Absorption Performance of Carbon Materials in Wastewater Industry: A Brief Study on Heavy Metal Removal

[1]Norli Abdullah, [1]Sharifah Bee Abd. Hamid, [2]Imran Syakir Mohamad

[1]Centre for Research in Nanotechnology and Catalysis (NANOCEN),
Institute of Postgraduate Studies, University of Malaya,
50603 Kuala Lumpur, Malaysia.

[2]Department of Thermal-Fluid, Faculty of Mechanical Engineering,
Universiti Teknikal Malaysia Melaka, Locked Bag 1752, Pejabat Pos Durian Tunggal,
76109 Durian Tunggal, Melaka, Malaysia.

INTRODUCTION

In Malaysia, the palm oil industry generates large amounts of palm oil waste and by-product. Some of the by-product is usually used as fuel to produce process steam or electricity in palm oil mills. However, a large portion of it is either burned in open air or dumped in areas near to the mill, which creates huge environmental and disposal problem. Therefore, this study was conducted to make palm kernel shell more valuable as a precursor for activated carbon production. Over the past 30 years, adsorption onto activated carbon has been successfully applied for treating municipal and industrial wastewater and drinking water. Successful removal of heavy metals from aqueous solutions using activated carbon has recently been demonstrated . Carbon adsorption is considered the best available technology for eliminating non-biodegradable and toxic organic compounds from aqueous solutions . Thus, activated carbon is considered the universal adsorbent because its inherent physical properties, large surface area, porous structure, high adsorption capacity and extensively reactive surface which make it extremely versatile . In this study, we investigate the absorption performance of carbon materials toward iron and nickel metals removal in wastewater industry. Perhaps, the research finding will further attract more researchers to use waste palm kernel shell activated carbon as a potential based for absorption media.

MATERIAL AND METHODOLOGY

Five different carbon materials with different morphology and chemical properties were used in this study. The description of the carbon materials are shown in . All the carbon materials were dried at 100°C for 2 hours prior to analysis. Industrial wastewater was collected from the outlet of an industry drain located in Kerteh, Terengganu. Wastewater were collected as per standard method (APHA) and transport immediately to the laboratory for analysis.

Sample	Description
AC1	Commercial palm kernel shell activated carbon
AC4	Treated activated carbon
CNF13	Carbon nanofiber (CNF) produced by catalytic decomposition of ethylene using nickel (Ni) based catalyst
CNF19	Carbon nanofiber (CNF) produced by catalytic decomposition of ethylene using iron (Fe) based catalyst
CNF-C	Vapor-grown carbon nanofibers purchased from Pyrograf Products Inc. (Ohio, USA)

Table : Description of the different carbon materials use in this study

The aliquots of wastewater were adjusted to pH1, pH4 and pH6. The validity of the proposed procedure was checked for nickel and iron content in certified reference materials using ICP-OES.

RESULT AND DISCUSSION

Scanning Electron Microscopy

Scanning Electron Microscopy (SEM) images of activated carbon are shown in . The as-received activated carbon was characterized to determine the surface morphology of the samples. The image show that the activated carbon consists of micropore form materials which very important for gases and chemical absorption.

