International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 8 Aug. 2022, pp: 1297-1301 www.ijaem.net ISSN: 2395-5252

Synthesis and Characterization of Ion exchange Resin and its Application in Wastewater Treatment

Madhu Bala Raigar[1], SavitaBargujar*[1]
[1]Department of Chemistry, Ramjas College, University of Delhi, Delhi, New Delhi – 110006

Submitted: 10-08-2022 Revised: 22-08-2022 Accepted: 24-08-2022

ABSTRACT
The pollutants, which are present in minute amounts in water resources all over the world for a number of reasons, have grave ramifications. As a consequence, this negatively affects the environment, particularly marine organisms, and consequently, mankind. The most effective adsorbent alternative is polymeric resin, which is used in ion exchange process. This polymer offers considerable porosity, permeability, ease of access, and stable characteristics. The efficacy of the adsorption of ions of heavy metals is increased when unmodified. Cellulose is combined with 3-Aminobenzoic acid. In contrast, modified cellulose-3-aminobenzoic acid (CABA) resin has strong adsorption capacity, particularly for lead (Pb^{2+}), copper (Cu^{2+}), chromium (Cr^{3+}), and cadmium (Cd^{2+}), which are environmentally unfriendly metal ions. By the batch and column methods, the resin demonstrated better retention of heavy metal ions.
The present work involves the preparation of resin by the adsorption of 3-aminobenzoic acid on cellulose and also investigating the treating of industrial waste to remove heavy metals in it. Thermogravimetric analyses and FTIR were used to characterize the adsorbent. The pH, metal ion concentration, contact time, and other variables were changed during the experiments.
Keywords: Heavy metal ions, Industrial Effluent, Cellulose-3-Aminobenzoic acid,FTIR.

I. INTRODUCTION

Because of various human activities, a number of various metals are deposited in the water reservoirs and environment. Presence of these ions above the limits leads to serious concern like it may cause cancer, neurological damage and other health problems [1-8]. There are number of methods available for treatment of Industrial wastes water to remove the heavy metals but most effective method is Ion exchange method based on adsorption desorption process. Functional selection groups in polysaccharides also exhibited the removal of heavy metal ions from an aqueous solution of industrial wastewater [9].

There are number of conventional technologies used for the removal of heavy metal ions from the industrial waste water, like sedimentation, screening, filtering, and membrane separation are examples of physical procedures. Adsorption, neutralisation, aggregation, ion exchange etc. are a few examples of chemical processes [10-11]. Under Biological processes both aerobic and anaerobic conditions are used. The most effective of them all is the adsorption method, which efficiently and safely removes pollutants from water or wastewater. Adsorption involves the mass transfer of bonded metal ions from the solution towards the sorbent in its simplest form.The economic success of synthetic resin depends on its low cost, ease of production, and recoverability, which increase its economic importance[12-17]

II. MATERIALS AND METHODS

The supplier of cellulose powder was Ases Chemicals in Jodhpur, India. It was decided to get epichlorohydrin and 3-Aminobenzoic acid from Sisco Chemical Industries in Mumbai, India. We used products from Sarabhai Chemicals in Baroda, India for the sodium hydroxide and dioxane.

SynthesisofCellulose3-Aminobenzoic Acid (CABA)Resin: The synthesis of cellulose 3-Aminobenzoic acid resin was carried out in two steps. 16.2 g of cellulose powder in dioxane was taken in a round-bottom flask and to this 4 g (0.1 mol) of 50%, sodium hydroxide aqueous solution was added to make it alkaline. Please make sure that the pH of the solution was 9.5. After stirring for 1 hour, epichlorohydrin was added drop by

International Journal of Advances in Engineering and Management (IJAEM)
Volume 4, Issue 8 Aug. 2022, pp: 1297-1301 www.ijaem.net ISSN: 2395-5252

drop, and stirring continued for 4 hours at a temperature of 600 C then epoxypropyl ether of cellulose was produced. In the first step, epoxypropyl ether of cellulose is produced by reacting with 3-Aminobenzoic acid (13.7g, 0.1mol), which is then stirred for 5 hours at 65^0 C. The resulting resin was purified by filtering it under a vacuum and washing it with 90% methanol and HCl. CABA resin was a fine powder with yield of 31.09 g.[18]

Figure 1: Scheme for the synthesis of Cellulose -3-aminobenzoicoic acid (CABA)

Figure 2: Interaction of CABA resin with Metal Ion

Sample Analysis: The effluent of Apex Steel Industry has been taken as sample for characteristic studies. The result of analysis of the effluent of Apex Steel Industry, Jodhpur, Rajasthan is shown in Table No. 1.

