MORPHOLOGICAL STUDY ON IRRADIATED SAND AND ACTIVATED CARBON

Asyraf Arif Bin Abu Bakar[1], Anas Muhamad Pauzi[1], Abdul Aziz Mohamed[1], Faridah Mohamad Idris[2], Hafizal Yazid[3]

[1]*College of Engineering, Universiti Tenaga Nasional, 43000 Kajang, Selangor, Malaysia.*

[2]Reactor Technology Centre, Malaysian Nuclear Agency, Bangi, 43000 Kajang, Selangor, Malaysia.

[3]*Materials Technology Group, Malaysian Nuclear Agency, Bangi, 43000 Kajang, Selangor, Malaysia.*

e-mail: aasyraf@uniten.edu.my

ABSTRACT

Sand and activated carbon materials are frequently used in water filtration system. In fact, these common materials take a longer time to filter the water. As this study, to increase the effectiveness of filter materials, both materials were irradiated with neutron and gamma to induce the defect of materials. Early investigation was run by using scanning electron microscope to observe the morphology of materials. It is found that the irradiated sand with neutron shows number of pores with average pore diameter is 1.043µm compared to non-irradiated is 1.334 µm. Irradiated activated carbon with neutron and gamma shows increasing number of pores compared to non-irradiated and have average pore diameter is 0.7881µm and 1.429 µm respectively.

ABSTRAK

Sistem penapis air kebiasaannya menggunakan bahan seperti pasir dan karbon teraktif. Pada realitinya, kedua-dua bahan ini mengambil masa yang lama untuk menapis air. Kajian ini berperanan untuk memastikan penapisan air menggunakan bahan ini menjadi lebih efektif apabila didedahkan kepada sinaran neutron dan gamma. Kajian awal telah dijalankan dengan menggunakan mikroskop electron pengimbas untuk melihat struktur permukaan bahan yang telah rosak akinat terdedah kepada sinaran radiasi. Hasilnya, pasir yang telah didedahkan dengan radiasi neutron menunjukkan beberapa pori di permukaan dengan purata diameter pori adalah 1.043µm berbanding dengan pasir yang tidak didedahkan kepada radiasi adalah 1.334 µm. Karbon diaktif yang telah terdedah dengan sinaran neutron dan gamma pula menunjukkan peningkatan bilangan pori berbanding dengan karbon teraktif yang tidak terdedah dengan sinaran radiasi dengan masing-masing mempunyai purata diameter pori adalah 0.7881µm dan 1.429 µm

Keywords: scanning electron microscope, sand, activated carbon

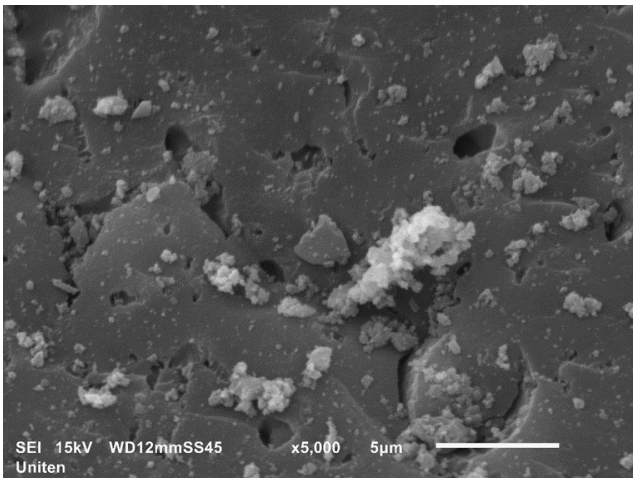
INTRODUCTION

Gamma and neutron irradiation effect on sand and activated carbon had been studied intensively. Various studies suggest that there is a strong correlation between the neutron fluence or the gamma energy and their subsequent effect on the physical and mechanical damage on materials. This research was carried out to study the effect of irradiation on sand and activated carbon, when irradiated with neutron and gamma radiation. For neutron irradiation, the source used was neutron beam of Reactor TRIGA Puspati (RTP) core and gamma-rays the source was Cobalt-60 of Sinagama facility in Malaysia Nuclear Agency (Nuclear Malaysia). The study was also focusing on the morphological analysis on the irradiated materials by using the scanning electron microscope (SEM). For irradiated of activated carbon material, the increment number of pores were observed for both neutron and gamma. For sand, there was no significant change in textural profile of the surface for neutron irradiated, while for gamma irradiated sand the changes were observed.

