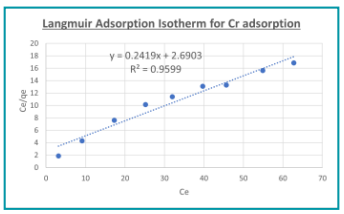
Based on the results of this study following conclusions could be drawn;

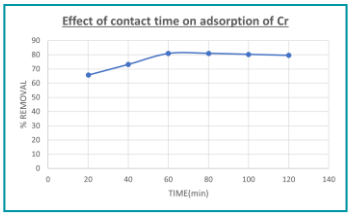
The CS-GO composite material was successfully developed using modified Hummer's method. The XRD, FTIR showed oxidation of graphite to GO and using other characterizations such as SEM confirmed the formation of CS-GO composite material

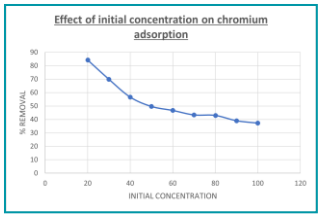
Influence of process parameters such as pH, adsorbent dosage, contact time, initial metal ion concentration was at moderate levels such that they can affect the removal efficiencies of the heavy metals were concerned.

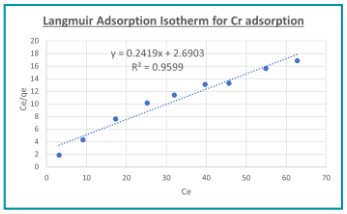












The optimum pH of solution for chromium removal was found to be 4 with efficiency of 84.68%. The optimum time for adsorption of chromium was found to be 60 min.Initial metal ion concentration showed the negative effect on adsorption efficiency i.e., at lower levels the adsorption was higher.

Scope for Future Work:

1. Further studies of adsorption capacity of regenerated as well as modified CS-GO might be carried out.
2. Some other characteristics of CS-GO useful in wastewater purification, should be investigated, such as for removal of suspended solids, dissolved solids, BOD, COD.
3. Like chromium, CS-GO could be used for removal of some other heavy metals like cobalt, mercury, bismuth, lead and arsenic.
4. Column design could be further improved to avoid leakage problems, increase efficiency and implementing adsorbent recovery process.