Table 1: Analysis of effluent of Apex Steel Industry, Jodhpur, Rajasthan

Appearance	Turbid
Colour :	Yellowish Green
pH :	4.5
COD (mg/L) :	98.0
BOD (mg/L) :	246.0
Total hardness:	889
Dissolved Solid (mg/L):	1979
Suspended Solid(mg/L) :	14896

Metal ions	**Fe^{+2}**	**Cu^{+2}**	**Zn^{+2}**	**Pb^{+2}**	**Cd^{+2}**	**Mg^{+2}**	**Ca^{+2}**

Conc.(ppm)	1.04	0.85	6.31	0.71	0.043	98.21	280
Other anions (mg/kg)	Flouride 0.31		Sulphate 863.0			Cyanide 0.07	

FT-IR Characterization: ForFT-IRcharacterization,PerkinElmermodel 2380, Atomic Absorption Spectrophotometer was implemented which gives the data related to band region and functionalgroupstretchingfrequency.First,ungrafted orunmodifiedcellulosewas analysed and it showed band of broad nature in the 3100 cm-1 and 3400 cm-1 regions with characteristic --OH (Functional group) stretching frequency. After grafting of 3-Aminobenzoic acid on cellulose (CABA) resin, it showed a characteristic band at 1730 cm-1 which confirmed the formation of 3-Aminobenzoic acid resin grafted cellulose. The characteristic bands of the carboxylate are located at 1320 cm-1 for symmetric vibration and at 1570 cm-1 for asymmetric vibration.

ThermogravimetricAnalysis: The thermogravimetric analysis was carried out using thermogravimetric analyzer TGA model 951, which was set up with a heating rate of 20° C/min. It was found that at 390 degrees, the CABA resin became stable before degrading quickly.

Column operation/analysis: Metal ions were recovered using analysis column method. The apparatus needed for this approach is a glass tube with an interior diameter of 1.6 cm and a height of 18 cm that has 8 cm of resin embedded in it. The flow rate is managed by a peristaltic pump. Metal ions are separated using the principle of selective elution, then the traces amounts of unadsorbed ions are removed with distilled water.

III. RESULTS AND DISCUSSION

Distribution coefficient (Kd) of metal ions: The distribution coefficient (Kd) of metal ions is significantly influenced by pH. The analysis of the data revealed that as pH is raised, the distribution coefficient value initially rises and then falls. pH 6 yielded the best outcomes as shown in Table 2.

Table 2:Distribution Coefficients (K_d) of metal ions in the effluent of Mineral Industry, Jodhpur on Cellulose -3-aminobenzoicoic acid (CABA) Resin (K_d x10^2)

pH	Pb (II)	Cd (II)	Zn(II)	Cu(II)	Fe(II)
2.0	09.19	32.63	29.23	29.78	31.32
3.0	13.41	33.57	43.76	51.25	69.61
4.0	16.96	41.17	43.23	41.46	78.65
5.0	28.56	72.24	71.86	113.16	102.32
6.0	92.01	131.10	171.52	267.24	167.65
7.0	31.54	43.21	55.28	61.23	61.77
8.0	08.69	19.67	27.74	21.92	31.53

Effect of pH: A variety of factors were considered, and a wide range of pH reveals increasing and decreasing values for the distribution coefficient of metal ions. This pH value is important to discuss since it impacts the solubility of the metal ion as well as the degree of ionisation of the adsorbent during the reaction and the concentration of counterions on its functional group. In the pH range of 2 to 8 represented in tables 1 and 2, the impact of pH on relative activity was determined as shown in Table.3.

Table 3: Percentage removal of metal ions from the effluent of Mineral Industry, Jodhpur, by Cellulose -3-aminobenzoicoic acid (CABA) resin. at optimum pH

pH	Pb (II)	Cd (II)	Zn(II)	Cu (II)	Fe (II)
2.0	51.34	61.09	64.51	71.06	77.05
3.0	61.25	72.52	77.39	79.29	81.63
4.0	69.23	81.35	83.92	86.09	87.48
5.0	80.10	83.89	86.73	93.45	97.07
6.0	91.56	94.62	95.39	96.98	98.92
7.0	71.44	74.56	76.06	78.45	79.31
8.0	37.98	51.67	55.99	61.38	68.57

IV. CONCLUSION

To achieve the desired goal of successfully separating heavy metal ions from wastewater in the lab, insoluble cellulose 3-aminobenzic acid (CABA) resin was synthesized. Because there were several binding sites available on the surface of the CABA resin, an experimental method demonstrates that 0.1 g of resin is sufficient for the treatment of 1 litre of wastewater. In order to remove heavy metal ions from wastewater, CABA resin was finally prepared for use.