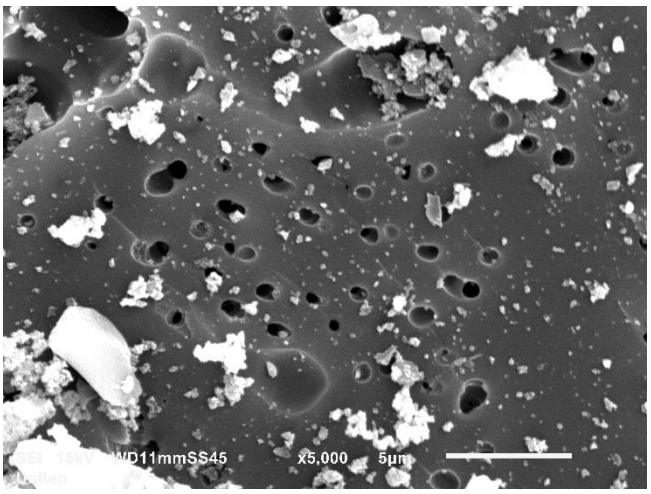
RESULTS AND DISCUSSION

The surface morphology of the non-irradiated and irradiated by gamma and neutron was evaluated through scanning electron microscope (SEM) to confirm the effect of gamma and neutron treatment on the sand and activated carbon. Figure 1 shows the SEM images of the non-irradiated activated carbon, gamma activated carbon, and neutron activated carbon in 5000× magnification. These images show the changes on their surface structure after irradiation. It can be observed that there were many pores formed on them. This was due to the ability of gamma-rays and neutrons to cause atomic displacement [1]. They interacted with carbon nucleus mainly through Compton scattering and absorption. The recoiled electrons with sufficiently high energy from the Compton scattering would collide with neighbouring carbon nuclei, shifting them from their lattice position. Then, the knocked-on atoms would continue to collide their neighbour atoms, transferring energy. If the energy exceeded the threshold of further interactions and displacements, it would result in cascading damage [2].

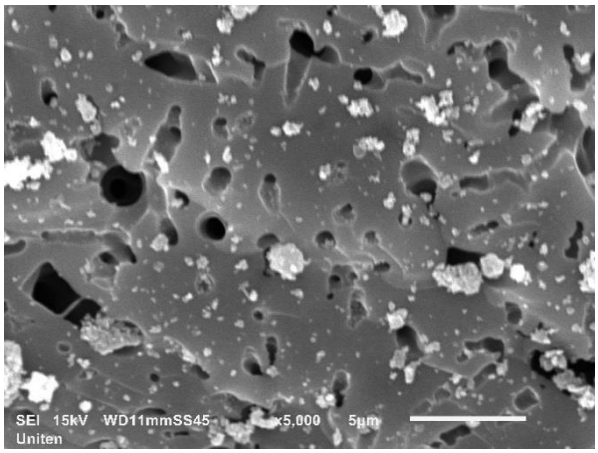
The average size of pores was taken using dimension tools provided by the SEM where pores were chosen at random. The neutron-radiated activated carbon had small average pore diameter of 0.7881 μm. Meanwhile, the non-irradiated activated carbon and gamma-radiated activated carbon showed no significant difference in average pore diameter which were 1.429 μm and 1.603 μm respectively.



