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Cellulose Derivatives: Optimization of Regression Equation to Predict Viscosity of Aqueous Solutions

Z. ŠKLUBALOVÁ

Department of Pharmaceutical Technology, Faculty of Pharmacy, Charles University in Prague, Heyrovského 1203, 500 05 Hradec Králové, Czech Republic

E-mail: zdenka.sklubalova@faf.cuni.cz

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For over 50 years, cellulose derivatives have been used as excellent pharmaceutical excipients. Commercially, cellulose products are designated with viscosity grade, proportional to the molecular weight or chain length, which identifies the product numerically based on viscosity value (in mPa·s) measured at 2% w/v concentration in water at 20°C using an Ubbelohde viscometer. A wide range of viscosity grades are available. When polymers are used, the common practice is dilution of a solution master batch to a solution of the required viscosity level. This is complicated by the non-linearity of both the viscosity/concentration and the viscosity/temperature relationships. Generally, the linear function of the eighth root of viscosity and the concentration of the aqueous solution at 20°C is recommended to predict viscosity and/or concentration (METHOCEL® cellulose ethers – Technical handbook, The Dow Chemical Company 2002, 19). In this work, the relationship between viscosity, concentration of the aqueous solution, and temperature was investigated. Two cellulose derivatives of pharmaceutical quality were used, methylcellulose (MC 400, Methocel® A4C Premium) and hypromellose (HPMC 4000, Methocel® F4M Premium). The empirically proposed multiple linear regression used the transformation of viscosity by the logarithm, the absolute temperature as the reciprocal value, and the concentration as the square root. To predict the viscosity of both investigated cellulose derivatives simultaneously, expansion of the linear regression between variables with the logarithm of the polymer viscosity grade is necessary. Out of possible interactions between variables, only the linear interaction between the logarithm of the viscosity grade and the square root of the concentration significantly increased the precision of viscosity prediction to the acceptable level of approximately 4%. However, at the actual experimental temperature, the proposed multiple linear regression can be easy simplified and utilized to predict the concentration of a solution of the required viscosity for methylcellulose and/or hypromellose of the selected viscosity grade.

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