INTERNATIONAL JOURNAL ON OCCUPATIONAL HEALTH & SAFETY, FIRE & ENVIRONMENT – ALLIED SCIENCE
ISSN 2349-977X

VOL. 5 ISSUE 1 JULY-SEP, 2015 (017-019)

Available online at www.ohsfejournal.com

Synthesis of Low Cost Carbon Replica for Paracetamol Removal from Waste Water and Effect of Temperature on Adsorption Capacity

***Prashant Pandey*[a]*, *Vipin Kumar Saini*[b]

[a]*M.Tech Civil Student, SENR, Doon University, Dehradun, India*

[b]*Assistant Professor, Dept. Civil Engineering, WIT Dehradun, India*

ARTICLE INFO

Article history:
Received 10 May 15
Received in revised form 07 July 15
Accepted 12 July 15

Keywords:
Carbon Replica
Polyurethane foram
Paracetamol
Waste Water

ABSTRACT

Low-cost Mesoporous Carbon Replica was synthesized via sucrose as carbon source and polyurethane foam (PUF) as template for removal of pharmaceutical pollutant such as Paracetamol from waste-water generated by pharmaceutical industries. Prior to impregnation on PUF, Sucrose dissolve in Distilled water have conc.H2SO4. After impregnation sample set aside in oven at 100^0C for 6hr follow by polymerization at 160^0C again for 6 hr. During heating to carbonization temperature (290^0C) impregnated resins were cured and name as Carbon Replica (CR-1). The maximum Adsorption capacity was 2.989 mg/g of Paracetamol on CR-1 calculated. Further heating treatment to CR-1 from 2900C to 3100C and is named as CR-2 shows subordinate adsorption capacity 0.5 mg/g of Paracetamol and 310^0C to 330^0C named CR-3 shows zero adsorption capacity. Hence this study shows increase in temperature has adverse effect on surface area of Mesoporous Carbon Replica. This significance validate the feasibility of CR-1 Carbonized at 290^0C for highly effective removal of Paracetamol from aqueous solution.

1. Introduction

India having a total area of about 3.3 million km^2 is geographically located in Southern Asia. The water resources potential of country is assessed as the natural runoff of the river and is estimated at 1864.33 km3 of which only 1089 km3 are considered as utilizable. It was estimated that in 2010 total water withdrawal was 716 km^3. Out of this 17 km^3 were used for industrial purpose. Industries such as pharmaceuticals, chemicals, dyes, leather, textiles, paper and pulp, and many more uses water in abundance. The water discharged from these industries contains many soluble and insoluble organic and inorganic contaminants which may degrade the nearby environment. This in turn may lead to serious health implications on the people who directly or indirectly come in contact with it or are dependent on the same. It is for this reason that degradation of water quality must be checked to ensure the protection of natural water resources as well as establishing sustainable water supply systems. The water from industries after use thus appeals treatment.

Many effective techniques have been developed such as filtration, advanced oxidation, coagulation, filtration with coagulation, precipitation, reverse osmosis, ozonation, ion exchange, and adsorption for removal of pollutants from aqueous solution.

Among this Adsorption process by solid adsorbents shows potential as one of the most efficient methods for the treatment because of simple design and can involve low investment in term of both initial cost and land required along of its high surface areas that range from 500 to 1500 m^2 g-1 it is widely used in the treatment of wastewaters. The effectiveness of Activated carbon in cleaning up polluted water is due to its well developed porosity structure as well as the presence of a wide spectrum of surface functional groups. This makes it capable of distributing pollutants on its large internal surface, making them accessible to reactants.

* *Corresponding author*. Tel.: +91-9458784077; +91-9897958508.
E-mail address: prashant24.rai@gmail.com; vipinkumar20@gmail.com
Peer review under responsibility of Editor

Hosted by International Journal on Occupational Health & Safety, Fire & Environment. – Allied Scicence.

In spite of this, activated carbon having pore size between 1-2 nm (Micropore size <2nm) are not much effective for larger compounds removal. These compounds left behind after treatment (tertiary treatment) are in trace amount known as emerging pollutants, showing adverse effect on humans as well environment. As emerging pollutants from industries, pharmaceuticals have a lot contribution. Some of pharmaceuticals emerging pollutants are: Trimethoprim, pentabromobiphenyl ether, 4-nonyl-phenol, codein, ibuprofene, diazepam, C10-C13 chloroalkanes, di(2-ethylhexyl) phthalate (DEHP) and many more. Therefore, scientists showed their attention towards nanostructured porous carbons. These novel mesostructured or nanostructured porous carbons having pore size between 2-50nm.

