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SYNTHESIS AND CHARACTERIZATIONOF ALGINATE BASED MAGNETIC BEADS FOR WASTEWATER TREATMENT

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ABSTRACT: Wastewater is undesirable products from industries after the production and manufacturing of products .These wastes contains many ionic compounds, organic and inorganic compounds which released into the water sources and enter into food cycle and causes diseases like cancers, lung diseases like asthma. To prevent suchdisease industrial wastewater has to be treated before releasing it into water resources .Industrial wastewater can be treated by various processes like adsorption, ultrafiltration and coagulation .This project aims to treat industrial wastewater with high efficiency at low cost . For the efficient adsorption of dyes from industrial effluents natural sources like biopolymers namely alginate, chitin and pectin etc. are used. In specific, sodium alginate is used for treatment of wastewater due to its functional, chemical and physical properties. Sodium alginate is a biopolymer which is obtained from brown algae, it is easily available, biocompatible and biodegradable. Calcium chloride and alginate is used in the preparation of alginate bead and in preparation of magnetic bead and iron oxide nanoparticles are also synthesized. The nanoparticle is centrifuged at 5000rpm and then the bead is made to dry. The resultant nanoparticle is characterized using SEM, X-ray diffraction and FTIR .The prepared magnetic bead was dispersed in wastewater and finally the absorbents is noted. This project encompasses production of cost effective and high efficient alginate based nanobead for the treatment of industrial wastewater.

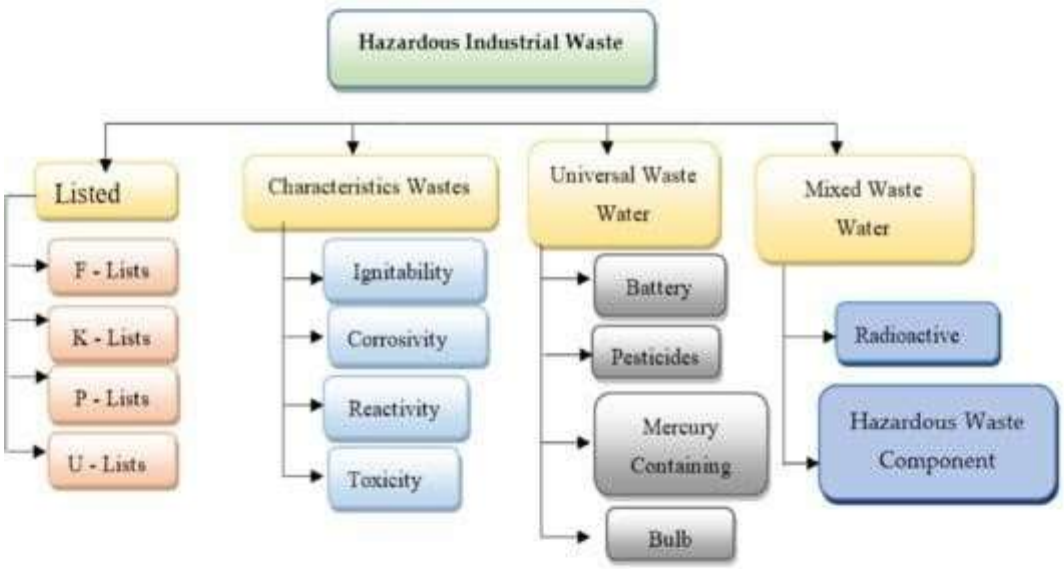
Keywords: Industrial wastewater ,alginate,biopolymers, biocompatible,biodegradable, nanoparticle, centrifuge, cost effective and high efficient.

1.1 INTRODUCTION

With the rapid increase of urbanization and industrialization, industries and pollutions parallelly increasing. Many industries during their processes ofmanufacturing many undesired byproducts are produced which may be in form of solid, liquid and gases. Polluted water from industries are Industrial wastewater, which havelarge amount of pollutants like organic, inorganic materials and heavy metals. These pollutants causes serious threads to the environment. These pollutants has to be treated before releasing it into the environment. (Geetha Palani et.al.,2021).

