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Excellence in Science

Mooney Viscometer

SMV-301/301RT

Measuring the Mooney Viscosity and Scorch Time of Raw or Unvulcanized Rubber

Mooney Viscometer

SMV-301/301RT

SMV-301/SMV-301RT Mooney viscometers feature a color LCD touch panel display that allows the instrument to be operated by anyone and enhances safety.

In addition to plotting Mooney viscosity curves, the SMV-301/301RT systems include extensive functionality for statistical analysis.

Full Compliance to Global Standards

The SMV-301 / 301RT allows the user to measure the Mooney viscosity, scorch time, minimum Mooney viscosity, and other characteristics of rubber in accordance with JIS, ISO, and ASTM test methods. With outstanding temperature recovery characteristics and easy operability, it can also be used for stress relaxation measurements or for tests that involve varying the rotor speed.

> JIS K 6300-1: Rubber, unvulcanized – Physical property –
> Part 1: Determination of Mooney viscosity and pre-vulcanization characteristics with Mooney viscometer
> ISO 289-1,2,3,4: Rubber, unvulcanized – Determinations using a shearing-disc viscometer
> ASTM D 1646: Standard Test Methods for Rubber
> – Viscosity, Stress Relaxation, and Pre-Vulcanization Characteristics (Mooney Viscometer)

Max. 200 M Capacity (or optional 400 M capacity)
The automatic calibration unit (optional) allows weights to be automatically calibrated to ensure high testing reliability.

A V-groove die compliant with JIS, ISO, and ASTM standards ensures tests can be performed in accordance with global standards.

Torque can be calibrated easily via the touch panel by calibrating weights using the automatic weight calibration unit (optional). The ability to perform routine sensitivity calibration electronically via the touch panel ensures highly reliable routine testing.

V-Groove Die

Excellent thermal stability and temperature recovery characteristics enable high reproducibility.

Optimal control and film heater units provide shorter temperature recovery times after inserting specimens and, due to the highly stable temperature control system, highly reproducible test results.

SMV-301/300

SMV-202/201

Set temperature

Temperature

Sample inserted

Test started

Temperature Recovery Curve

Time
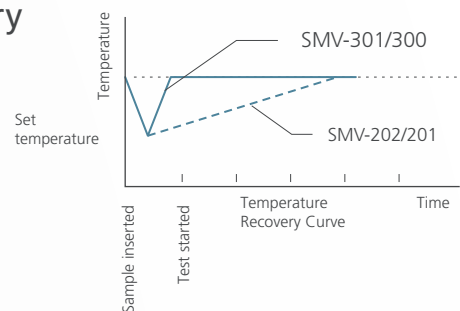
Also supports stress relaxation testing, cycle testing, and variable rotor speed testing.

The SMV-301RT can also measure stress relaxation and decay in accordance with ISO 289-4 and ASTM D 1646. In addition, the difference in viscosity between samples can be determined more easily by using multiple rotor speeds (between 0.1 and 20 rpm) during testing to evaluate mixing or by varying the strain level. Performing various tests in that manner allows viscoelasticity of rubber samples to be evaluated.

Mooney Viscosity Test

Mooney Scorch Test

Stress Relaxation Test (SMV-301RT)

Cyclic Test (SMV-301RT)

Variable Rotor Speed Test (SMV-301RT)

Simple Cleaning and High Safety Improve Testing Efficiency

A windbreaker casing is also included standard.
The auto-start function is linked to the casing to improve both safety and efficiency.

The casing prevents external disturbances from the surrounding temperatures during measurements and prevents temperature variations around the die. An interlock mechanism prevents the crosshead from ascending or descending except when the casing door is closed. The viscometer also includes an auto-start function that can automatically start tests when the casing door is closed while in the standby mode. These functions help ensure that tests can be performed efficiently and safely.

Installing an optional display tower signals a warning to surrounding personnel.

