PREPARATION AND CHARACTERISATION OF POLY (VINYL ALCOHOL)/CHITOSAN/SILICON DIOXIDE (PVA/CS/SiO_2) BEADS FOR THE CHROMIUM (VI) (Cr (VI)) REMOVAL

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Especially dedicated to the beloved one:

For my Abah and Ma,
Haji Sulaiman bin Dollah and Hajah Noriza binti Yusof,
There's no love and sacrifices like yours,
And nobody can replace both of you,
And yet not even a single word can be expressed to thank all of your kindness towards me,

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Thanks for all your encouragement, advices and guidance,
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For my true love,
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With Allah's will, your love and supports make me strong and move forwards,
Thanks for all your times, sacrifices, kindness and your sincere help,
I'm so glad that I have you…

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You all are the most beautiful flower in my garden friendship,
Remain the same forever…

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ABSTRACT

Chromium pollution has become a global issue and many techniques have been developed for the removal of Chromium (VI) (Cr(VI)) from wastewater. In this study, blend polymer absorbent beads which was poly (vinyl alcohol)/chitosan/silicon dioxide (PVA/CS/SiO_2) beads were prepared by dropwise method by crosslinking with sodium hydroxide and ethanol and further crosslinked with glutraldehyde for the purpose of Cr(VI) ion removal in aqueous solution under UV irradiation. All of the samples of PVA/CS/SiO_2 beads were put under UV irradiation for two hours in the high acidic medium of Cr(VI) solution. After that, the Cr solution was analysed by atomic absorption spectroscopy (AAS), and the beads have been characterised by scanning electron microscopy (SEM), energy dispersive x-ray spectroscopy (EDX) and fourier transform infrared spectroscopy (FTIR) analysis. pH value for each sample before and after the absorption test also has been measured. As a result, the data obtained by AAS showed that the Cr(VI) solution of PVA/CS/SiO_2 beads of PCS 25 recorded the most percentage of Cr(VI) absorption which was 99.9% meanwhile PCS 1 recorded the less percentage of Cr(VI) absorption which was 93.4%. Beads morphology images showed that all of the 25 samples of PVA/CS/SiO_2 beads revealed macro and micro pores on the surface of beads before the Cr(VI) absorption and the pore size increased with the increment of CS and SiO_2 concentration. The pores for all of the sample beads before the Cr absorption can be clearly seen. However, the surface of beads became smooth after Cr(VI) absorption, indicating that the pores on the surface were filled up with Cr. This change was further supported by EDX analysis which provided the existence of Cr peaks as the direct evidence. Whereas, FTIR results showed small shifts in wavelength at several peaks before and after the Cr absorption for each sample indicated that there was metal binding process taking place at the surface of the beads. The results of pH value of Cr after the absorption test showed that PCS 1 recorded the lowest pH value which was 5.81 and PCS 25 recorded the highest pH value which was 6.08. As for the conclusion, PCS 25 has been chosen as the best absorbent with the highest Cr absorption and the results suggested that, the use of PVA/CS/SiO_2 beads is a sustainable strategy for eliminating Cr(VI) from industrial wastewater.

ABSTRAK

Pencemaran kromium telah menjadi isu global dan banyak kaedah telah dimajukan untuk penyingkiran kromium (VI) (Kr(VI)) dari air buangan. Dalam kajian ini, manik penyerap polimer kisaran iaitu manik polivinil alkohol/citosan/silikon dioksida (PVA/CS/SiO_2) telah dihasilkan melalui kaedah bertitisan dengan sambungan silang oleh natrium hidroksida dengan etanol dan sambungan silang selanjutnya dengan glutaraldehid bagi tujuan penyingkiran ion Kr(VI) di dalam larutan akuas di bawah sinaran UV. Kesemua sampel manik PVA/CS/SiO_2 diletakkan di bawah sinaran UV selama dua jam di dalam larutan Kr(VI) yang bermedium asid tinggi. Selepas itu, larutan Kr telah dianalisis oleh kespktroskopan penyerapan atom (AAS), manakala manik PVA/CS/SiO_2 telah diperincikan dengan miroskopi electron penskanan (SEM), spektroskopi penyebaran tenaga x-ray (EDX) dan spektroskopi inframerah transformasi fourier (FTIR). Nilai pH untuk kesemua sampel sebelum dan selepas ujikaji penyerapan juga telah diukur. Hasilnya, data yang telah diperolehi melalui AAS telah menunjukkan bahawa larutan Kr(VI) oleh manik PVA/CS/SiO_2 untuk PCS 25 telah mencatatkan peratusan penyerapan Kr(VI) yang tertinggi dengan 99.9%, manakala PCS 1 mencatatkan peratusan penyerapan Kr(VI) yang terendah dengan 93.4%. Imej morfologi pula telah menunjukkan kesemua 25 sampel manik PVA/CS/SiO_2 mendedahkan liang-liang makro dan mikro pada permukaan manik PVA/CS/SiO_2 sebelum penyerapan Kr(VI) dan saiz liang bertambah dengan pertambahan kepekatan CS dan SiO_2. Liang-liang untuk kesemua sampel manik sebelum penyerapan Kr boleh dilihat dengan jelas. Namun begitu, permukaan manik ini kelihatan licin selepas penyerapan Kr(VI), menunjukkan bahawa permukaan ini telah terisi dengan Kr. Perubahan ini telah dikukuhkan lagi dengan analisis EDX yang menunjukkan kewujudan puncak Kr sebagai bukti. Sementara itu, hasil keputusan FTIR pula telah menunjukkan beberapa anjakan kecil pada panjang gelombang di beberapa puncak sebelum dan selepas penyerapan Kr bagi setiap sampel menunujukkan bahawa terdapat proses pengikatan logam yang mengambil tempat pada permukaan manik. Hasil keputusan nilai pH pada Kr selepas ujikaji penyerapan pula telah menunjukkan PCS 1 mencatatkan nilai pH yang terendah iaitu 5.81 manakala PCS 25 pula mencatatkan nilai pH yang tertinggi iaitu 6.08. Kesimpulannya, PCS 25 telah dipilih sebagai penyerap terbaik dengan penyerapan Kr yang tertinggi dan hasil kajian mencadangkan bahawa penggunaan manik PVA/CS/SiO_2 adalah satu langkah lestari untuk menyingkirkan Kr(VI) daripada air buangan industri.

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