MICELLAR PROPERTIES AND GELATION OF A HIGH MOLECULAR WEIGHT POLOXAMINE IN AQUEOUS SOLUTION

D.Attwood, J.H. Collett and C.A. O'Connor, Department of Pharmacy, University of Manchester, Manchester M13 9PL, U.K.

Poloxamines are block copolymers formed by the polycondensation of propylene oxide and ethylene oxide on ethylenediamine. The amphiphilic nature of these compounds has led to their use as detergents, dispersants and emulsifying agents. The poloxamines are structurally similar to the polyoxyethylene-polyoxypropylene-polyoxyethylene block copolymers which have been shown to undergo thermally reversible gelation. In view of this we have examined the physicochemical properties of aqueous solutions of a poloxamine, Synperonic T908* of high molecular weight (nominally 2.5 x 10^4), in an assessment of its potential for use in the preparation of controlled release systems.

Total intensity light scattering measurements showed evidence of limited association, the weight average aggregation number increasing with temperature over the range 30-50° (see Table 1). Association commenced at a clearly defined critical

Table 1. Micellar properties of Synperonic T908*

Temp °C	Aggregation number	CMC (%w/w)	D_o ($x10^{11} m^2 s^{-1}$)	Hydrodynamic radius r_h(nm)	Intrinsic viscosity [η]	Micellar hydration $gH_2O/gT908$
30	1.7	0.028	2.26	12.3	27.4	10.0
40	3.3	0.020	2.74	12.8	25.8	9.4
50	4.4	0.013	3.32	13.0	23.0	8.2

micelle concentration (CMC) which, as shown by surface tension measurements, decreased markedly over this temperature range. The apparent diffusion coefficient as determined by photon correlation spectroscopy, was concentration invariant in solutions of concentration <1-2% $^w/_w$ at all temperatures. Hydrodynamic radii, r_h, calculated from the limiting diffusion coefficient, D_o, using the Stokes-Einstein equation showed only a limited increase with temperature, in marked contrast to the pronounced increase of anhydrous radii as determined from the total intensity light scattering studies. Viscometric measurements using a capillary viscometer indicated that the micelles were heavily hydrated. Increase of temperature caused micellar dehydration which, in combination with the concomitant increase of aggregation number, accounted for the observed lack of any significant variation in r_h. In more concentrated solutions, concentration increase produced a pronounced decrease of the apparent diffusion coefficient at each temperature, indicative of micellar growth or increased intermicellar interaction. Such changes in micellar properties led to reversible gelation as the concentration exceeded approximately 30% $^w/_w$.

The changes in micellar properties of this poloxamine with increase of temperature are similar to those reported for the polyoxyethylene-polyoxypropylene-polyoxyethylene copolymer Pluronic F127 (Attwood *et al* 1985). Gelation occurs due to interactions of the polyoxyethylene chains of adjacent micelles. Such interactions are more effective in linking together the micelles to form a gel as they become dehydrated at elevated temperatures.

*Synperonic T908 (ICI) has a similar structure to Tetronic 908 (BASF, Wyandotte).

Attwood, D., Collett, J.H. and Tait, C.J. (1985) Int. J. Pharmaceutics, 26: 25-33.