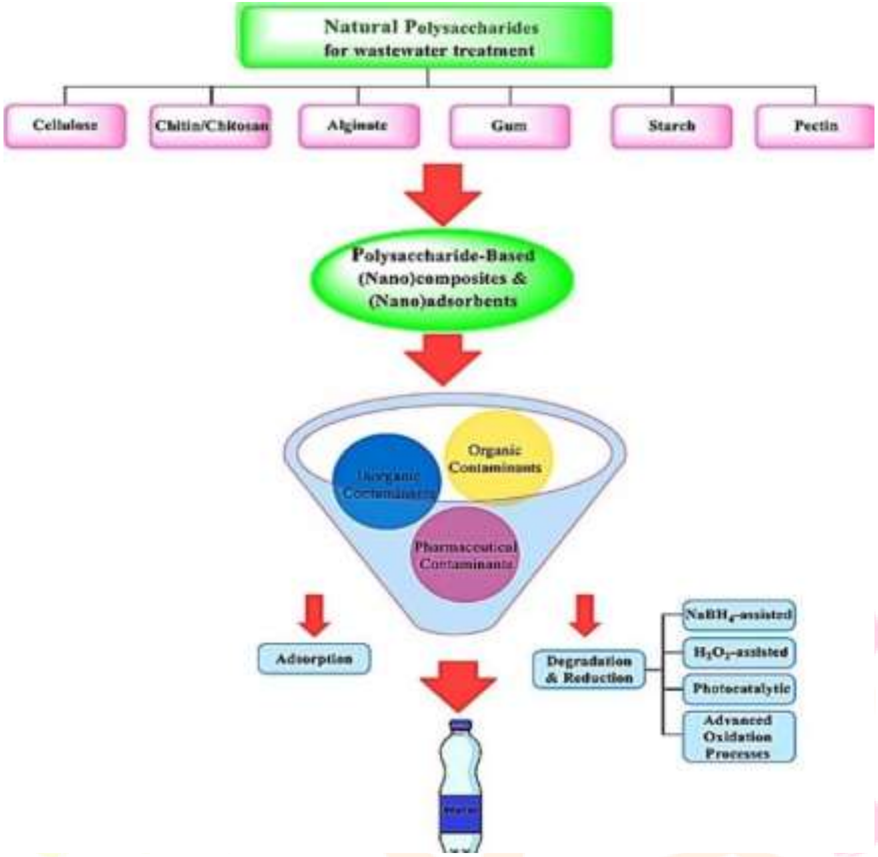
Human life depend on freshwater for their survival. The earth's water is primarily saline in nature (about 97%). Of the (3%) water, 87% of it is locked in the polar and graciers. This would mean only 0.4% of all water on earth is accessible freshwater. This freshwater has to be conserved and treated (Wun Jern Ng,2006). Untreated wastewater also contains several microorganisms such as virus, bacteria, protozoans, algae that have major public health (concerns as these are cause of many waters borne diseases. The untreated wastewaters affect the quality of water in water bodies and human health to entering into trophic levels of food chain.Many diseases like cancers , lung and respiratory diseases like asthma is caused due to the untreated wastewater(Shivani Garg ,et.al.,2021).Treatment of industrial wastewater before releasing it into any water sources is called wastewater treatment, as above mentioned industrial wastewater has to be treated to conserve the water sources and to controls the disease occurred due to industrial wastewater. Heavy metals like arsenic, copper, cadmium, chromium, nickel, zinc, lead, and mercury are major pollutants of freshwater reservoirs because of their toxic, non-biodegradable, and persistent nature Various methods have been developed and used for water and wastewater treatment to decrease heavy metal concentrations. These technologies include membrane filtration, ion- exchange, adsorption, chemical precipitation, nanotechnology treatments, electrochemical and advanced oxidation processes (Arezoo Azimi et. al.,2017). Treatment of metal ions in wastewater require synthetic toxic reagents which are expensive too and hence the capital cost for treatment increases The wide availability, biodegradability, non-toxicity and relatively inexpensiveness of biopolymers present an attractive alternative to such toxic synthetic and chemical products . Biopolymers are used in the treatment of industrial wastewater. (Jyoti Pandey ,2020). Biopolymers are polymers produced from natural sources either chemically synthesized from a biological material or entirely biosynthesized by living organisms. Cellulose, chitosan, and keratin proteins are the most commonly used biopolymers for wastewater purification. (Muhammad Zubair et. al.,2020). Alginate is one of a type biopolymer obtained from brown algae. Alginate readily aggregates and forms a physical gel in the presence of cations. The association of the chains, and ultimately gel structure and mechanics, depends not only on ion type, but also on the sequence and composition of the alginate chain that ultimately determines its stiffness. It is natural and used medical field, in the food industry, and more recently in cosmetics as a skin care ingredient. (K.I. Draget et. al.,2021). Due its structural and functional properties alginate is used as absorption material ,Alginate isused in the treatment of industrial wastewater.