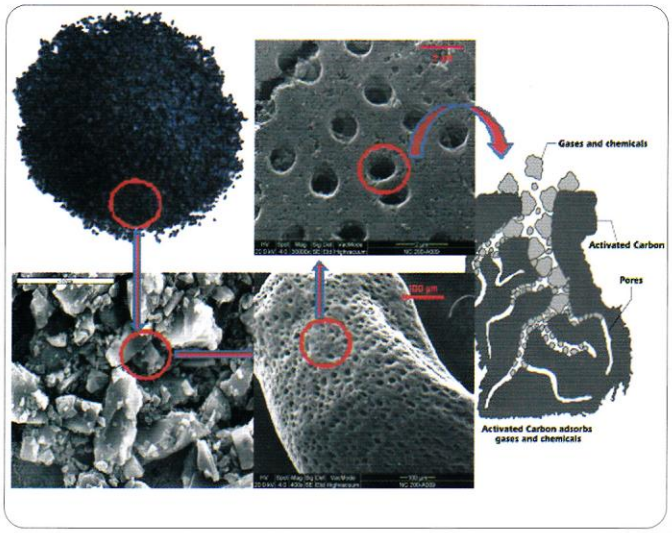

Figure : Scanning Electron Microscopy (SEM) image of the activated carbon

Adsorption Performance Analysis

All the carbon materials showed an excellent result for heavy metal (iron and nickel) removal. The adsorption isotherm increased drastically as the pH was increased from 4 to 6. Maximum adsorption uptake was achieved at pH6 as showed in . The effects of the pH attribute to interactions between ions in solution and complexes formed on the carbon surface. When the pH solution exceed the isoelectric point (IEP), Fe^{3+}/Ni^{2+} are attracted by the negative charges on the carbon surface, favoring the accumulation of the cation on the surface and thus promoting adsorption. At pH values below 6, the adsorption uptake was very weak due to the competition between Fe^{3+}/Ni^{2+} and H^{+} in the solution.

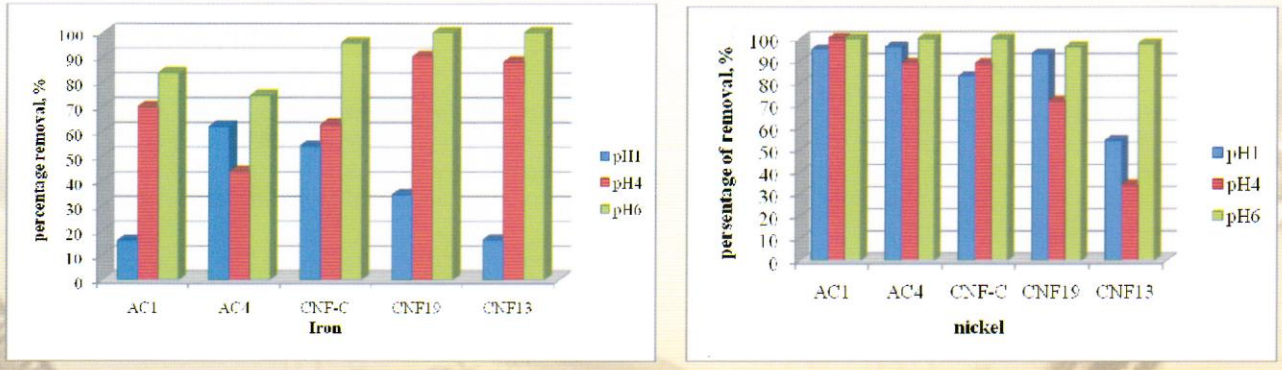

Figure : Adsorption of heavy metal in industrial wastewater using different carbon materials.

CONCLUSION

In this study, we investigate the absorption performance of carbon materials toward heavy metal removal in wastewater industry. SEM analysis confirmed that the carbon materials surface is in micropore form. This pore contributes to excellent properties of adsorption for heavy metals removal. Further investigation, we analyze the adsorption capability of selected carbon materials using ICP-OES. The results showed that all the carbon materials gave great adsorption towards iron and nickel metals. The adsorption capabilities of carbon materials increased with the increment of pH solution. This phenomenon is due to Fe^{3+}/Ni^{2+} that attracted by the negative charges on the carbon surface. This, resulting the accumulation of the cation on the carbon surface and thus promoting adsorption. Overall, this carbon materials exhibited high adsorption capacity and could be successfully applied in the industrial wastewater treatment technologies for heavy metals removal.

REFERENCES

[1] Leyva R. et.al (2002) "Adsorption of zinc(II) from an aqueous solution onto activated carbon" Journal of Hazardous Materials, B90, 27-38

[2] Michele R. S. et.al. (2008). "Potential method to improve the treatment efficiency of persistent contaminants in industrial wastewater" Journal of Hazardous Materials, 150, 438-445

[3] Bansode R.R. et.al. (2003) "Adsorption of volatile organic compounds by pecan shell and almond shell-based granular activated carbons". Bioresource Technology, 90,175-184