Excellence in Science

Constant Test Force Extrusion Type Capillary Rheometer Flowtester CFT-EX Series

Application News

Evaluation of Blended Rubber

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User Benefits

- It is possible to measure under pressure and temperature close to the molding condition.
- It is easy to clean the equipment after the test.

■ Introduction

Rubber products are made by uniformly mixing raw rubber or synthetic rubber with a combination agent to give a specific function, molding them in a mold, etc., and then heating them to make an elastic body. Therefore, the fluidity of the rubber has a significant impact on the quality of products made from blended rubber. The properties of the blended rubber may change over a period of time before molding, so the fluidity may deteriorate and adversely affect molding. Therefore, it is important to store and manage the blended rubber in an appropriate environment.

This article presents an example of evaluating changes in fluidity of blended rubber due to storage methods.

■ Samples and Test Conditions

The blended rubber was measured immediately after preparation and kneading. The storage temperature was divided into normal and low temperatures, and the fluidity was evaluated after 14 and 28 days. The test conditions were as shown in Table 1, and the flow was conducted at a high pressure of 20.1 MPa through a relatively small hole.

Table 1 Test Conditions

Test Method:	Constant temperature method
Die Diameter:	0.5 mm
Die Length:	1 mm
Test Temperature:	280 °C
Test Pressure:	20.1 MPa
Preheating Time:	0 s
Sample Size:	1.6 g

Fig. 1 CFT-500EX

The CFT-500EX type flowtester (Fig. 1) was used for the measurement. This device is a canalicular rheometer that measures the viscous resistance of the melt as it passes through the canaliculus.

With the structure shown in Fig. 2, the sample filled in the cylinder was heated from the periphery and melted, and a constant pressure was applied from the top through the piston. The melted sample was extruded through a die with a narrow hole to obtain the melt viscosity.

This principle is the same as that widely used in international melt flowrate (MFR) measuring machines, but the flowtester offers a wide range of pressure choices. Measurement can be performed under actual molding conditions or similar test conditions to obtain highly practical data. In addition, samples with high viscosity that cannot be measured with a rotary viscometer can be accurately measured.

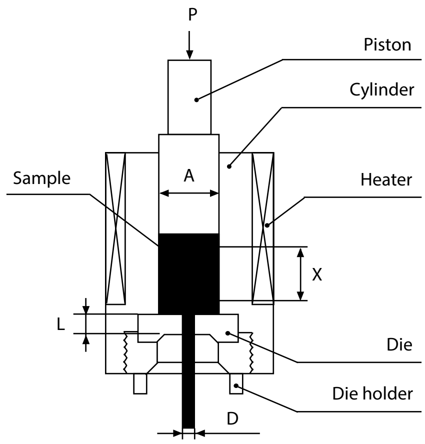

Fig. 2 Test Concept Diagram

Viscosity is calculated by calculating the flowrate, obtaining the shear rate and shear stress, the ratio of which corresponds to viscosity, as shown in the following equation:

(1) Flowrate Q

$$Q = \frac{X}{10} \cdot \frac{A}{t} \ (cm^3/s)$$

t : Measurement time(s)
X : Apparent displacement(mm)
A : Piston cross sectional area (cm^2)

(2) Apparent shear rate γ

$$\gamma = \frac{32Q}{\pi D^3} \cdot 10^3 \ (s^{-1})$$

D : Die orifice diameter (mm)

(3) Apparent shear stress τ

$$\tau = \frac{PD}{4L} \ (Pa)$$

P : Test pressure(Pa)
L : Die length(mm)

(4) Apparent viscosity η

$$\eta = \frac{\tau}{\gamma} = \frac{\pi D^4 P}{128LQ} \ (Pa \cdot s)$$

■ For Stable Results

When the test is performed, the sample adheres to the cylinder, piston, and die. This will adversely affect the next test and should be cleaned.

(1) Cleaning the piston (Fig. 3)

Remove the piston from the cylinder and wipe it with a cloth. If you cannot wipe the adhesion off with a wet cloth, use a metal cleaner to remove it, and wipe it off again with a cloth.

