

VISCOSITY AND STABILITY STUDIES OF HYDROXYPROPYL METHYLCELLULOSE POLYMER SOLUTIONS

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ABSTRACT

Viscosity studies of three grades of hydroxypropyl methylcellulose polymer solutions have been done in detail. The solutions showed pseudoplastic behaviour and their viscosity increased with increase in concentration of the polymer, but use in temperature significantly lowered the viscosity. The effect of aging on solutions' viscosity at 25°C was measured.

Introduction

Interfacial properties of aqueous solutions of methyl and hydroxypropyl methylcellulose (HPMC) were studied by Sarkar (1984). He reported a general correlation between the interfacial tension and degree of substitution of various groups, molecular weight, aging time and temperature. Recently Klock *et al* (1986) reported the surface shear viscosities of aqueous HPMC solutions and their relationship with various parameters.

Derivatives of cellulose polymers have been used in emulsion preparations. Davies and Rowson (1960) prepared stable emulsions with methyl and methylethylcellulose. They found that low viscosity grade polymers produced more globules per cubic mm of oil. Kassem *et al*. (1973) reported the preparation of cod liver oil emulsion with methylethylcellulose and sodium carboxymethylcellulose. The emulsion produced by the former polymer was stable than that produced by the later one. The effect of different techniques on the preparation of liquid paraffin, castor oil and cod liver oil emulsions using methylcellulose as emulsifying agent was reported by Krowczynsky and Kluczykoska (1971).

In the present study the viscosity of HPMC polymer solutions prepared with various viscosity grade polymers has been reported. The effect of concentration, temperature and aging on the viscosity of polymer solutions is also investigated. This report represents part of the work in preparing HPMC polymer based emulsion which can be used as pharmaceutical ointment base.

Materials and Methods

Hydroxypropyl methylcellulose (Colorcon) of three viscosity grades (E15, E50 and E4M) was used. A 2% solution of each of these polymers had a viscosity of 15, 50 and 4000 cps respectively. HPMC polymer solutions were prepared in hot distilled water (80°C) with continuous stirring until all particles were wetted and all agglomerates disappeared. The solutions were kept at room temperature for 24 hours for complete clearance of air bubbles.

Rheological measurements were done by a Contraves Rheomat 135 connected to a Hewlett-Packard microcomputer. Coaxial double walled cylinder measuring system MSO 115 was used. Eighteen ml of the solution was filled into the system. All rheological measurements were conducted at 25°C, except those on the effects of temperature variation. The measuring system was left to stand for 20-30 minutes in order to attain the desired temperature. Viscosity measurements were conducted from low shear rate 50 s⁻¹ with an increment of 50 s⁻¹, up to high shear rate 500 s⁻¹. At each shear rate the sample was sheared for 6 s. The total time of shearing for ten shearing rates was 60 s. The shear rate was then similarly decreased from 500 s⁻¹ to 50 s⁻¹. The total time for decreasing shear was also 60 s. Samples of HPMC polymer solutions were stored at 25°C and their viscosities were measured periodically.

Results and Discussion

All the three HPMC polymer (E15, E50 and E4M) solutions showed pseudoplastic behaviour (Colorcon, 1985). Yamamoto et al (1967) reported similar pseudoplastic behaviour with concentrated aqueous solution of methylcellulose. This pseudoplastic behaviour can be attributed to strong hydrogen bonding between the polymer and water molecules which results in submicroscopic molecular aggregates. The decrease in viscosity with increasing shear rate is due to disaggregation of the molecular aggregates and decrease of the crowding effect.

