ABSTRACT

The productions of nanoparticles in nanotechnology industries keep increasing as the demands increase each year due to its unique properties of nanoparticles that can be fully utilized. Zinc oxide (ZnO) nanoparticles is one of the examples that has attracted scientists to produce in larger scales production especially in the consumer products. Without realizing the consequences, ZnO nanoparticles will be released into the environment in various ways either directly or indirectly. Once released, ZnO nanoparticles may be dissociated into Zn^{2+} ions which is toxic to the environment and eventually effects on human health. In this study, two commercially available zinc oxide (ZnO) nanoparticles of size 50 nm and 100 nm were purchased and characterized using X-ray diffraction (XRD), transmission electron microscopy (TEM), surface area Brunauer-Emmet-Teller (BET) and Fourier transform infrared (FTIR) spectroscopy. The transformation of ZnO nanoparticles under environmental relevant conditions were also studied. Water chemistry such as pH and ionic strength play important roles in the release of Zn^{2+} ions. The presence of humic acid and exposure to sunlight could also affect the dissolution of ZnO nanoparticles. XRD and TEM confirmed that the size of the particles was in the range stated at the labels. The dissolutions were measured using inductively coupled plasma optical emission spectroscopy (ICP-OES). It was found that the dissolution of ZnO nanoparticles is higher at pH 1 and decreased as the pH increased to pH 11. Dissolution of ZnO nanoparticles also showed pH dependency whereby for both sizes, the dissolution increased when pH decreased. This study also indicates that the fate of ZnO nanoparticles is highly dependent on water chemistry. At higher pH, dissolution of ZnO was limited by solubility equilibrium, because of the negative charge of humic acid, it alters the surface charge of

ZnO nanoparticles, attracts them and preventing the particles to aggregates and precipitate. In the presence of humic acid also slowed down the release of Zn^{2+} ions in aquatic environment. The adsorption of humic acid onto ZnO nanoparticles is observed to follow Langmuir isotherm. Exposure to sunlight encouraged the dissolution of ZnO nanoparticles.

Keywords: Zinc oxide nanoparticles, dissolution, sunlight, humic acid, pH, ionic strength

Transformasi Nanopartikel Zink Oksida di bawah Pengaruh Keadaan Persekitaran yang Berkaitan

ABSTRAK

Permintaan daripada industri nanoteknologi semakin meningkat saban tahun. Bilangan penggunaan nanopartikel ZnO dalam produk pengguna juga semakin meningkat pesat disebabkan oleh ciri-ciri yang unik dan menarik minat para saintis untuk menghasilkan lebih banyak pengeluaran berskala besar. Akhirnya, nanopartikel ZnO akan dilepaskan ke alam sekitar dalam pelbagai cara. Setelah dibebaskan, nanopartikel ZnO akan memisahkan ion Zn^{2+} yang berbahaya kepada alam sekitar dan menjejaskan kesihatan manusia. Kimia air seperti kekuatan pH dan ionik memainkan peranan penting dalam pembebasan ion Zn^{2+}. Kehadiran asid humik dan pendedahan kepada cahaya matahari juga boleh menjejaskan disolusi nanopartikel ZnO. Dalam kajian ini, dua nanopartikel zink oksida (ZnO) bersaiz 50 nm dan 100 nm telah dibeli dan dicirikan dengan menggunakan XRD, mikroskop elektron tranmisi (TEM), kawasan permukaan Brunauer-Emmet-Teller (BET) dan spektroskopi Fourier transform inframerah (FTIR). XRD dan TEM mengesahkan bahawa saiz zarah berada di julat yang dinyatakan pada label. Disolusi telah diukur menggunakan spektroskopi pelepasan optik plasma yang digabungkan secara induktif (ICP-OES). Didapati bahawa disolusi lebih tinggi pada pH 1 dan menurun apabila pH meningkat ke pH 11. Disolusi nanopartikel ZnO juga menunjukkan kebergantungan pH di mana untuk kedua-dua saiz, disolusi meningkat apabila pH menurun. Kajian ini juga menunjukkan bahawa nanopartikel ZnO bergantung kepada kimia air. Pada pH tinggi, disolusi ZnO adalah terhad oleh keseimbangan kelarutan. Kerana caj negatif asid humik mengubah cas permukaan nanopartikel ZnO,

menariknya dan menghalang zarah-zarah untuk mengagregat dan diendapkan. Kehadiran asid humik juga melambatkan pembebasan ion Zn^{2+} *dalam persekitaran akuatik. Pendedahan kepada cahaya matahari menggalakkan penyebaran nanopartikel ZnO. Penjerapan asid humik ke nanopartikel ZnO mengikuti isoterm Langmuir.*

Kata kunci: *Nanopartikel zink oksida, disolusi, cahaya matahari, asid humik, pH, kekuatan ion*