Journal of Energy Research and Environmental Technology (JERET)
p-ISSN: 2394-1561; e-ISSN: 2394-157X; Volume 5, Issue 3; July-September, 2018; pp. 82-83

http://www.krishisanskriti.org/Publication.html

A Review on Activated Carbon from Biowaste: Process, Application and Prospects

Shakir A Mir[1] and Mushtaq A Rather[2]

[1]Ph.D. Scholar, Department of Chemical Engineering, NIT Srinagar
[2]Associate Professor, Department of Chemical Engineering, NIT Srinagar
E-mail: [1]shakir_se2016@nitsri.net, [2]marather_nit@yahoo.com

Abstract—*Rapid population development and the resultant contamination of freshwater sources are expected to create water stress conditions on the world sooner rather than later. Adsorption procedure is a popular technique in decreasing the amount of contaminations that enter water bodies, and researchers are concentrating on improvement of activated carbons from cheap sources to supplant costly commercial activated carbons. Remediation of wastewater utilizing activated carbon from cheap sources is picking up consideration among researchers, in that capacity innovation diminishes the expense of activated carbon creation while decreasing the expense on biowaste disposal. An overview on AC is presented together with methods used to generate AC. The possible applications of AC and their future prospects are also discussed.*

1. INTRODUCTION

With the advances in science and technology, various chemicals and substances are currently being used to improve the quality of human daily life. Most industries dispose these chemicals in water bodies in an uncontrolled and unsafe manner thereby causing long term adverse effects on the aquatic life and human health. Since most pollutants from industrial processes are metal ions or recalcitrant organic molecules, their presence in water bodies make them unsuitable for drinking purposes as well as recreational activities. According to UN Water 2017, nearly 70% of the industrial waste in developing countries is discarded into water without treatment, and 90% of wastewater in these countries ended up in rivers, lakes and coastal zones thereby jeopardizing food security and access to safe drinking and bathing water. If no corrective actions are taken to curb water pollution, it is anticipated that two-thirds of the world population will suffer water stress conditions by 2025, where available freshwater sources fail to meet water demand due to poor quality (UNESCO, 2017). Therefore to prevent freshwater sources, various processes are designed to remove toxic pollutants from wastewater before its disposal in water bodies, including adsorption, membrane filtration, and electrochemical advanced oxidation methods. The most adopted of these methods is adsorption using activated carbons (ACs) as it has been developed and applied extensively due to several advantages, including easy operation and high removal efficiency. However, its widespread use is restricted due to high associated costs. To decrease treatment costs, attempts have been made to find inexpensive alternatives to commercial activated carbons (ACs) with adsorbents from waste materials. Both conventional (from agriculture and wood industry) and non-conventional (from municipal and industrial activities) wastes can be used to prepare AC, that can be applied in various treatment processes, namely to remove organic pollutants, dyes, volatile organic compounds, and heavy metals. Many studies have identified huge potential in production of adsorbents from biowaste, which is defined as waste material derived from living organisms or of organic origin, and capable of decomposing under anaerobic or aerobic conditions. Most of the biowastes studied are agricultural wastes (for example, rice husk).High carbon content in these materials makes them suitable for adsorbent production. In addition, conversion of these waste materials to absorbents adds commercial value to these products, which otherwise require extra cost for disposal.

2. SYNTHESIS OF ACS FROM BIOWASTE

For synthesis of ACs from biomass the sample is given pretreatment which includes crushing, drying (at 100 ^{o}C) and sieving to obtain small particles within a specific size range. This is followed by conversion to either biochar hydrochar. Biochar is obtained by carbonization of biomass in dry inert atmosphere (300-500 ^{o}C) which facilitates elimination of volatile matters and tars, while hydrochar is obtained by hydrothermal carbonization of biomass in which the biomass is mixed with water or reagent solution prior to carbonization. It is claimed that hydrothermal carbonization is more advantageous than conventional carbonization as the initial biomass drying step is not required. In addition, a lower temperature (180-250 ^{o}C) is used in such process, as the pressure from the steam present in the closed system acts as an extra driving force to convert the biomass to hydrochar. It is believed that subcritical water formed under such conditions degrade cellulose, hemicellulose and lignin in the biomass.

After carbonization of biomass, activation of carbonized material is required which is achieved by either physical or chemical activations. The physical activation includes carbonization and activation step whereby steam and carbon dioxide (CO2) are the most broadly used reagents, significantly influencing the porosity of the AC. On the other hand, chemical activation is achieved by addition of activating reagent (usually acid or base) to the biochar/hydrochar prior to heating, followed by washing to neutralizethe pH of AC formed. In short, evidence shows that chemical activation carbonized biomass produce ACs with higher adsorption performance, regardless to the type of biowaste used.

