Available online at <u>www.pelagiaresearchlibrary.com</u>



Pelagia Research Library

Der Chemica Sinica, 2015, 6(5):23-27



Effect of gamma radiation on the cohesive properties of carboxymethylcellulose sodium in dilute aqueous salt solution

Gibrel S. El Diabani^{*} and Muna A. A. Lateef^{**}

^{*}Department of Chemistry, College of Art and Science, Omar AL Mukhtar University, Darna, Libya ^{**}Department of Radiology, Faculty of Medical Technology, Darna, Libya

ABSTRACT

The radiative degradation curve of carmellose sodium (CMC sodium) in aqueous solution has been reported. Both densities and viscosities of aqueous (CMC sodium) in moderate concentrations irradiate. Gamma irradiation of (CMC sodium) decreased the value of density, specific viscosities molar mass and hydrodynamic volume of CMC sodium in solution. It also increases the value of Schulz-Blaschke constant, solute-solvent interaction and decreases the Solute-solute constant in the solution of degradable CMC sodium.

Keywords: Gamma radiation, cohesive properties, CMC sodium, salt solution

INTRODUCTION

Carboxymethylcellulose sodium (CMC sodium) which its structure is shown below, is widely used in oral and topical pharmaceutical formulations primarily for its viscosity increasing properties, viscous aqueous solution are used to suspend powders intended for either topical or oral parenteral administration⁽¹⁾, carboxymethylcellulose sodium (CMC sodium) may also be used as a tablet binder and disintegrant⁽²⁻⁴⁾ and to stabilize emulsions⁽⁵⁾.



It is also used in cosmetics toiletries and food products. Because of its wide spectra of applications and degradations, polymeric CMC sodium and in particular in water – soluble compounds could provide a major attention for research in this field $^{(6)}$. Relevant interest also includes the development of radiation –sterilizable suspension of such products.

Carboxymethylcellulose sodium (CMC sodium) however, undergoes substantial radiative degradation due to the presence of the aliphatic carboxyl ether linkage in their repeat units. Such developments will therefore, be a major breakthrough, since most of these polymeric products are sterilized by ethylene Oxide (7).

In our present investigation, we report the effect of Gamma irradiation on structure - viscous behavior relationship of moderate dilute CMC sodium aqueous solution in terms of density, viscosity and related parameters.

MATERIALS AND METHODS

The CMC sodium is referred to carboxymethylcellulose sodium (Carmellose Sodium) and it is used as powder material of USP grade was supplied by a Libyan Co. (JOWF) double distilled water was used to make 10 equal volumes of CMC sodium solution of 10 kg/m³ concentration for non degradable and find degradable samples of CMC sodium, Mo and My respectively. The measurements were performed as described by Kulicke ⁽⁸⁾. The accuracy of the density and viscosity measurements was 0.01% and 0.015% respectively. Ten samples of prepared solution were irradiated in air at room temperature by a Canadian Cobalt- 60 Gamma Source located in Darna Hospital. Each sample was exposed to radiation at constant dose rate of 115 Rad \min. for different periods of time. Monitoring the change in each sample was made immediately after irradiation and at intervals afterwards for the samples with finite degradable changes, by using the viscometric technique⁽⁸⁾.

RESULTS AND DISCUSSION

The measured and calculated results are given in table 1 and figs. 1, 2, 3 and 4. The variation in efflux time of CMC sodium solution with the exposure time of irradiation is shown in fig.1 which demonstrates the progress of gamma session on the polymer chain ⁽⁷⁾. The degradation curve suggests the irradiation had a very marked session – in effect up to 180 min, whereas no more effect is observed after such exposure time.

Figs.2 and 3 show typical plots of density (ρ) and specific viscosity (η sp) values against mass concentration (C ρ), respectively; all being increasing over the moderate concentration range involved. On the other hand, the rate of increment in these values after irradiation is less than those before irradiation. unlike the behavior of simple liquid, the normal linear plots of density before and after irradiation of CMC sodium in water as shown in fig. 2 reflect the action of physical entanglement of the polymer⁽⁹⁾, while the exponential increase in viscosity values before and after gamma degradation demonstrate such action in dilute and semi dilute concentration domains of aqueous CMC sodium⁽¹⁰⁾. fig.3

Schulz – Blaschke equation ⁽¹¹⁾:

$$(\eta \text{sp }/\text{C}\rho) = [\eta] + \text{ksb } [\eta] \eta \text{sp};$$

While values of the relative average viscosity molar mass, (MV)r, and hydrodynamic volume Vh, Table 1 were calculated according to the following form of Mark –Houwink⁽⁸⁾ equation:

$[\eta] = 9.53 \text{ x} 10^{-6} \text{kg}^{-1} \text{m}^3 \text{x} < \text{MV} > r^{0.87}$	(2)
$Vh=(2 / 5) [\eta] < Mv > /NA$	(3)

Respectively.