This CABA resin is advantageous to human society and environmentally benign. Water can be purified using modified cellulose 3-aminobenzoic acid to remove dangerous heavy metal ions as Pb(II), Cd(II), Zn(II), Cu(II), and Fe (II).It was found that methods other than ion exchangers are not feasible due to technical complicity and economical unfavourableness, but in case of little concentration of pollutants, this process is very efficacious. It is thus proved that the CABA resin can be successfully used for the selective separation and effective removal of different metal ions from industrial effluents.

REFERENCES

[1] Shah, M. C.; Kansara, J. C.; Shilpkar, P.G. Current World Environment.2015 : 10 (1), 281-284.

[2] Sikora, E.; Hajdu, V.; Muránszky, G.; Katona K. K.; Kocserha I.; Kanazawa, T.; Fiser, B.; Viskolcz, B. Vanyorek, L. Chemical Papers.2021:75 (1) 187–1195.

[3] Naef A. A.; Qasem, Ramy, H.; Mohammed, Dahiru U. Lawal, npj Clean Water.2021:436.

[4] Kumara P.S., et al., A critical review on recent developments in the low-costadsorption of dyes from wastewater, Desalination. Water Treat.2019:172, 395–416.

[5] Salma A. , et al., Biosorption of acid red 14 found in industrial effluents usingaspergillusfumigatus, Asian J. Microbiol. Biotechnol. Environ. Sci.2018:20 (1)120–127.

[6] Shah M.C., Kansara J.C., Shilpkar P.G.: Current World Environment 2015:10 (1) 281-284.

[7] Sikora E., Hajdu V., Muránszky G. et al.: Chemical Papers 2021:75, 1187-1195.

[8] Qasem N.A.A., Mohammed R.H., Lawal D.U.: npjClean Water 2021:4, (36) 1-15.

[9] Fadel D.A., Bahy S.M.E.I. and Abdelaziz Y.A., Heavy metals removal using iminodiacetate Chelating resin by batch and column techniques, Desalination Water Treat. 2016: 57(53), 25718- 25728.

[10] Gupta R., Ahuja P., Khan, S. Saxena R.K. Mohapatra H. Microbial biosorbents: Meeting challenges of heavy metal Pollution in aqueous solutions. Curr. Sci. 2000 :78 (8), 967-973.

[11] Harper T.R, Kingham N.W. Removal of arsenic from wastewater using chemical precipitation methods, Water Environ. Res. 1992:64 (3), 200–203.

[12] ParaskevaP. ,Kalderis E.D. , Diamadopoulos, production of activated carbon fromagricultural by-products, J. Chem. Technol. Biotechnol. 2008: 83, 581–592.

[13] Dolores L. , Juan P.M. , Falco C. , Titirici M. , Diego C. , Porous biomass-derivedcarbons: activated carbons, Sustainable Carbon Materials From Hydrothermal Processes, vol. 1, 2013, p. 100

[14] Tamez C., Hernandez R., Parsons J. , Removal of Cu (II) and Pb (II) from aqueoussolution using engineered iron oxide nanoparticles, Microchem. J. 2016:125, 97–104.

[15] Sharifpour E., Khafri, H.Z., Ghaedi M. , Asfaram A. ,Jannesar R. , Isotherms and kinetic study of ultrasound-assisted adsorption of malachite green and Pb2+ ionsfrom aqueous samples by copper sulfifidenanorods loaded onactivatedcarbon:experimental design optimization, UltrasonSonochem. 2018: 40, 373–382.
[16] Devanathan R., Balaji G.L., Lakshmipathy R.: Journal of Environmental and Public Health. 2021, 661,1-8.
[17] Wu S., Yan P.Yang W. et al.: Chemosphere 2021:264, 128557.
[18] Abo-Shosha, M. H.; Ibrahim, N. A.; Elnagdy, E. I.; Gaffar, M. A. Polymer-Plastics Technology and Engineering 2002: 41, 963.