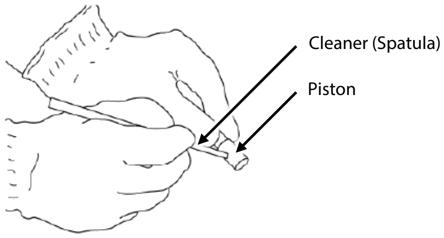

Fig. 3 Cleaning the Piston

(2) Cleaning the die (Fig. 4)

Wipe off the rubber or resin on the surface of the die with a cloth or with a cleaner. Then, the die cleaning pin is used to remove the adhesion inside the hole of the die, and the surface of the die is wiped off to finish.

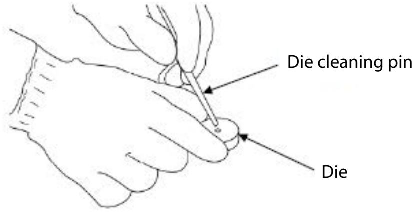

Fig. 4 Cleaning the Die

(3) Cleaning the cylinder (Fig. 5)

Clean the cylinder with a wire brush or a cylinder cleaner wrapped with gauze.

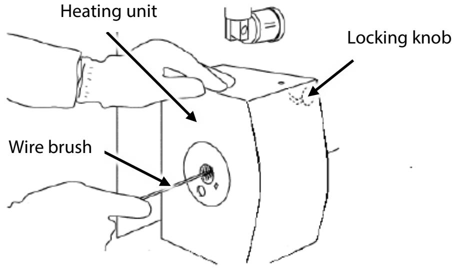

Fig. 5 Cleaning the Cylinder

Since the heating unit can rotate 90° from side to side, cleaning is easy.

<Related Applications>

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■ Result

Fig. 6 shows a stroke-time graph of the test results immediately after kneading. In this test, the slope of the graph is not constant, so the viscosity was calculated using an automatic method (the part of the graph with the largest slope is automatically selected). For details of the calculation method using the automatic method, see the reference[1].

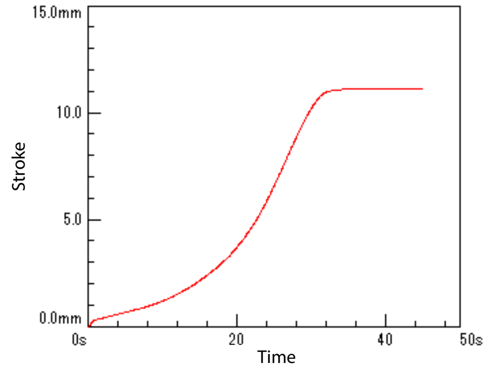

Fig. 6 Stroke-Time Graph

The test results are shown in Table 2 and Fig. 7. In the case of this sample, when the temperature and the number of days of storage were changed, in the case of low temperature storage no significant change in fluidity was observed even after about one month of storage. On the other hand, in the case of storage at room temperature, it was found that the viscosity increased greatly for 14 days, and the subsequent change was small.

Table 2 Test Results

Storage Period	Viscosity (Pa•s)	
	Ambient Temperature	Low Temperature
0	395.7	
14	568.1	447.5
28	600.0	419.3

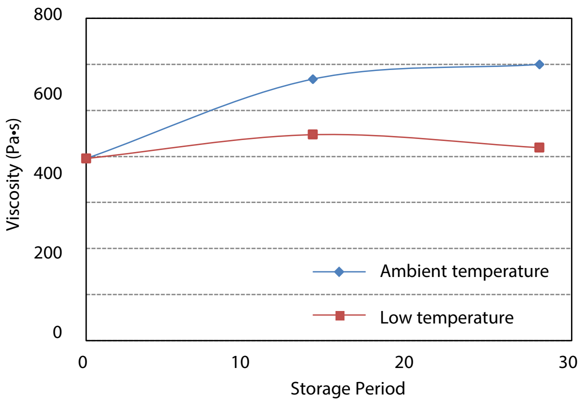

Fig. 7 Changes in Viscosity Due to Storage Methods

■ Conclusion

In this article, the change in the fluidity of blended rubber with the number of storage days was measured under normal and low temperatures. When the blended rubber was evaluated with a flowtester, it was possible to confirm the viscosity of the blended rubber at a pressure and temperature close to the molding condition without actually molding. By using a flowtester, it is possible to prevent molding defects by determining the viscosity suitable for molding, checking the viscosity before molding, and determining the temperature and period suitable for storage.

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