The rotor lifting function makes cleaning easier.

Mooney viscosity testing requires cleaning the die and rotor after each test. Because the surface of SMV-301/301RT rotors is treated to prevent sticking to samples, while also maintaining adequate rotor hardness, samples are much easier to peel off of the rotor after tests. The rotor lifting function also makes it easier to remove the rotor after tests.

A warm-up function provides a smoother test starting process.

This function automatically warms up the system to a specified temperature, so that it is ready to start testing at the specified time.
It also allows saving and loading test conditions, thereby improving the efficiency of testing using multiple different conditions.

A Color LCD Touch Panel Improves Testing Efficiency by Improving Testing Operations

A color LCD touch panel makes it easy to specify test conditions. It also includes extensive data analysis functionality, such as for displaying results, performing statistical calculations, editing data, and displaying graphs.

Creating and Loading Test Conditions

All test conditions can be set via the screen.
Saved test conditions can be loaded from a file. Up to 10 values can be specified for Mooney viscosity detection time, rotation speed (on RT models), or scorch point settings. Mooney viscosity values can be used for automatic pass/fail decisions as well.
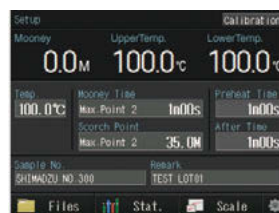

Screen for setting conditions

Screen for loading condition settings

Start Test ⇒ Preheat ⇒ Test

The auto-start function automatically lowers the crosshead and starts preheating as soon as the windbreaker casing is closed. After preheating, it automatically starts the test. If multiple measurement conditions are set, in addition to displaying results when the test is finished, interim results for each setting can be displayed at any time during measurements.
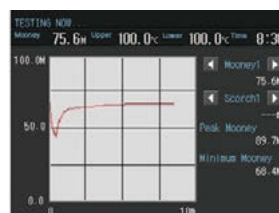

Time vs. Mooney value graph
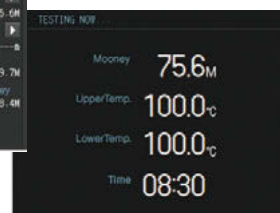
Enlarged display of real-time values during measurements

## Display Results, Print Reports, or Output Data

After testing is finished, Mooney viscosity criteria specified in advance or pass/fail results based on those criteria can be displayed, and a logarithmic graph of scorch time or stress relaxation measurements can be plotted automatically. Test results can be printed out directly from the touch panel (printer is optional), or test conditions, results, and raw data can be output to a PC.
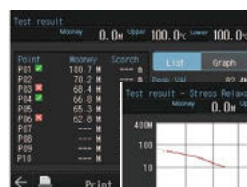
Test results

Stress relaxation measurement results
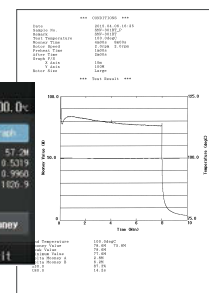
Example of stress relaxation measurement report output

Statistical Processing

All data with the same sample number in test conditions can be processed as one file for statistical processing. Saved test results can be displayed, statistical data plotted, or histograms created.

Plot

Histogram

Example of printing data file

Example of printing statistical calculation results

SMV-301/301RT
Mooney Viscometer

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PC Software Improves Testing Efficiency

The SMV-301/301RT models make it possible to set test conditions, display data in real time, and acquire, save, analyze, or statistically process data using computer software. Furthermore, up to four SMV-301/SMV-301RT Mooney viscometers can be controlled from one PC for more efficient testing.*

* Multiple units cannot be controlled in combination with an SMV-300 model.

