ICS 81.040.01
CCS N64

NATIONAL STANDARD OF THE PEOPLE'S REPUBLIC OF CHINA

GB/T 42414-2023

Glass viscosity measurement - Rotational viscometer method

玻璃黏度测定 旋转黏度计法

Issued on: March 17, 2023 **Implemented on: October 1, 2023**

Issued by: State Administration for Market Regulation;
Standardization Administration of the PRC

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Foreword

This document was issued on 17 March 2023 by the State Administration for Market Regulation; Standardization Administration of the PRC and takes effect on 1 October 2023.

It is a GB/T standard: recommended rather than compulsory, but it is the text a Chinese reviewer applies when assessing a submission.

1 Scope

GB/T 42414-2023 describes how the viscosity of molten glass is measured with a rotational viscometer, for melts that behave as Newtonian liquids. The principle clause explains what the instrument actually senses: a rotor turning continuously in the melt drags against the glass at its surface, and the friction that resists it is read as torque. From there the document sets out the apparatus, how the sample is prepared, the test procedure, and the data processing that turns instrument parameters, rotor speed and torque at each temperature into a viscosity value through the given formula. A test report clause fixes what has to be recorded alongside the number, and an informative appendix lists the technical differences from ISO 7884-2:1987 and the reasons for them. Viscosity against temperature is the curve a glass plant runs on: melting, refining, conditioning and forming are each set at a point on it, and a curve measured on a poorly calibrated instrument, or on a melt that never reached thermal equilibrium, throws the whole schedule off and shows up later as cord, bubbles or a forming line that will not hold shape. For glass makers, furnace and

forming engineers, and the laboratories that qualify new compositions.

This Document describes the rotational viscometer test method for the glass viscosity measurement.

This Document is applicable to the measurement of Newtonian liquid glass melt viscosity in the range of 1Pa.s~104 Pa.s.

2 Normative References

The provisions in following documents become the essential provisions of this Document through reference in this Document. For the dated documents, only the versions with the dates indicated are applicable to this Document; for the undated documents, only the latest version (including all the amendments) is applicable to this Document.

GB/T 16839.1 Thermocouples - Part 1: EMF specifications and tolerances (GB/T 16839.1-2018, IEC 60584-1:2013, IDT)

3 Terms and Definitions

For the purposes of this Document, the following terms and definitions apply.

3.1 Newtonian liquid

A liquid that obeys Newton's law of viscosity.

NOTE: The viscosity of this type of fluid has nothing to do with shear rate. The viscosity is constant at a certain temperature.

3.2 Field of flow

The space filled by the glass melt and its boundaries with the inner surface of the crucible, the rotating shaft and the outer surface of the rotor.

3.3 Special instrument constant; k*

Instrument constants integrated by taking into account the flow field coefficient, dimensional coefficient, viscometer head coefficient, and rotor viscosity coefficient.

NOTE: k* has nothing to do with torque, speed and viscosity.

3.4 Melting temperature

The temperature corresponds to the viscosity of 10Pa.s.

3.5 Working temperature

The temperature corresponds to the viscosity of 103Pa.s.

3.6 VFT-equation

An empirical formula that describes the relationship between the viscosity of glass and temperature.

NOTE: VFT is the abbreviation of Vogel-Fulcher-Tammann.

4 Principles

When a rotational viscometer is used to measure the high-temperature viscosity of glass melt, the motor drives the rotor to continuously rotate in the glass melt, and friction force is generated between the rotor surface and the contacting glass melt interface. The friction force is related to the viscosity of the glass melt. Therefore, changes in the rotation speed and torque of the rotor reflect the viscosity of the glass melt. The greater the torque is, the greater the viscosity of the glass melt is. The higher the rotation speed is, the smaller the viscosity of the glass melt is. vice versa. The torque and rotational speed of the rotor in the glass melt are measured experimentally, and the viscosity of the glass melt is calculated by using Formula (1).

Where:

eta - viscosity, in Pa.s;

k* - constant of special instrument;

tau - torque applied to the rotator, in N.m;

n - speed of rotator.

The high-temperature viscosity of the glass melt is mainly related to the composition and temperature of the glass. The viscosity plot of the glass melt with a specific composition measured at different temperatures constitutes the viscosity-temperature curve of the glass.

by the reference glass and the same viscosity value in Appendix C is greater than 10 degrees C, the

instrument status shall be adjusted to meet the usage requirements.

7.2 Testing

7.2.1 Place the crucible containing the glass sample to be measured into the high-temperature

furnace of the viscometer. Make sure that the crucible is placed stably on the base.

7.2.2 Set the test condition parameters, including the heating rate of the high-temperature

furnace (recommended 5 degrees C/min~10 degrees C/min), upper limit temperature, lower limit temperature,

holding time, cooling rate during the test (recommended 1 degrees C/min~3 degrees C/min), reheating rate after

testing. When setting the upper limit temperature, in addition to considering the possible

chemical reactions between the glass melt and the crucible and rotor materials, it is also

necessary to consider the volatilization and devitrification tendencies of the glass.

For volatile glass, the upper limit temperature should not be too high, as long as the bubbles

can be fully discharged (refer to the temperature corresponding to 100Pa.s of the glass melt).

For easily devitrified glass, it should use a faster cooling rate during measurement. The

temperature change rate should refer to the data set when calibrating the instrument using

standard glass. When setting parameters, measurements should be made within a short period

of time to avoid changes in the chemical or physical properties of the glass during long-term

measurements. The viscosity measurement can be carried out under uniform cooling conditions;

or the insulation setting can be performed at a specific temperature during the cooling process,

and the viscosity can be measured continuously.

7.2.3 Start heating and temperature-rising the sample to the set upper limit temperature, and