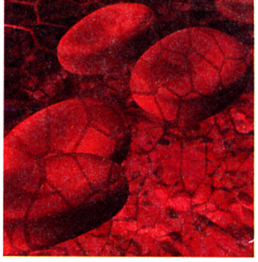

METHOCEL®

PREMIUM CELLULOSE ETHERS

Properties of Solutions of METHOCEL

Molecular Weight / Viscosity Relationships

The apparent viscosity of aqueous solutions of METHOCEL is proportional to the molecular weight or chain length of the specific METHOCEL product used. Commercial designations of METHOCEL products are based on viscosity values determined in water at 20°C, with a concentration of 2% METHOCEL. The measurement methods used are described in the current ASTM monographs D1347 and D2363. The correlation between the number average molecular weight (Mn) and the commercial viscosity designation for METHOCEL A cellulose ethers is shown in Figure 1.

Table 1 provides further information regarding the correlation of number average molecular weight with the commercial viscosity designation. Intrinsic viscosity is the limiting quotient of the specific viscosity divided by the concentration as infinite dilution is approached (as the concentration approaches zero). The number average molecular weight (Mn) is calculated from the limiting osmotic pressure of the solvent as the concentration of the solute approaches zero. The weight average molecular weight (Mw) will be 3 to 10 times the Mn.

Effect of Concentration on Viscosity

Most formulations require a predetermined product viscosity of METHOCEL cellulose ether. Figure 1 shows how the concentration of METHOCEL products of varying viscosity affects the aqueous solution viscosity at 20°C. The measurements were made using an Ubbelohde viscometer (ASTM D2363). Data for both low and high molecular weight METHOCEL products are shown and represent the average material found within a viscosity specification.

Figure 1. Molecular Weight / Viscosity Correlation, 20°C

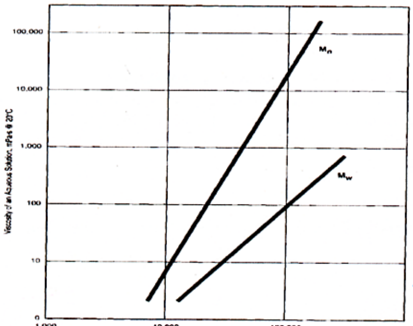

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Table 1: Viscosity of Methyl Cellulose of Various Molecular Weights

Viscosity Grade 2% 20°C, mPa·s	Intrinsic viscosity (h) dL/g	Number average degree of polymerization	Number average molecular weight (Mn)
5	1.2	53	10,000
10	1.4	70	13,000
40	2.0	110	20,000
100	2.6	140	26,000
400	3.9	220	41,000
1,500	5.7	340	63,000
4,000	7.5	460	86,000
8,000	9.3	580	110,000
15,000	11.0	650	120,000
19,000	12.0	750	140,000
40,000	15.0	950	180,000
75,000	18.4	1,160	220,000

This graph is plotted on an 8^{th} root scale, not a logarithmic scale. The 8^{th} root of the viscosity is a roughly linear function of the concentration.

The equation which expresses the illustrated approximate relationship between solution viscosity and polymer concentration is $\eta \quad = (C\alpha) +$ where η is the solution viscosity in millipascal-seconds, C is the polymer concentration in solution (expressed in percent), and α is a constant specific to the molecular weight. The value of α may be calculated by substitution and may then be used to calculate the approximate viscosity at the desired concentration.

Having calculated α for a particular METHOCEL product, this value can be used to calculate viscosity at other concentrations.

To find the line for any intermediate grade, locate the desired 2% viscosity above 2% on the abscissa and draw a straight line to the point of origin.

Effect of pH on Viscosity

Because METHOCEL products are nonionic, the viscosities of their solutions are generally stable over a wide pH range. Outside the range of pH 3 to 11, however, there may be gradual loss of viscosity at higher temperatures after long periods of standing, especially with high-viscosity solutions. Solutions of METHOCEL cellulose ethers in acids or in strong caustic solutions will decrease in viscosity. This factor should be considered when determining the shelf life of products.

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Effect of Additives on Viscosity

In the preparation of formulations, viscosities may occasionally result which are considerably higher than expected. This phenomenon can be caused by the interaction of METHOCEL with one or more of the formula ingredients. As a result, it may be possible to use less thickener and still have adequate viscosity.

In systems having lower concentrations of additives (η1%), METHOCEL A or METHOCEL F products are frequently suitable. In systems where the concentration of additives is rather high (η10%), the more highly substituted products such as METHOCEL E or K products may be more compatible.

Effect of Freezing on Solutions

Solutions of METHOCEL cellulose ether products do not undergo separation into phases upon freezing. There is no separation of fluid layers (syneresis) or formation of insoluble precipitates or haze.

Preservatives for Aqueous Solutions

METHOCEL cellulose ethers normally do not require preservatives. They are not, however, antimicrobial agents. If contamination occurs, micro-organism growth will not be inhibited.

To preserve solutions of METHOCEL, addition an antimicrobial or preservative is suggested. For regulated uses, you should use the appropriate permitted preservative.

Compatibility of Aqueous Solutions

The methycellulose molecule is non-ionic and is not precipitated as an insoluble salt by multivalent metal ions. However, METHOCEL cellulose ethers can be salted out of solution when the concentration of electrolytes or other dissolved materials exceeds certain limits. This is caused by competition of the electrolytes for water and results in reduced hydration of the cellulose ether.

Because of the difference in the amounts of organic substitution, METHOCEL E, F, and K products generally exhibit a higher tolerance for salts in solution than METHOCEL A methylcellulose products. There is only slight variation in electrolyte tolerance among the various METHOCEL hypromellose products.

Water-insoluble materials such as pigments, fillers, etc., will not adversely affect METHOCEL cellulose ethers. Actually, solutions of METHOCEL often serve as excellent dispersing media for such materials.

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