The viscosity of the polymer solutions at various concentrations was measured at 500 s⁻¹ shear rate. Figure 1 shows the viscosity increase of polymer as a function of concentration. At low concentration the increase in viscosity is gradual, but at higher concentration the increase in viscosity is much greater. The high molecular weight polymer (NM) showed a marked increase in viscosity for small increase in concentration in comparison with that of the low molecular weight HPMC (E15). Rowe (1982) has reviewed the literature on methylcellulose and showed that the intrinsic viscosity of the polymer is directly proportional to the molecular weight

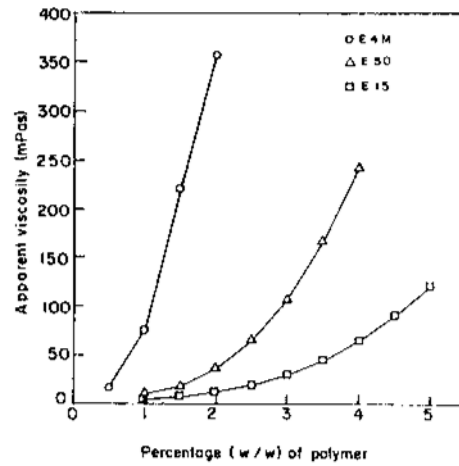


Figure 1. Viscosity of HPMC solutions as a function of concentration; shear rate 500 s-1, temperature 25°C

The effect of temperature on the viscosity of polymer solutions is shown in Figure 2. It is evident that temperature significantly lowers the viscosity of the polymer. The viscosity of the HPMC polymer solutions decreases to almost half over the rise of temperature from 20° to 40°C. At higher temperature disaggregation of molecular aggregates occurs and as a result the viscosity is decreased. Similar temperature dependent viscosity changes have been reported for polyvinyl alcohol polymer solutions (Ferdous, 1991).

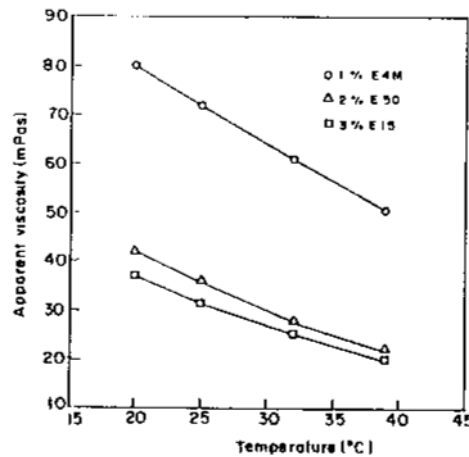


Figure 2. Viscosity change of HPMC solutions with temperature; shear rate 500 s-1.

Figure 3 shows the viscosity change of HPMC solutions on storage at constant temperature of 25°C. There was negligible change in viscosity of E15 and E50 polymer solutions over the period of ten weeks of observation. In case of E4M polymer solution, there was initial increase of viscosity after two weeks, which slightly decreased and remained steady for the rest of the period of observation. The viscosity increase on aging was probably due to the formation of additional entanglements of the long chain polymers. The lower molecular weight polymers (E15 and E50) do not form additional entanglements and consequently their viscosity does not change on aging. Joslin and Sperandio (1957) observed that viscosity of methylcellulose dispersions slightly increased on aging at room temperature.

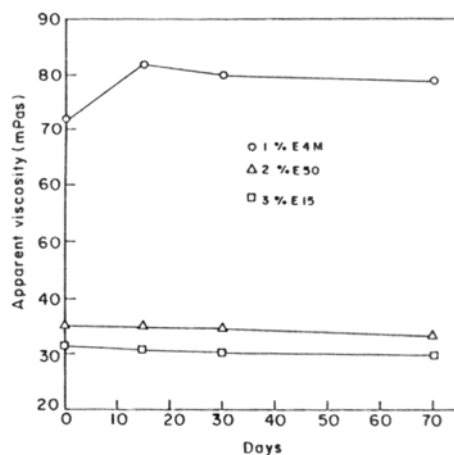


Figure 3. Viscosity change of HPMC solutions on storage at 25°C; shear rate 500 s⁻¹

From the present viscosity studies it is clear that emulsions could be prepared with higher viscosity grade polymers. The viscosity change of emulsion on storage would be minimum in case of HPMC emulsions which is a very important factor in emulsion formulation.

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