Preparation of radiation crosslinked superabsorbent hydrogel using carboxymethylcellulose

by

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DEDICATION

I dedicate this thesis to my parents, husband, brother, teachers and all my family members who helped me in my academic achievements.

"The work described in this thesis was carried out by me under the supervision of Mr.J.T.S Lal Motha and a report on this has not been submitted in whole or in part to any University or any other institution for another Degree or Diploma".

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"I certify that the above statement made by the candidate is true and that this thesis is suitable for submission to the university for the purpose of evaluation".

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LIST OF ABBREVIATIONS

AAc :Acrylic acid

CMC : Carboxymethylcellulose

Carboxymethylchitin

CMCTS : Carboxymethylchitosan

CMS : Carboxymethylstrach

cP :centi poise

DS : Degree of Substitution

FT-IR : Furere Transmission Infra Red

γ : gamma

Gf% : Gel fraction

Wi : Initial weight of dried gel

LDPE : Low density polyethylene

MAA : Methacrylic acid

PEO : Polyethylene oxide

PEG : Polyethylene glycol

PVA : Polyvinyl alcohol

PVP : Polyvinylpyrrolidone

$KMnO_4$: Potassium permanganate

SEM: Scanning Electron Microscopy

SR : Swelling Ratio

Ws : Swollen weight

Temp : Temperature

Wd : Weight of the insoluble gel

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ABSTRACT

Radiation crosslinking of Carboxymethylcellulose (CMC) with a Degree of Substitution (DS) of 0.76 and 0.9 was the subject of the investigation. This radiation crosslinked CMC can be used as a substitute for conventional hydrogels. CMC was irradiated in solid state and aqueous solutions at various irradiation doses. DS and the concentration of the aqueous solution had a remarkable effect on the crosslinking of CMC. Irradiation of CMC in solid state and low concentrated aqueous solution has low crosslinking whereas 20% CMC gave the highest gel fraction. CMC with a DS of 0.9 caused for higher crosslinking than that with DS of 0.76 with the same concentration.

It was apparent that high DS and high concentration in an aqueous solution were favorable for high crosslinking of CMC. It is assumed that high radiation crosslinking of CMC was induced by the increase mobility of its molecules in water and by the formation of CMC radicals from the abstraction of hydrogen atoms from macromolecules in the intermediate products of water radiolysis.

The effect of various parameters such as concentration of different inorganic salts , pH , swelling temperature , swelling time on the swelling ratio in water were investigated in detail. 0.9 CMC hydrogel swelled by 120g of water per gram of dry gel at 60kGy applied dose and 0.76 by 110g of water per gram of dry gel. Swelling tests of CMC hydrogels in salt concentrations and media of various pHs showed that swelling values decreased with the increase of salt concentration and was high at the neutral pH media . Radiation crosslinked Na-CMC showed good water absorption below 50^0C,

whereas it became solution when heated more than 60^0C .Equilibrium swelling time of the Na-CMC was also investigated by a kinetic study and the equilibrium swelling was reached after 16 hours.

The effect of the sealing condition on crosslinking of CMC was investigated. Vaccum sealed CMC samples showed higher swelling values and gel fraction than that of the samples sealed by polythene sealer. Irradiation of CMC even in 5%,10% aqueous solution and solid state resulted in degradation, hence viscosity decreases. More concentrated solution of 20% CMC was taken high viscosity due to the crosslinking by radiation.

FTIR spectra revealed, radiation crosslinking reaction of CMC occurred in side chains of CMC molecules due to the presence of –OH, $-CH_2$ and R-O- CH_2-COO^- whereas radical formed in –CH-O-CH- of main chain of CMC molecule lead easily to the chain scission. Scanning electron micrographs show highly porous structure of the gel.Therefore large amount of water will absorb to them and retain even under pressure.