Smooth Process from Creating Test Conditions to Statistical Processing of Test Results

<Main Specifications>

・Display real-time data during tests.
・Display real-time graphs of time vs. Mooney value or time vs. temperature.
・Control up to four Mooney viscometer units connected to the computer.
・Specify test conditions, display results after tests, determine pass/fail results, overlay graphs, and output data for data analysis.
・Statistical processing, such as calculating average values and standard deviations and plotting graphs and histograms
・Integrating software for displaying the connection and operating status and ID codes of respective instrument
・Change test conditions from the viscometer unit.
・USB 2.0 communication interface with the PC

Screen during testing

Screen for setting test conditions

Up to 4 instruments can be controlled with a single PC

Recalculating, Overlaying, or Statistically Processing Test Results Is Easy

When the viscometer connects to the software, it waits in standby mode using the previous test conditions settings, which means tests can be performed consecutively without having to change test conditions.

Saved test results and data can be displayed or control charts created from the data, such as graphs or histograms.
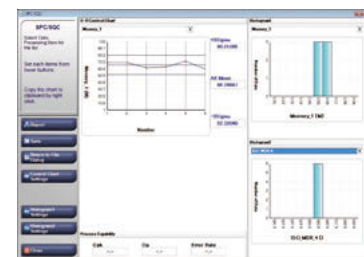
Control chart and histograms

Varied Rotor Speed in Cycle Tests for Mooney Viscosity and Stress Relaxation (SMV-301RT)

Multiple cycles of combined Mooney viscosity test and stress relaxation measurements can be specified (total measurement time: max. 30 minutes).
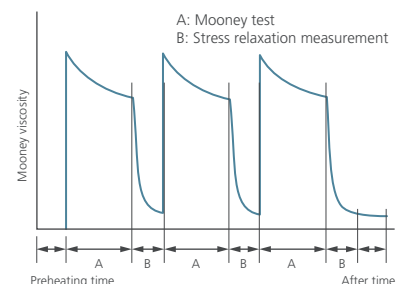
Rubber Viscoelasticity Evaluation from Mooney Viscosity to Stress Relaxation

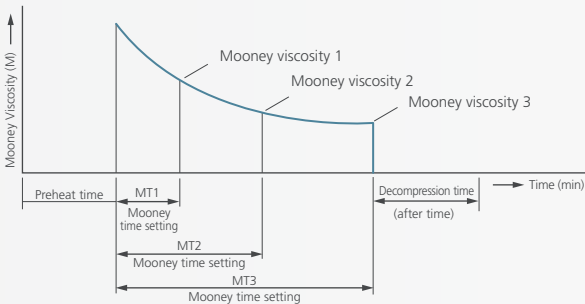## Operating Principle and Mooney Viscosity

A drive motor rotates a rotor in the center of a cylindrical test chamber formed from upper and lower dies. The test chamber is filled with the sample and the rotor is rotated with the sample heated to a given constant temperature. The torque on the rotor, applied by sample resistance, is detected by a load cell and measured as the sample's Mooney viscosity.

The rotating force on the rotating plate, generated from the rotor counter torque, applies a thrust force, P, on the load cell. JIS K 6300 specifies using standard weights to calibrate the load cell so that a Mooney viscosity value of 100 is equivalent to a rotor counter torque of 8.30 N-m.
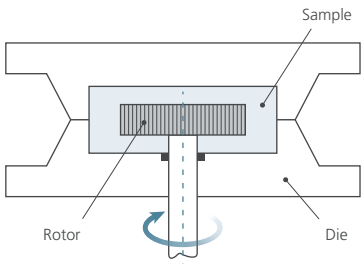
Measuring Mooney Viscosity

