Issue 9 vol 3 ISSN: 2321-8134

IJFEAT

INTERNATIONAL JOURNAL FOR ENGINEERING APPLICATIONS AND TECHNOLOGY

DEVELOPMENT OF ACTIVATED CARBON (AC) FROM COTTON FIBER WASTE AS MERCURY ADSORBENT

Mayur.A.Dhote[1],Parag.S.Mahadik[2], Prajwal.D.Redekar[3]

[1]*Student, Chemical, J.D.I.E.T, Yavatmal, Maharashtra, India,* ***mayurdhote517@gmail.com***
[2]*Student, Textile, J.D.I.E.T, Yavatmal, Maharashtra, India,* ***hrithikhrk5513@gmail.com***
[3]*Student, Textile, J.D.I.E.T, Yavatmal , Maharashtra, India,* ***prajwalredekar00@gmail.com***

Abstract

The study attempted to develop the activated carbon of cotton fibre(ACCF) from cotton waste as a high $Hg2^{+}$ adsorbent media and characterized physicochemical properties using scanning electron microscopy coupled with energy dispersive spectroscopy(SEM-EDS) and $Hg2^{+}$ adsorption kine0tic by batch adsorption study with the function of the contact time, solution pH, dosages of ACCF ,and Hg concentration. The SEM-EDS study revealed that ACF is composed of carbon(95.1%) and phosphorus pentoxide(4.9%). Obtain results of adsorption kinetics showed that 15 Min of contact time is require to achieve the equilibrium state and wide range of pH(4.08-7) is favourable for maximum Hg adsorption. The $Hg2^{+}$ adsorption capacity showed a decreasing trend with increasing dose of ACCF, whereas a reverse response of adsorption capacity was pronounced with increasing Hg concentration. The data was well described by Freundlich isotherm model and determined the high $Hg2^{+}$ adsorption capacity of ACCF(169.2 mg/g). To our knowledge, the application of ACCF in removing $Hg2^{+}$ is the first study. High $Hg2^{+}$ adsorption capacity, economic feasibility, availability of cotton fibre waste, and simple preparation method concluded that it could be use as a novel low-cost and environmentally sound adsorbent media for removing high rate of $Hg2^{+}$ from aqueous phase.

Keyword: *Activated carbon, Adsorption, Freundlich Isotherm, Cotton Fibre, etc.*

---------- *** ----------

1. INTRODUCTION

Mercury (Hg) is one of the top ten most toxic and hazardous pollutants in the Priority List of Hazardous Substances for causing serious human and environmental health risks by bio concentration, bioaccumulation, and bio magnification phenomena. Hg and its derivatives can be adsorbed through the gastrointestinal tract, skin, and lungs and hence it is recognized as dangerous and insidious poisons. The monomethylmercury ($Might^{+}$) or dimethyl mercury (Me_2Hg) can penetrate through cell membranes within seconds and cross the blood-brain barrier, which results in the induction of serious carcinogenic, mutagenic, teratogenicity, tyrosinemia, and paralysis, serious neural, intestinal, and renal disorders in the organ systems. The severity of Hg toxicity was recognized in the late 1950s and 1960s because of an environmental tragedy in Mina Mata Bay, Japan, where hundreds of individuals suffered from mercury poisoning (Mina Mata disease).

The major sources of Hg contamination in the environment are eugenic, anthropogenic, and reemitted Hg. The eugenic sources are volcanic activity and weathering of rocks and the major industrial sources are coal burning, electronic, paper, pharmaceutical industries choler-alkali, paint, pulp and paper, oil refinery, electrical, rubber processing, and fertilizer industries According to USA's Environmental Protection Agency (EPA) permissible limit of Hg in wastewater is nil; according to the WHO the limit for mercury in drinking water is 0.001 mg/L and according Indian Standards it is 0.01 mg/L for wastewater.

1.1 Adsorbent

The material whose surface the adsorption takes place is called an adsorbent.Mostly activated carbon is used as an adsorbent. Adsorbents are used in the form of spherical pellets, rods, mouldings, monoliths with hydrodynamic diameters. The adsorbents must also have a distinct pore structure which enables fast transport of the gaseous vapours. Most industrial adsorbents fall into one of three classes:

1.1.1 Types Of Adsorption

Depending on the type of attractions between adsorb ate and adsorbent, the adsorption can be divided into two types.

Forces of attraction exist between adsorbate and adsorbent. These forces of attraction can be due to Wander Waal forces of attraction which are weak forces or due to chemical bond which are strong forces of attraction. On the basis of type of forces of attraction existing between adsorb ate and adsorbent, adsorption can be classified into two types: Physical Adsorption and Chemical Adsorption.

Physical Adsorption or Physisorption

When the force of attraction existing between adsorb ate and adsorbent are weak Vander Waal forces of attraction, the process is called Physical Adsorption or Physisorption.