3. POTENTIAL USES ACS DERIVED FROM BIOWASTE

The absorptive ability and high surface area possessed by activated carbon ability makes it a significant constituent in many industries like petroleum, fertilizer plants, nuclear, pharmaceuticals, cosmetics etc. Also AC has been found to be a good porous material making it a very effective adsorbent of solutes from aqueous solutions. This was suggested to be due to the possession of large specific surface area. AC has also been extensively used for solvents recovery, separation of gases, dye removal from industrial wastewater and as a catalyst in the process of biodiesel production. Other applications are purification of drinking water, treatment of industrial effluents and the groundwater treatment. Adsorption of pesticides and nitrate from surface water can also be achieved by the use of AC.

4. CONCLUSIONS AND RECOMMENDATIONS FOR FURTHER STUDIES

Safe water has become a competitive resource in many parts of the world due to increasing population, prolonged droughts, climate change, and so forth. ACs have unique characteristics, for example, large surface areas that make them particularly attractive for water/wastewater treatment applications such as disinfection, adsorption, and membrane separations.ACs derived from biowaste is an adsorbent with high potential to replace commercial ACs in wastewater treatment, due to the low cost of the precursor. The review of the literature has shown that water/wastewater treatment using ACs derived from biowaste is a promising field for current and future research.

REFERENCES

[1] Abioyea, A.M., Ania, F.N., 2017. Advancement in the production of activated carbon from biomass using microwave heating. J. Teknol. 79 (3), 79-88

[2] FoE, 2004. Biowaste-towards a Friends of the Earth Position. *www.foe.co.uk/sites/default/files/downloads/biowaste_guide.pdf*

[3] Hassan, A.F., Elhadidy, H., 2017. Production of activated carbons from waste carpets and its application in methylene blue adsorption: kinetic and thermodynamic studies. J. Environ. Chem. Eng. 5 (1), 955-963.

[4] Jain, A., Balasubramanian, R., Srinivasan, M.P., 2016. Hydrothermal conversion of biomass waste to activated carbon with high porosity: a review. Chem. Eng. J. 283, 789-805.

[5] Sohaimi, K.S.A., Ngadi, N., Mat, H., Inuwa, I.M., Wong, S., 2017. Synthesis, characterization and application of textile sludge biochars for oil removal. J. Environ.Chem. Eng. 5 (2), 1415-1422.

[6] Selvaraju, G., Abu Bakar, N.K., 2017. Production of a new industrially viable green activated carbon from Artocarpus integer fruit processing waste and evaluationof its chemical, morphological and adsorption properties. J. Clean. Prod.141, 989-999.

[7] Singh, H., Chauhan, G., Jain, A.K., Sharma, S.K., 2017. Adsorptive potential of agricultural wastes for removal of dyes from aqueous solutions. J. Environ. Chem. Eng. 5 (1), 122-135.

[8] UN Water, 2017. Statistics. www.unwater.org/statistics/ru/. (Accessed 21 May 2017).Uner, O., Gecgel, U., Kolancilar, H., Bayrak, Y., 2017. Adsorptive removal of rhodamineB with activated carbon obtained from okra wastes. Chem. Eng. Commun. 204(7), 772-783.

[9] UNESCO, 2017. Facts and Figures-water Pollution Is on the Rise Glablly. www.unesco.org/new/en/natural-sciences/environment/water/wwap/facts-andfigures/all-facts wwdr3/fact-15-water-pollution/. (Accessed 21 May 2017).

[10] Van Tran, T., Bui, Q.T.P., Nguyen, T.D., Le, N.T.H., Bach, L.G., 2017. A comparative study on the removal efficiency of metal ions (Cu2+, Ni2+, and Pb2+) using sugarcanebagasse-derived ZnCl2-activated carbon by the response surface methodology.Adsorpt. Sci. Technol. 35 (1-2), 72-85.

[11] Wong, S., Lee, Y., Ngadi, N., Inuwa, I.M., Mohamed, N.B., 2017a. Synthesis of activatedcarbon from spent tea leaves for aspirin removal. Chin. J. Chem. Eng.*https://doi.org/10.1016/j.cjche.2017.11.004*.

[12] Wendimu, G., Zewge, F., Mulugeta, E., 2017. Aluminium-iron-amended activatedbamboo charcoal (AIAABC) for fluoride removal from aqueous solutions.J. Water Process Eng. 16, 123-131.

[13] Xue, Q., Li, J.S., Wang, P., Liu, L., Li, Z.Z., 2014. Removal of heavy metals from landfill leachate using municipal solid waste incineration fly ash as adsorbent. Clean. Soil, Air, Water 42 (11), 1626-1631.

[14] Zhou, N., Chen, H., Xi, J., Yao, D., Zhou, Z., Tian, Y., Lu, X., 2017. Biochars with excellent Pb(II) adsorption property produced from fresh and dehydrated banana peels via hydrothermal carbonization. Bioresour. Technol. 232, 204-210.

[15] Zubrik, A., Matik, M., Hredzak, S., Lovas, M., Dankova, Z., Kovacova, M., Briancin, J., 2017. Preparation of chemically activated carbon from waste biomass by single stage and two-stage pyrolysis. J. Clean. Prod. 143, 643-653.