The Mooney viscosity test is performed to measure the Mooney viscosity of raw rubber and rubber compounds. Mooney viscosity is the viscosity reached after the rotor rotates for a given time interval (Mooney time setting). JIS K 6300 specifies measuring the Mooney viscosity four minutes after the preheating time ends. However, SMV-301/301RT models allow the user to specify up to ten Mooney viscosity detection times.
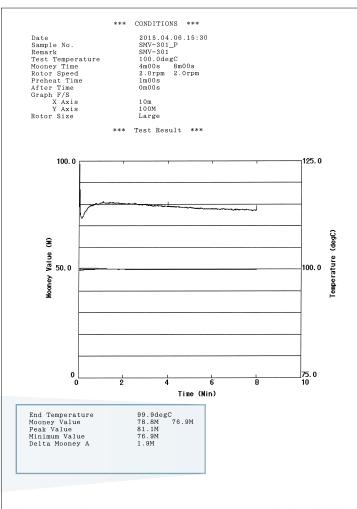

● Screen for Specifying Mooney Viscosity Measurement Conditions

● Sample printout of Mooney viscosity test results

● Mooney Viscosity Test Results

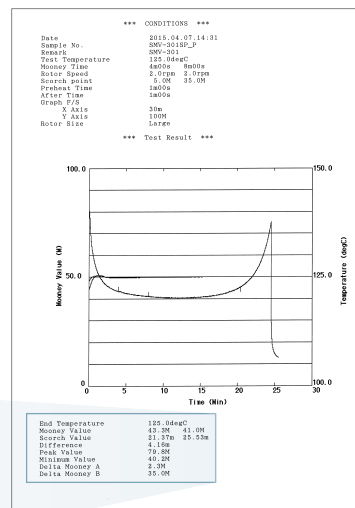|	
End Temperature	99.9degC
Mooney Value	78.8M 76.9M
Peak Value	81.1M
Minimum Value	76.9M
Delta Mooney A	1.9M

Mooney Scorch Test and Measuring Scorch Time

The Mooney scorch test is performed to determine the scorch time of rubber compounds. In the scorch test, viscosity decreases before increasing as vulcanization progresses. The test measures the time (scorch time) it takes for viscosity to increase from a minimum viscosity value (Vm) to a specified increased value (scorch point). JIS standards prescribe a scorch point of 5 M. Model SMV-301 allows the user to specify up to 10 arbitrary scorch points, and measure the peak value (Vp), minimum value (Vm), and scorch times.
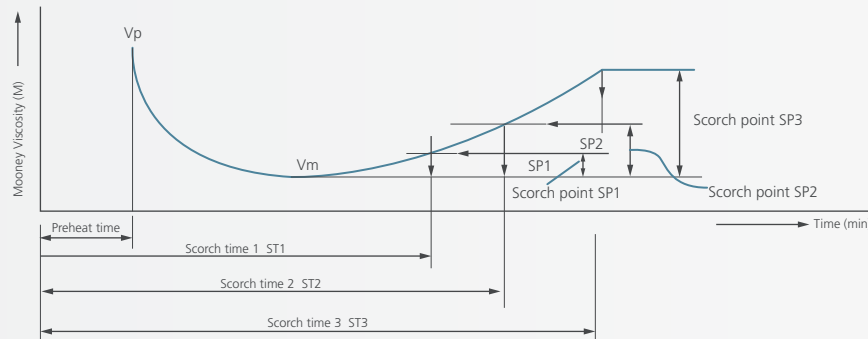
● Screen for Specifying Scorch Point Measurement Conditions

● Sample printout of Mooney scorch test results

● Scorch Point Measurement Test Results

|	
End Temperature	125.0degC
Mooney Value	43.3M 41.0M
Scorch Value	21.37m 25.53m
Difference	4.16m
Peak Value	79.8M
Minimum Value	40.2M
Delta Mooney A	2.3M
Delta Mooney B	35.0M

Capable of Measuring Differences in Mooney Viscosity (in accordance with ISO 289-3)

Delta Mooney A:
The difference in Mooney viscosity between the first and last detection time settings specified is determined.