A moment ago, carbon materials have received enormous consideration because of adjustable thermal and electrical conductivity, low thermal expansion coefficient and large surface area. Carbon materials are discovered in variety forms like diamond, carbon fibers, graphite and carbon nanotube, and graphene, and so on. Especially, carbon foams have the properties of conventional carbon materials, are chemically inert to organic solvents, and have large quantities of open pores. Therefore, carbon foams have been applied to high temperature thermal insulation, electrodes for batteries, catalyst supports, etc. In present paper low cost PUFs used as template and sucrose as carbon source.

2. Experimental

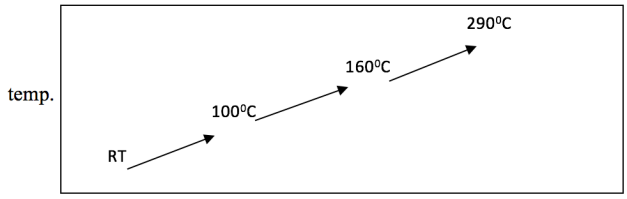
Synthesis of Carbon Replica:

PUFs in cylindrical shape (18 samples) has been primed using cutter (2.251gm). Solution of distilled water and conc.H_2SO_4 (450ml d/w +8ml acid) has been prepared. Taking 45ml of this solution and 12.5gm of sucrose were dissolved in this. The carbon replica were synthesized by the carbonization of impregnated PUFs. Sucrose solution used to impregnate PUFs drop wise. These impregnating processes were repeated four times at regular interval of 30 min. Then impregnated foams were dried at 100oC for 6hr to evaporate the solvent (distilled water). The impregnated foam was heated again at 160^{o}C for polymerization at a heating rate of 1^{o}C/min from room temperature. For the carbonization process, the temperature was maintained at 290^{0}C for 1.5hr, starting with temperature 25^{0}C and increasing 25^{0}C per 5 minute upto 200^{0}C, the followed by 10^{0}C per minute upto 2900C and after carbonization temperature (290^{0}C) impregnated resins were cured and name as Carbon Replica (CF_{290}).

Table: 1: Sample Evaluation

Sample (PUFs)	*End of 100^{0}c treat.*	*% gain*	*End of 160^{0}c treat.*	*%loss*	*Foam Removal*	*% loss*
2.25gm	26.34gm	10.7%	22.46gm	0.14%	18.06gm	0.19%

Graph 1: Heating Program



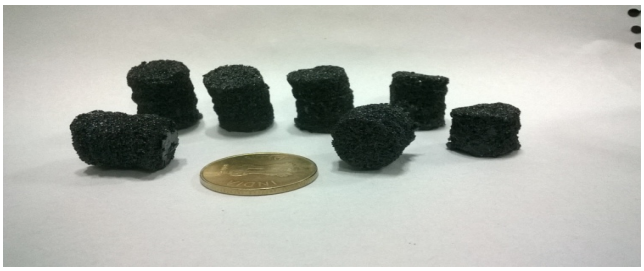


Figure 1: Carbon Replica

3. Result and Discussion

Performance evaluation of Carbon Foam (CF_{290}-CR-1) against Paracetamol (PCM):

The effect of contact time:

Stock solution of 500ppm prepared make up to 1000ml. Working solution of 20ppm prepared and make upto 500ml from stock solution. CR-1 is randomly selected from CF_{290} of initial wt.= 0.920gm dipped in concentration of 20ppm in 500ml solution of PCM and kept stirrer at 200RPM and samples to study contact time effects are collected at regular interval of time which described below in table.

Table 2: Evaluation Table: For Concentration Measurement Double Beam Spectrophotometer Has Been Used:

Vials no.	*Contact time (minute)*	*Concentration mg/ml*
1	5	20
2	10	22
3	15	21
4	20	21
5	25	22
6	30	22
7	35	21
8	40	21
9	45	22
10	50	22
11	55	21
12	60	21
13	75	22
14	105	21
15	120	22
16	180	22
C_0	0	27

Adsorption capacity of CR-1

Adsorption capacity = C_0-Ce/wt. *vol. (in ml)/1000. 1

Using above formula adsorption capacity were calculated 2.989 mg/g.