Where <Mv> is the average viscosity molar mass and NA is Avogadro's constant. The calculated results show that intrinsic viscosity, molar mass and hydrodynamic volume of CMC sodium in water is greater than those of irradiated one. This could be attributed to the marked session effect on the polymer chain ⁽⁷⁾. Further more consideration of results in table 1 indicates the polymer in water has a more extended configuration than the degradable one due to the greater solute solvent interaction ⁽¹⁰⁾.

Pelagia Research Library

(1)

Table 1. Intrinsic viscosity and related parameters of CMC sodium in water before and after γ -irradiation at 25 $^{\circ}$ C

Sample	[η]/ 10 ⁻³ m ³ kg ⁻¹	Ksb/10 ⁻³	<mv>r</mv>	Vh/10 ⁻²⁰ m ³
Mo	6453.02	14.04	5025321.5	5.34
Mγ	1686.51	31.28	1077333.92	0.25

This would be in accord with high value of Schulz- Blaschke constant of degradable CMC sodium, compared with non-degradable one, Table 1. Indeed, ksb is an index of Huggions interaction coefficient and accordingly reflects how far the viscosity of the system increase with increase of polymer concentration, which is due to the interaction of neighboring chains⁽⁸⁾. Thus for CMC sodium in water, and the solute-solute contracts are greater than for degradable one. Consequently, for irradiated CMC sodium, the solute – solvent interactions are greater than the non – irradiated one. This explains that CMC sodium in water undergoes chain session when exposed to gamma radiation in air. The period of exposure time has considerable influence on the amount of session and consequently on the length of CMC sodium in water. Characterization of density and viscosity of the polymer in moderate concentration domain before and after gamma irradiation reveals the fact that irradiation of CMC sodium induces degradation, which in turn decreased the mass, size, extension configuration, solute –solute contact and increases the solute –solvent interpretation.



Fig.1 Efflux time changes of CMC sodium in water with exposure time before and after γ -irradiation at 25 0 C





Fig. 2 Linear increase of density with increasing concentration of CMC sodium in water before and after γ - irradiation at 25 0 C



Fig. 3 linear increase of specific viscosity with increasing concentration of CMC sodium in water before and after γ -irradiation at 25 ^{0}C



Fig.4 linear increase of reduced viscosity with increasing specific viscosity of CMC sodium in water before and after γ -irradiation at 25 ^{0}C

REFERENCES

[1] M.A. Hussain, B.J. Aungst, M.B. Mauria, Drug Der Ind Pharm 1991, 17, 67.

[2] K. A. Khan, C. T. Rhodes, Pharm Acta Helv., 1975, 50, 99.

[3] N. H. Shah, J. H. Lazarus, P.R. Sheth, J. Pharm Sci., 1981, 70, 611.

[4] J. Singh, Drug Der Ind Pharm 1992,18, 375.

[5] K.P Oza, S.G Frank , J. pharm. Sci 1975, 64,447.

[6] E. Reichmanis, C.W Frank, J.H. ODonnell and D.J.T Hill, American Chemical Society Symposium 1993 Series 527.

[7] F. Elashhab, L. Sheha, O. Zubeir, A. Eldali and A. E. Eid, Egyptian J. Applied Sci., 2002, 17 (1) 62.

[8] W.M. Kulick, Viscosimetry of Polymers and Polyelectrolytes, Berlin, Springer, **2004**, M. Kurata And Y. Tsunashima, Polymer Hand book, New York, John Wiley & Sons Inc., **1999**, 7(1-83).

[9] P.G. Gennes, Scaling Concepts in Polymer Physics, Ithaca, NY, Cornell University press 1979.

[10] H. Fujita, Studies in Polymer Science, Elsevier Science Publishers 1997,9.

[11] C.K. Schoff, Polymer Handbook, New York, John Wiley & Sons, Inc., 1997,265-289.