
International Standard



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Cellulose in dilute solutions — Determination of limiting viscosity number — Part 1 : Method in cupri-ethylene-diamine (CED) solution

Cellulose en solutions diluées — Détermination de l'indice de viscosité limite — Partie 1 : Méthode utilisant une solution de cupri-éthylène-diamine (CED)

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Foreword

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Draft International Standards adopted by the technical committees are circulated to the member bodies for approval before their acceptance as International Standards by the ISO Council.

International Standard ISO 5351/1 was developed by Technical Committee ISO/TC 6, *Paper, board and pulps*, and was circulated to the member bodies in January 1980.

It has been approved by the member bodies of the following countries :

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No member body expressed disapproval of the document.

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Cellulose in dilute solutions — Determination of limiting viscosity number —

Part 1 : Method in cupri-ethylene-diamine (CED) solution

0 Introduction

The viscosity (or dynamic viscosity), symbol η , of a fluid is defined by the Newtonian equation

$$\tau = \eta \cdot \dot{\gamma}$$

where

τ is the shear stress;

η is the viscosity;

$\dot{\gamma} = \frac{dv}{dz}$ is the velocity gradient (v is the velocity of one plane relative to the other, and z the co-ordinate perpendicular to the two planes).

In non-Newtonian behaviour, normally the case with high-polymer solutions such as cellulose, the ratio of the shear stress to the velocity gradient varies with the shear stress.

The data required for evaluation of the limiting viscosity number of cellulose in dilute solutions (for definitions and symbols, see clause 4) are derived by means of a capillary-tube viscometer. The results of these measurements are seriously affected by the shear rate. The solution to the problem that thereby arises can be sought either by determination of the viscometric properties at so low a concentration of cellulose that the effect of shear rate is small, or by determination at a shear rate closely reproducible in different laboratories. In this document, both alternatives are given, as it has been proved that the results they provide are equal so long as the limiting viscosity number is less than 1 000 ml/g. For values which exceed this, alternative procedure B gives somewhat higher results by reason of the lower shear rate.

In **alternative A**, the concentration c of cellulose is chosen that if multiplied by the limiting viscosity number it gives a product of $[\eta] \cdot c = 1,0$ to $1,5$, corresponding to viscosity ratio $\frac{\eta}{\eta_0}$ equal to $2,3$ to $3,4$. At this low concentration, the effect of shear rate can be ignored, and determinations of the efflux times of the solution and diluted solvent can be made in the same viscometer.

In **alternative B**, the concentration c of cellulose is so chosen that if multiplied by the limiting viscosity number it gives a product of $[\eta] \cdot c = 3,0 \pm 0,4$, corresponding to viscosity ratio $\frac{\eta}{\eta_0}$ equal to 6 to 10 . The determination shall then be

carried out at a reproducible shear rate of $200 \pm 30 \text{ s}^{-1}$; this involves the employment of two viscometers, one for the diluted solvent, and one for the solution. This alternative should be applied when there is reason to expect that the narrow capillary specified in alternative A will become clogged by undissolved particles, or when difficulty is experienced in attaining the prescribed degree of accuracy in weighing the small amounts of sample implied by alternative A in some cases.

1 Scope and field of application

This part of ISO 5351 specifies a method for the determination of the limiting viscosity number of cellulose in dilute cupri-ethylene-diamine (CED) solution.

This method is applicable to CED-soluble samples of cellulose, for instance in pulps and textiles.

NOTE — The viscosity test is a means for determining the extent of cellulose degradation produced by cooking and bleaching. This degradation greatly affects the suitability of pulp for dissolving purposes and papermaking.

ISO 5351/2 specifies a method for the determination of the limiting viscosity number of cellulose in dilute iron(III) sodium tartrate complex (EWNN_{mod NaCl}) solution.

2 References

ISO 638, *Pulps — Determination of dry matter content*.

ISO 1833, *Textiles — Binary fibre mixtures — Quantitative chemical analysis*.

ISO 5089, *Textiles — Preparation of laboratory test samples and test specimens for chemical testing*.

ISO/TR 5090, *Textiles — Methods for the removal of non-fibrous matter prior to quantitative analysis of fibre mixtures*.

3 Principle

Measurement of the times of efflux of the diluted solvent and solution of cellulose through a capillary-tube viscometer at a specified concentration at 25°C . Calculation by Martin's formula of the limiting viscosity number from these measurements, and from the known concentration of the solution.