SYNTHESIS AND CHARACTERIZATION OF SUPERPOROUS HYDROGELS BY USING GAS BLOWING METHOD

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SUPERVISOR'S DECLARATION

I hereby declare that I have checked this thesis and in my opinion, this thesis is adequate in terms of scope and quality for the award of the degree of Master of Science.

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I hereby declare that the work in this thesis is based on my original work except for quotations and citations which have been duly acknowledged. I also declare that it has not been previously or concurrently submitted for any other degree at Universiti Malaysia Pahang or any other institutions.

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ABSTRAK

Hydrogel superporous (SPH) adalah rangkaian tiga dimensi polimer hidrofili yang menyerap sejumlah besar air dalam jangka masa yang sangat pendek kerana adanya pori mikroskopik yang saling berkaitan. Penemuan hydrogel superporous dibuat untuk pengubahsuaian polimer superabsorbent (SAP) kerana sifat pengembangan yang perlahan. SAP sekarang mengandungi struktur yang kurang berpori, sehingga menghasilkan sifat pengembangan yang perlahan. Kadar pengembangan kebanyakan SAP biasanya rendah dan memerlukan masa yang lebih lama untuk mencapai keseimbangan kerana keupayaan penyerapan air yang perlahan. Kekurangan ini seterusnya membatasi kemungkinan penggunaan hydrogel untuk digunakan di berbagai bidang, termasuk sebagai bahan penyampaian ubat dan sebagai perapi tanah dalam pertanian. Oleh itu, terdapat minat yang besar dalam mengembangkan kaedah sintesis dan pemilihan bahan dalam penyediaan SPH yang dapat menghasilkan sifat penyerapan pembengkakan yang cepat. Dalam kajian ini, SPH dibuat dari monomer acrylamide (AM) dan co-monomer acrylic acid (AA) dengan menggunakan kaedah peniupan gas dengan ammonium persulphate (APS) sebagai pemula dan N'N'-methylenebisacrylamide (MBA) sebagai agen penyambung silang. Kesan kepekatan natrium bikarbonat ($NaHCO_3$) (0 wt% - 5 wt%) sebagai agen pembuih, asid asetik (0 wt% - 5 wt%) sebagai agen bantu buih dan Span 80 (0 wt% - 7.5 wt%) sebagai busa penstabil dikaji dengan menentukan penyerapan air, morfologi (SEM), kekuatan mampatan, kumpulan fungsional (FTIR), kestabilan terma (TGA) dan kinetik pengembangan SPH. Berdasarkan hasil optimum, ini menunjukkan bahawa kesan agen pembuih ($NaHCO_3$) optimum pada kadar 4% berat (178 g / g) sementara kesan bantuan pembuih optimum pada kadar 0% berat kerana penambahan asid asetik tidak mempunyai perbezaan yang signifikan dengan 0% berat. kemudian, kesan penstabil berbuih (Span 80) mengoptimumkan pada 4.5 wt% di mana ia memberikan penyerapan air tertinggi pada 206 g / g. Faktor yang menyumbang kepada penyerapan air yang tinggi terutama disebabkan oleh pembentukan pelbagai ukuran liang dalam struktur SPH yang memungkinkan penembusan air yang dicirikan oleh SEM. Berdasarkan hasil morfologi, Span 80 SPHs 4.5 wt% akhir menghasilkan penyerapan air yang lebih tinggi kerana terdapat banyak liang dengan ukuran yang seragam dalam struktur SPHs. Kemudian, kadar pengembangan juga menyokong kesan penstabil berbuih kerana Span 80 4.5 wt% berat memberikan penyerapan air yang lebih tinggi pada waktu yang lebih pendek. Terakhir, hasil kinetik pembengkakan menunjukkan bahawa SPH mematuhi urutan kedua dengan nilai keresapan, *n* kurang dari 0.5 seperti yang menunjukkan bahawa ia mengikuti undang-undang Fick. Sebagai kesimpulan, SPH yang disiapkan dengan teknik meniup gas memberikan prestasi pembentukan liang yang lebih baik pada hidrogel yang terlalu besar.

ABSTRACT

Superporous hydrogels (SPHs) is a three-dimensional network of a hydrophilic polymer that absorbs a large amount of water in a very short period due to the presence of interconnected microscopic pores. The invention of superporous hydrogels is made up for modification of superabsorbent polymers (SAPs) due to the slow swelling properties. The present SAP contains less porous structure, thus produced slow swelling properties of the SAPs. The swelling rate of most SAPs is typically low and takes a longer time to reach equilibrium due to the slow water absorption capability. This disadvantage further limits the possible application of the hydrogel to be utilized in various fields, including as drug delivery material and as soil conditioner in agriculture. Therefore, there is a significant interest in developing synthesis methods and the selection of material in preparation of the SPH that can produce fast swelling absorption properties. In this study, SPHs were prepared from monomer of acrylamide (AM) and co-monomer acrylic acid (AA) by using gas blowing method with ammonium persulphate (APS) as an initiator and N'N'-methylenebisacrylamide (MBA) as cross linker. The effects of sodium bicarbonate ($NaHCO_3$) concentration (0 wt% - 5 wt%) as foaming agent, acetic acid (0 wt% - 5 wt%) as foaming aid and Span 80 (0 wt% - 7.5 wt%) as foam stabilizer were studied by determined the water absorbency, morphology (SEM), compression strength, functional group (FTIR), thermal stability (TGA) and swelling kinetics of SPHs. Based on the optimum results, it shows that effect of foaming agent ($NaHCO_3$) optimum at 4 wt% (178g/g) while effect of foaming aid optimum at 0 wt% as the addition of acetic acid has no significant difference with 0 wt%. then, the effect of foaming stabilizer (Span 80) optimize at 4.5 wt% where it gives the highest water absorbency at 206 g/g. The factor that contributed to the high water absorbency is mainly due to the formation of various sizes of pores in the structures of SPHs which allow the penetration of water which characterized by SEM. Based on the morphology results, the final 4.5 wt% Span 80 SPHs produce higher water absorbency due to present of many pore with uniform size in the SPHs structures. Then, the swelling rate also supports the foaming stabilizers effect as the 4.5 wt% Span 80 gives the higher water absorbency at shorter time. Lastly, the swelling kinetics results show that the SPHs obeyed the second order with diffusivity value, n is less than 0.5 as indicates that it follows the Fick's Law. As a conclusion, SPHs prepared by gas blowing technique gave better performance of pore formation on superporous hydrogels.

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