Nanoparticles are spherical, polymeric particles composed of natural or artificial polymers. They range in size between 10 and 500 nm. The use of nanoparticle [NP] materials offers major advantages due to their unique size and physicochemical properties. These nanoparticle is incorporated with alginate for the treatment of industrial wastewater.



Source: *Geetha Palani et. al., (2021)*

Figure 1.1 Classification of industrial wastewater



Source*: Mahmoud Nasrollahzadeh et al.,2020*

Figure 1.2: Natural polysaccharides forwastewater treatment

MATERIALS AND METHODS

3.1 **Materials:**

FeCl3·6H2O (iron(III) chloride hexa hydrate), FeCl2·4H2O (iron(II) chloride tetra hydrate) were purchased from Loba Chemicals, India.; Sodium hydroxide(NaOH) and Sodium alginate were purchased from Titra Chem Co, India.; All chemicals were bought in analytical purity and used without further purification. In all experiments, deionized water was used.

3.2 Synthesis of Magnitite Alginate nanoparticles :

Synthesis of M-AlgNPs. M-AlgNPs were synthesized via the coprecipitation technique, where FeCl3·6H2O andFeCl2·4H2O have been dissolved separately in the ratio of 2 : 1. Then, the two previous solutions were mixed and heated (65°C) under mild stirring using a mechanical stirrer. An aqueous solution of NaOH (3M) is then added drop by drop until the formation of black suspended particles. The reaction continued for 30 min under the same conditions [11, 12]. Then, magnetite alginate was prepared via a ionotropic gelation method. Firstly, the previously synthesized magnetite nanoparticles were redispersed in a solution 2.5% of sodium alginate using an ultrasonic bath for 5 min. The resulting magnetite alginate nanoparticles were washed several times with deionized water; then, the particles were magnetically separated (Omnia A. A.El Shamy et al., (2019)).

3.2 Characterization:

FTIR was used to distinguish the functional groups of magnitite alginate nanoparticles using FTIR-1615 (Perkin Elmer (USA)) using the KBr disc, in wave-numbers that ranged from 4000 to 400 cm-1. The crystal structure of the synthesized Magnitic alginate nanaoparticles was estimated via an X-ray diffraction technique (Panalytical X'Pert PROMPD (Netherlands)). The instrument is outfitted with acopper anode (Cu-Kα) producing wavelength radiation of 1.54 Å. The diffraction pattern was registered at ambient temperature in the angular width of 4–80 (2θ) applying a scan time of 0.4 (s) and a step size of 0.02 (2θ). Zeta potential values were measured (Malvern Zetasizer ZS-HT, UnitedKingdom) to detect the optimum pH for the adsorption process. The morphology of the prepared M-AlgNPs was viewed utilizing the transmission electron microscope, JEM 2100 (JEOL, Japan).(Safoura Asadi et al.,(2018)).