(a)



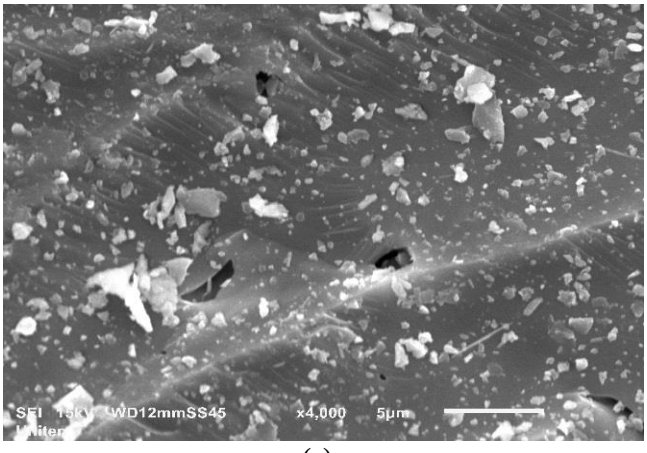
(b)



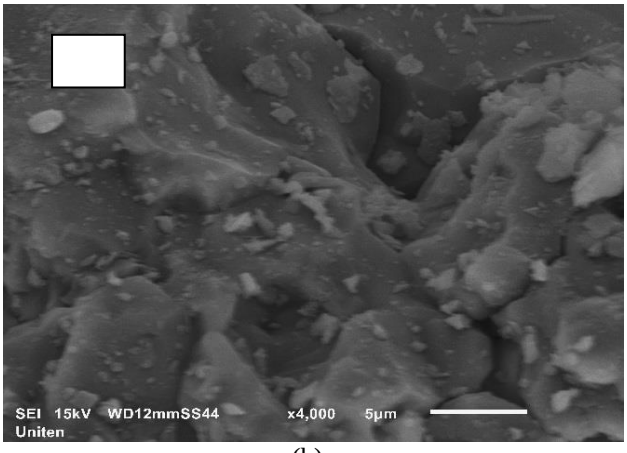
(c)

Figure 1. SEM image at (×5000) magnification of: (a) non-irradiated activated carbon, (b) irradiated activated carbon with 50kGy gamma dose, (c) irradiated activated carbon with 2.000×10^{12} cm^{-2} s^{-1} neutron flux

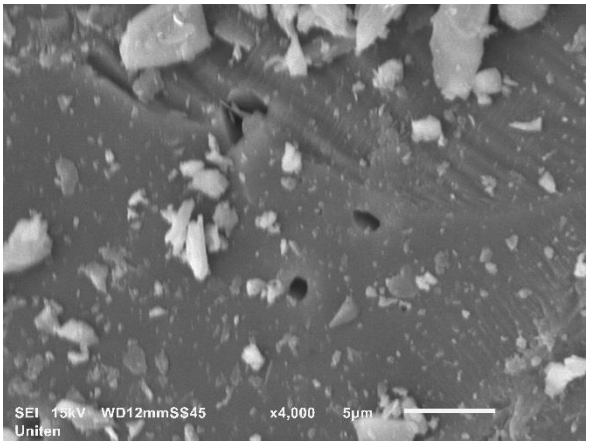
Figure 2 shows the SEM images of non-irradiated and irradiated sand at 4000× magnification. Generally, the pattern in behaviour sand (mainly build-up from quartz) has a particle shape with higher sphericity index and lower internal porosity [3]. The SEM image for gamma-radiated sand in Figure 4.2(b) shows the change in textural profile of its surface resulting valley and hill areas as compared to the non-irradiated sand in Figure 4.2(a) and the neutron-radiated sand in Figure 4.2(c). Pores were only visible on the surface of the non-irradiated sand and the neutron-radiated sand where their average size was 1.334 µm and 1.043 µm respectively. The change in topography of the surface and the small average size of pores prove that irradiation of neutron and gamma-ray can induce micropores or defects in the materials [4, 5].



(a)



(b)



(c)

Figure 1. SEM image at (×4000) magnification of: (a) non-irradiated sand, (b) irradiated sand with 50 kGy gamma dose, (c) irradiated sand with 2.000×10^{12} cm^{-2} s^{-1} neutron flux

Based on the discussion above, the neutron-radiated activated carbon had the smallest average pore size of 0.7881 μm. This might contribute to the highest capability of filtration as the small pores could trap foreign and contaminated substances in the water.

CONCLUSION

The observation from SEM image was found that irradiated sand and activated carbon with neutron were introduced increasing small number of pores meanwhile irradiated sand with gamma does not shows any pores. The changes were happened towards it textural profile of the surface difference form the non-irradiated and irradiated with sand.

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