Physical Adsorption takes place with formation of multilayer of adsorb ate on adsorbent. It has low enthalpy of adsorption i.e.

Chemical Adsorption or Chemisorption:

When the force of attraction existing between adsorb ate and adsorbent are chemical forces of attraction or chemical bond, the process is called Chemical Adsorption or Chemisorption. Chemisorption takes place with formation of inlayer of adsorb ate on adsorbent. It has high enthalpy of adsorption. It can take place at all temperature. With the increases in temperature, Chemisorption first increases and then decreases.

1.1.2 Typical application Of Commercial Adsorbent

Silica Gel

Drying of gases, refrigerants, organic solvents, transformer oils.
Desiccant in packing's and double glazing.
Dew point control of natural gas.

Activated Alumina

Drying of gases, organic solvents, transformer oils.
Removal of Hall from hydrogen.
Removal of fluorine in alkylation process.

Zeolites

Oxygen from air.
Drying of gasses.
Recovery of fructose from corn syrup.

Polymers & Resins

Water purification
Recovery and purification of steroids, amino acids
Separation of fatty acids from water and toluene

Clay

Treatment of edible oils
Removal of organic pigments.
Refining of mineral oils.

1.2 Cotton Fibre

Cotton is a soft and smooth fibre that grown in a form known as a circular around the seeds of the cotton plant. The earliest evidence of using cotton is from India and the date assigned to this fabric is 3000 B.C. There is also excavations of cotton fabrics of comparable age in various plant of cotton in Southern America. Cotton cultivation first spread from India to Egypt, China and the South Pacific.

The most fibre are often in spun into yarn or thread and it is used to make a soft, breathable textile, which is the most widely used natural-fibre cloth in clothing today.

Cotton today is the most used textile fibre in the whole world. Its current market share is 56 percent for all fibres used for apparel and home furnishings.

1.2.1 Properties Of Cotton

Each fibre is a single elongated cell that is flat twisted and ribbon like with a wide inner hollow (lumen). 90% cellulose, 6% moisture and the remainder fats and impurities.

The outer surface is covered with a protective wax like coating which gives fibre an adhesive quality.

Cotton is a natural fibre that is grown in countries around the world. It is a crop that requires adequate moisture and heat to mature and produce quality fibres. Cotton is a true commodity in the world markets and supply and demand truly affect prices of raw cotton. Cotton fibres are mainly made up of cellulose. Cellulose does not form unless temperatures are over 70 °F (21 °C). The cotton fibres are attached to the seeds inside the boll of the plant. There are usually six or seven seeds in a boll and up to 20,000 f biers attached to each seed.

1.2.2 Chemical Structure Of Cotton Fibre

Cotton is the natural fibre of vegetable origin. It is considered as King of the Textile Fibres. It is composed of cellulose. Each fibre is made up of 20-30 layers of cellulose coiled on a neat series of natural springs. Cellulose is one of the main constituent of the cotton fibre. In nature, plants utilize CO2 present in air & water & build up compounds containing C, H, and O in the presence of sunlight. This reaction is called photosynthesis. Glucose is one of the product formed by this way. When two glucose are combine then cellobiose molecule is formed and when cellobiose molecules combine with each other so the giant cellulose molecule is formed.

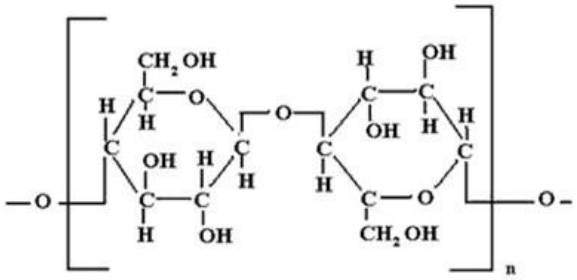

Fig.1 Chemical structure of cotton fibre

1.3 Cotton Waste

During the various stages in the process of converting the cotton fibre into yarn, a few cotton fibres are sieved out in order to preserve the quality of the yarn. This cotton fibre separated out during the processing task is termed as cotton waste. This waste material finds re- use at several industries and we deliver the committed quality in stipulated time to our clients.

Products	Hazardous Wastes
Medicines	Organic solvents and residues, heavy metals (mercury and zinc)
Metals	Heavy metals, fluorides, cyanides, acids and alkaline cleaners, solvents, pigments etc.
Paints	Heavy metals, pigments, solvents, organic residues
Leather	Heavy metals, organic solvents
Oil, Petroleum products	Oils, phenols, organic compounds, heavy metals etc.
Pesticides	Organic chlorine compounds, organic phosphate compounds.
Plastics	Organic chlorine compounds
Textiles	Heavy metals, dyes, organic chlorine compounds, solvants

Fig.2 Industrial product and their hazardous waste

The various types of cotton waste

1. Comber Noel

During the process of combing of cotton fibres, the short fibres are removed from the processed yarn, this extracted

waste is termed as Cotton Comber or Comber Noel. This unwanted waste is of great utility in industries such as security paper, pharmaceutical, and also for blending purposes in Open end spinning.