Delta Mooney B:
The difference in Mooney viscosity between the minimum value (MLmin) and the maximum value thereafter (MLmax) is determined.
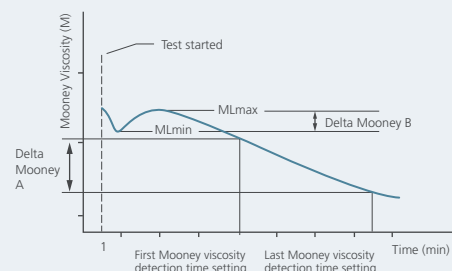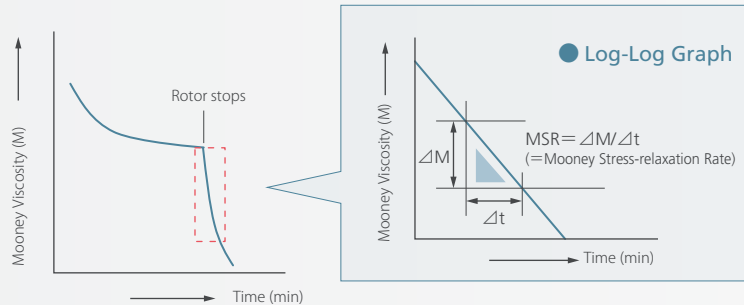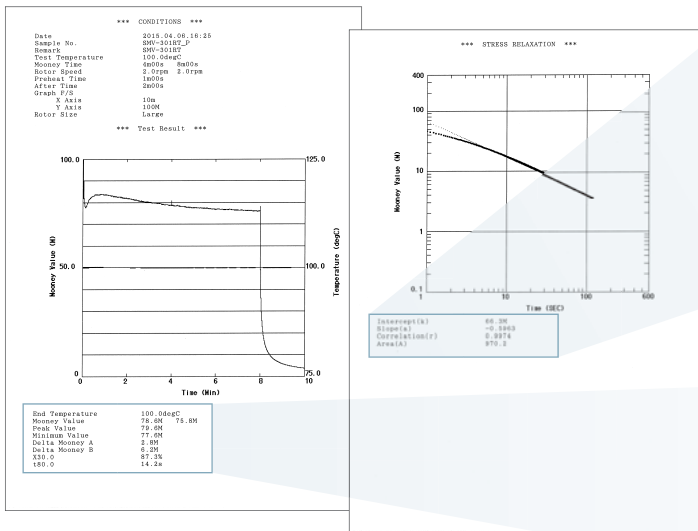
Stress Relaxation Test

The system allows stress relaxation measurements in accordance with ISO 289-4 and ASTM D 1646.

If the rotor is suddenly stopped after the Mooney viscosity test, the stress in the sample attenuates. The stress relaxation test determines the attenuation rate of the stress (torque) as a function of time. The relaxation of stress in rubber materials tends to depend on a combination of viscosity and elasticity, where a slower relaxation indicates a higher level of elastic components and a faster relaxation indicates a higher level of viscous components. The Mooney viscosity reflects the molecular weight of unvulcanized rubber, whereas the stress relaxation value is related to the rubber structure, such as the molecular weight distribution, molecular chains, and gel components. Therefore, it can be used to evaluate the mixing and processing characteristics of rubber.

● Log-Log Graph

$MSR = \Delta M / \Delta t$
(=Mooney Stress-relaxation Rate)

● Sample printout of stress relaxation test results

● Stress Relaxation Test Results (ASTM D 1646)

Intercept(k)	66.3M
Slope(a)	−0.5963
Correlation(r)	0.9974
Area(A)	970.2

● Mooney Viscosity Test Results

| End Temperature	100.0degC	
Mooney Value	78.6M	75.8M
Peak Value	79.6M	
Minimum Value	77.6M	
Delta Mooney A	2.8M	
Delta Mooney B	6.2M	
X30.0	87.3%	
t80.0	14.2s	

Decay Time

tx (sec):
Assuming a 100 % torque value after the rotor stops, tx is the time it takes for the torque to decrease by x % (user specified value).