Cleaning and activation of CR-1

Used sample stirred in 250ml of distilled water at 200RPM for 15minute and kept in oven at 70^0C over night. Then is carbonized to 310^0C and left for 1.5hr and is named CR-2

1^0c/min

CR-1 ⟶ CR-2

Adsorption capacity of CR-2 calculated by preparing working solution of 20ppm in 500ml of distilled water, dipping CR-2 of weight 0.932gm and kept at stirring for 3hr. Using double beam spectrophotometer initial and final concentration were measured C_0=18ppm; C_e=17 ppm respectively. Adsorption capacity 0.5mg/g was calculated.

Cleaning and activation of CR-2

Used sample again stirred in 250ml of distilled water at 200RPM for 15minute and kept in oven at 70^0C over night. Then is carbonized to 330^0C and left for 1.5hr. named CR-3

1^0c/min

CR-2 ⟶ CR-3

The same experimental procedure of CR-2 has been adapted for CR-3 resulting in zero adsorption capacity.

Table 3: Comparison of Adsorption capacity of CR-1,CR-2 and CR-3

Carbon replica	*Adsorption capacity(mg/g)*
CF_{290}	2.989
CF_{310}	0.5
CF_{330}	0

CR-2 has lower adsorption capacity than CR-1. Because temperature treatment from 290^0C to 310^0C caused variation in poresize (contraction), reduces surface area which lowers efficiency against paracetamol. Its further treatment from 310^0C to 330^0C causes no adsorption. Means adsorption capacity becomes zero (0).

4. Conclusion

This study reports the preparation of carbon foams with the intention of using them in enhanced applications. The carbon foams were synthesized successfully using PUFs as a template and sucrose as carbon precursors. PUFs was impregnated with distilled water and acid solution. This method can be used to prepare the carbon foams in a very simple procedure. In whole process there is negligible loss in adsorbent and were easy to work showing no impact on health and their recovery increase their efficiency. Present paper also concludes increase in temperature shows adverse effect on surface area and pore size of Mesoporous Carbon Replica. This significance validate the feasibility of CR-1 Carbonized at 290^0C for highly effective removal of paracetamol from aqueous solution.

REFERENCES

- Alaton, I.A., Balciogem,I.A. and Bahnemann.D.W. "Advanced oxidation of reactive dyebath effluent: comparision of O3 , H2O2 /UV-C and TiO2 /UV-A processes", water res.,36,PP.1143-1154(2002).
- Critten den, J.C., Trusell, R.R., Hand , D.W., Home , H.J. and Tchob anoglous , G., water treatment , principles and design , 2nd Edn., John Wiley and Sons , Inc., Hoboken(2005).
- Olson , T.M. and Barbier , P.F. "Oxidation kinetics of natural organic matter by sonolysis and ozone", water res., 28, PP. 1383-1391(1994).
- Weaver , L.K., ling , F.H. and Hoffmann , M.H. "The combination of sonolysis and ozonolysis for aromatic compound degredation", Environ. Sci. Technol., 32 , PP. 2727-2733(1998).
- Crinia. Recent development in polysaccharides based materials used as adsorbents in waste water treatment, Prog. Poly Sci. 2005, 30, 38-70.
- Liu Q, Zheng T, Wang P, Jiang J, Li N. Adsorption isotherm, kinetic and mechanism studies of some substituted phenols on activated carbon fibers. Chemical Engineering Journals 2010; 157:348-356.
- R. Ryoo, S. H. Joo and S. Jun, J. Phys. Chem. B, 103 (1999) 7743.
- M. Kruk, M. Jaroniec, R. Ryoo and S. H. Joo, J. Phys. Chem. B, 104 (2000) 7960.
- S. H. Joo, S. Jun and R. Ryoo, Microporous and Mesoporous Mater., in press (2001).
- R. Ryoo and S. J. Choi, manuscript in preparation.
- S. Jun, S. H. Joo, R. Ryoo, M. Kruk, M. Jaroniec, Z. Liu, T. Ohsuna and O. Terasaki, J. Am. Chem. Soc., 122 (2000) 10712.
- R. Ryoo and O. Terasaki, manuscript in preparation.
- J. Lee, J. Kim, and T. Hyeon, Adv. Mater., 18, 2073 (2006).
- M. Zhu and G. Diao, Nanoscale, 3, 2748 (2011).
- S. Subramoney, Adv. Mater., 10, 1157 (1998).
- T. Kyotani, Carbon, 38, 269 (2000).
- G.-P. Hao, W.-C. Li, D. Qian, and A.-H. Lu, Adv. Mater., 22.