3.3 Adsorption:

The adsorption of Magnetite Alginate Nanoparticles was studied in a batch-mode system. The effect of different parameters including the initial dye concentration, amount of the adsorbent, and temperature on adsorption performance was assessed. The adsorption manner manner of the prepared magnetite alginate nanoparticles were added to the metal ion aqueous solution separately and checked well (200rpm) for two hours (selected time). The pH of the solution was measured at the beginning and the end of each experiment and was maintained at an optimal pH of 2 to 7.5 (using 0.1M of NaOH). Moreover, the effect of different weights of the synthesized magnetite nanoparticles was investigated at ambient temperature. The capacity of adsorption at equilibrium (qe) is calculated in mg/g using following equation:

$$q_e = \frac{(C_0 - C_e) * V}{W}$$

where W is the weight of the synthesized magnetite alginate nanoparticles , Vis the volume of the sample (L) , C0 is the initial metal ion concentration (mg/L),Ce is the concentration of the metal ions t equilibrium(Omnia A. A.El Shamy et al., (2019)).

RESULT AND DISCUSSION

Magnetite nanoparticles:

Figure 4.1 Black colour precipitate

The formation of black color precipitate indicate the formation of magnetite nanoparticles. Thus the magnetite nanoparticles was synthesized successfully through co-precipitation method.

Alginate Based Magnetite Nanoparticles:

The synthesized alginate based magnetite nanoparticles (Alg-MNPs) was shown in theFigure (4.1). The Alginate Magnitite Nanoparticles was prepared by blending method.

Figure 4.2 Alginate based Magnetite Nanoparticles

***In-vitro* Adsorption Studies:**

In-vitro adsorption study was carried out in a glass beaker at room temperature. 1.4g of Alginate Magnitite Nanoparicles was added to dye solution (1mg in 50ml distilled water). The adsorption of dye on the adsorbent was studied preliminarily through the UV-absorption spectrum.

Figure 4.3 Crystal Violet Dye Preparation

Figure 4.4 After adding Alginate Magnetite Nanoparticles

The UV-absorption maximum of crystal violet dye solution was shown in Figure (4.4).The absorption maximum of crystal violet dye was obtained at ~590nm. However, the absorbance of the dye solution after reacted with alginate-based magnetite nanoparticles (Alg-MNPs) was reduced significantly, thus confirming the successful adsorption of dye on the surface of the Alginate Magnetite Nanoparticles.UV-Absorption spectrum of crystal violet dye:

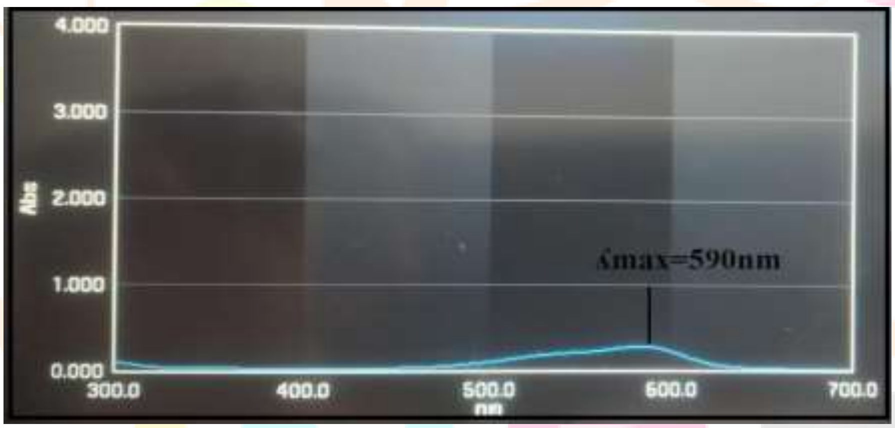


Figure 4.5 (a) UV-absorption spectrum of crystal violet dye

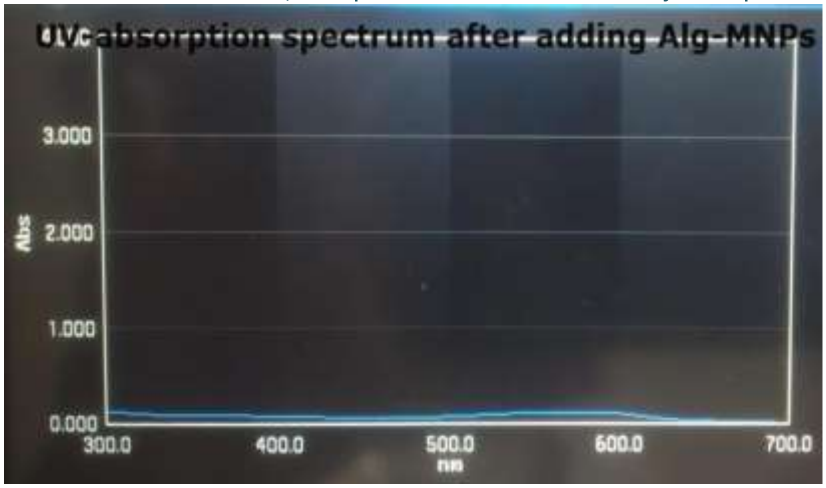


Figure 4.5 (b) UV-absorption spectrum of dye after reacted with Alg-MNPS

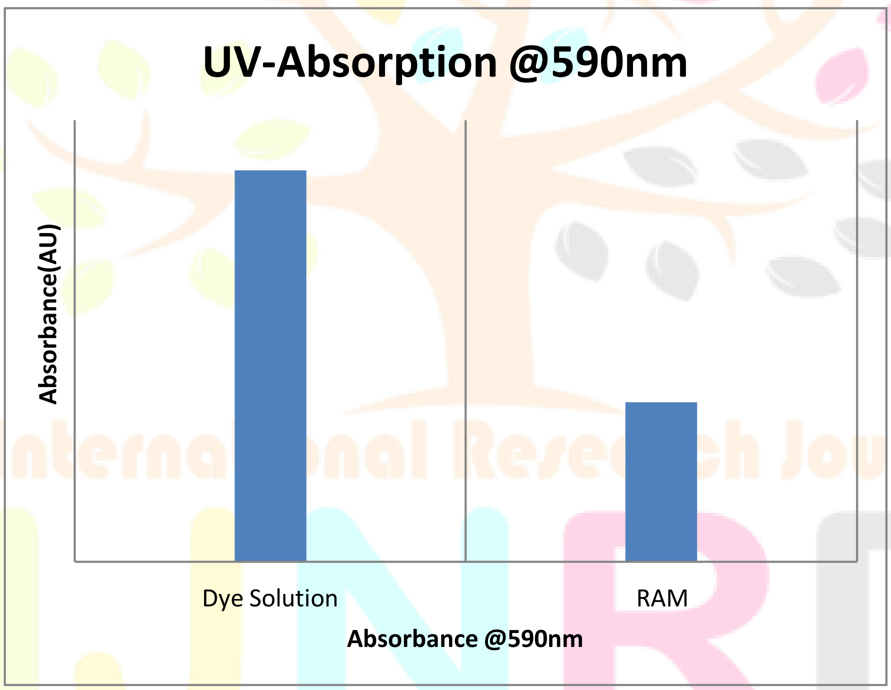


Figure 4.6 Absorbance of dye solution and the dye solution after reacted with AlginateMagnetite Nanoparticles

The absorbance of the dye solution and the dye solution, after reacting with Alginate Magnetite nanoparticles, was shown in the Figure (4.6). The significant reduction of absorbance indicates the adsorption of dye on the surface of Alginate Magnetite Nanoparticles.

5. CONCLUSION

In this study, Magnetite nanoparticles was synthesized successfully through the co- precipitation method. The Alginate based magnetite nanoparticles were prepared by simple blending method. *In-vitro* adsorption studies were also conducted. The adsorption of dye was preliminarily confirmed through UV-absorption spectrum. Further, characterization studies namely Scanning Electron Microscopy (SEM), Fourier Transform Infra-red Spectrum (FTIR) and X-ray diffraction (XRD) to be carried out in future. Hence this present study revealed the application of alginate base magnetite nanoparticles will be used as significant nano adsorbent for dye removal in effluent treatment.

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