AN EXPLANATION OF THE RHEOLOGICAL BEHAVIOUR OF MIXED AQUEOUS SOLUTIONS OF ANIONIC AND NON-IONIC CELLULOSE ETHERS

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Cellulose ethers are extensively used throughout the pharmaceutical industry. Their ability to impart viscosity is utilised in a variety of dosage forms ranging fron suspensions to tablets. Previous studies have described how on mixing aqueous solutions of anionic and non-ionic cellulose ethers the viscosity of the mixture is greater than that which would have been anticipated from the viscosities of the individual solutions (Walker and Wells 1982). These observations have been explained in terms of an increase in the strength of inter-chain cross-linking mediated by hydrogen bonding between carboxyl and hydroxyl groups (Walker and Wells 1982). This paper describes how the enhanced viscosities of such solutions can be explained in terms of changes in molecular shape. We have shown previously (Mannion et al 1989) that the zero shear specific viscosity of a solution containing two polysaccharides , A and B, at a total concentration C, is given by equation 1.

$$\text{Log}\eta^o_{sp(A+B)}=(f_A x_A+f_B x_B)\text{Log}(C(f_A[\eta_A]+f_B[\eta_B]))+f_A\text{Log}K_A+f_B\text{Log}K_B \qquad (1)$$

f_A and f_B are the weight fractions of each polysaccharide. $[\eta_A]$ and $[\eta_B]$ are the intrinsic viscosities of each polysaccharide. x_A, x_B, K_A, and K_B are constants the values of which are properties of the individual polysaccharides. This equation has been adapted to account for changes in the intrinsic viscosity of an ionic polysaccharide which occur due to alterations in the ionic strength of the solvent:

$$\text{Log}\eta^o_{sp(A+B)}=(f_A x_A+f_B x_B)\text{Log}(C(f_A[\eta_A]+f_B([\eta_B^*]+S.I^{-0.5})))+f_A\text{Log}K_A+f_B\text{Log}K_B \qquad (2)$$

B is the ionic polysaccharide. $[\eta_B^*]$ is the intrinsic viscosity of B at infinite ionic strength. I is the total ionic strength of the solution. S is a measure of chain stiffness of the polyelectrolyte, equal to the gradient of a graph of intrinsic viscosity against the reciprocal of the square root of the ionic strength.
Using hydroxypropylmethylcellulose (HPMC) and sodium carboxymethylcellulose (CMC) at a total polysaccharide concentration of 1% w/w experimental values for the zero shear specific viscosities of mixed solutions were obtained using a Deer rheometer. These were compared with the values predicted by equation 2. Figure 1 shows that there is good agreement between the predicted and experimental values. We believe this indicates that the enhanced viscosities observed when aqueous solutions of anionic and non-ionic cellulose ethers are mixed is principally due to coil expansion of the polyelectrolyte.
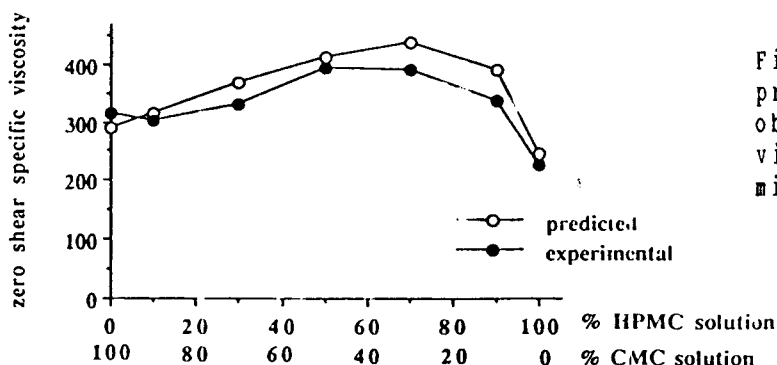

Figure 1. A comparison of the predicted and experimentally obtained zero shear specific viscosities of HPMC/CMC mixtures.

Walker,C.V., Wells,J.I. (1982) Int.J.Pharm. 11: 309-322
Mannion,R.O. et al (1989) J.Pharm.Pharmac. 41: P15