2. Flat Cotton Waste

This by-product is derived in the first carding machine in the yarn spinning industry. This cotton waste comprises of higher trash content than the comber noel. This fibre finds use as a blend with superior quality cotton in open-end spinning process.

Fig.3 Cotton Waste

3.Preparation Of Activated Carbon Of Cotton Fibre (Accf)

The AC of cotton fiber (ACCF) was prepared by the process of microwave assisted pyrolysis. Microwaves can be used to pyrolysis the carbon source. Waste cotton (used for microbiological work) of the laboratory was collected and extensively washed under tap water to remove any particulate matter, and finally sprayed with distilled water. This washed cotton was dried in sunlight. To pyrolysis, the cotton fiber (50 g) was placed within a lidded porcelain cup which in turn was placed inside the multimode microwave and heated at >500°C for 10 min. Activated carbon manufacturing consists of a charring or carbonization step in which most of the no carbon material (and much of the carbon) is volatilized by pyrolysis (usually between 500 and 750°C) and usually weight (60 to 70%) is lost. The basic microstructure of the char with micro porosity is formed around 500°C.

Why for mercury

Mercury (Hg) is one of the top ten most toxic and hazardous pollutants in the Priority List of Hazardous Substances for causing serious human and environmental health risks by bio concentration, bioaccumulation, and bio magnification phenomena. Which results in the induction of serious carcinogenic, mutagenic, teratogenicity, tyrosinemia , and paralysis, serious neural, intestinal, and renal disorders in the organ systems. In order to remove the Hg from water, the adopted common methods include sulphide precipitation, ion exchange, alum and iron coagulation, electro dialysis, ultrafiltration, activated carbon adsorption, and various biological processes.

Why cotton fibre use to develop AC

The study concerning the preparation of AC from the cotton fibre waste has been performed, its application is adsorbent media for removing the pollutants from water has not been executed so far. Therefore, the purposes of the present study were to develop the AC of cotton fibre (ACCF) as a novel and potential Hg^{2+} adsorbent media from waste of cotton fibre and characterize the Hg^{2+} adsorption kinetic by batch adsorption study for application in removing high rate of Hg^{2+} from the aqueous phase.

Comparison with other adsorbent

The activated carbon can be prepared from a various variety of materials. Commercially available AC in the market derived from peat, lignite, and wood are expensive. Though varieties of AC have been developed recently from apricot stones, nut shells, grape seeds maize cobs, rice husk, coconut husk, wood almond, hazelnut shells, pine timber and pine scrap to adsorb Hg from water, but many of them are costly and/or inaccessible and/or ineffective in the practical application. So there is a need to produce low-cost AC that can be prepared following the simple process and applied to pollution control.

Advantage

1. low-cost Hg adsorbent materials with easy application methods still have demand.
2. Simple process and applied to pollution control.
3. Easily available.

Disadvantage

Its application as adsorbent media for removing the pollutants from water has not been executed so far

Application

Removal of organic pollutants from aqueous or gaseous effluents.

4. CONCLUSION

This study developed an AC of high Hg adsorbing from cotton fibre waste using the microwave assisted heating process. The high surface area of ACCF is the major driving factor for adsorbing high amount of Hg from water phase. In spite of above properties, the economic feasibility, availability of waste cotton and simple preparation method concluded that it could be used as a novel low-cost adsorbent for removing Hg from water by converting the cotton waste into environmentally sound adsorbent media of AC with high Hg adsorbing capacity.

ACKNOWLEDGEMENT

This the heartfelt expression and gratitude to all those who all helping us to successfully complete this project. It has been a very pleasurable learning experience when we could put our theorotical knowledge to practical use and have learn the lot by working handson together in a team and thanking to the Amravati University for the biological study.

REFERENCES

[1]. Jitandra N. Bhakta, Ptyalin Maunder, Yukihiro Munekage, "International journal of chemical engineering", research article on Development of activated carbon from cotton fibre waste as mercury adsorbent, volume 2014, articles in 176483.

[2]. Binary K. Dutta, "Principles of mass transfer and separation operation", pg. no. 609-621

[3]. Gordon McKay, Ph.D., D.sc, "Use of adsorbents for the removal of pollutants from wastewaters", pg. no. 1-5

[4]. Phillip J. Wakelin, Barbara A. Triplett, J. Vincent Edwards, "International Fibber science and technology, Cotton fibre chemistry and technology", pg. no. 1-134

[5]. Harry Marsh, North shields, United Kingdom, Francisco Rodriguez-Reynoso, "Activated carbon", pg.no. 1-35

[6]. Wikipedia, "cotton fibre"