Xt (%):
Assuming a 100 % torque value after the rotor stops, Xt is the proportional attenuation of torque at a time t seconds after the rotor stops (user-specified value).

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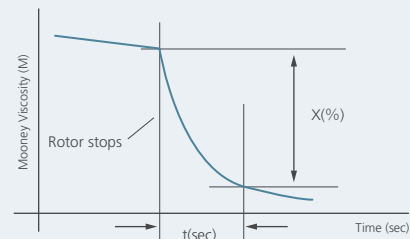
Specifications and System Configuration

Specifications

Model		SMV-301	SMV-301RT
Applicable Standards		JIS K 6300-1 ISO 289-1,2,3,4 ASTM D 1646	
Mooney Viscosity Measurement Range		200 M max. (400 M optionally supported)	
Mooney Viscosity Detection Method		Load cell	
Die	Type	V-groove die (rectangular section groove die available as an option)	
	Pressure	11500 ±500 N in normal use	
	Pressurizing Method	Actuation by air cylinder	
Test Temperature	Control Range	(20 ℃ above room temp.) to 200 °C, in 0.1 ℃ steps	
	Indication Precision	±1 %	
	Temperature Detector	Platinum resistance temperature sensor Pt100, Class A	
Rotor	Type	Large (Small rotor available as an option)	
	Rotor Disengagement	Automatic	
	Rotation Speed	0.209 rad/s (2 rpm)	0.0104 to 2.092 rad/s (0.1 to 20 rpm)
	Rotation Speed Precision	±1 %	±1 %
	Drive Motor	Synchronous motor	Servo motor
Mooney Viscosity Sampling Interval		100 msec min.	
Control PC*	Compatible Operating Systems	Windows 7 (32bit / 64bit)	
	Communication Interface	One USB 2.0 port	
	Display	Min. 1280 × 1024 pixel resolution recommended	
Main Unit Dimensions and Weight	Dimensions	W700 mm x D510 mm x H1440 mm	
	Weight	Approx. 220 kg	Approx. 230 kg
Utilities	Power Requirements	100 V AC, 50 / 60 Hz, 1500 VA	
	Compressed Air Supply	Approx. 0.5 to 0.7 MPa Provide a supply line that can be connected with the coupler (R1/4 socket with female threads) included.	
	Temperature	10 to 35 ℃	
	Humidity	60 % max. (no condensation)	

* A PC is required if optional PC control software is included.
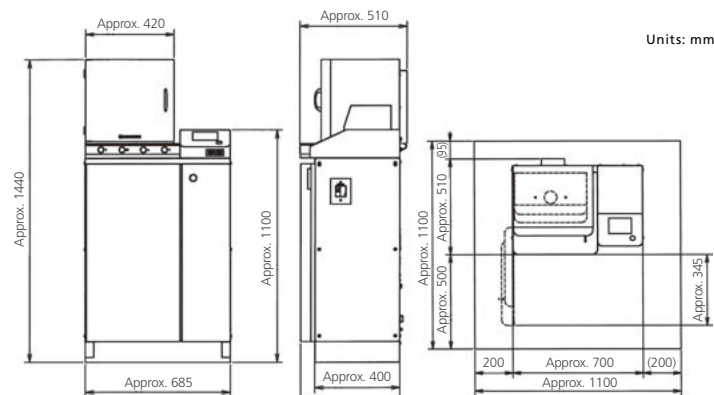
System Configuration

	SMV-301	SMV-301RT
Main Viscometer Unit	1	
V-Groove Die	1 set	
Large Rotor	1	
O-Ring	10	
40 M Standard Weight	2	
20 M Standard Weight	1	
Temperature Detector	2	
Power Cord	1	
Air Hose	1	

Example of Installation Configuration

With laptop PC

External Dimensions

Units: mm

Approx. 420
Approx. 510
Approx. 1440
Approx. 1100
Approx. 685
Approx. 400
Approx. 1100
Approx. 510
Approx. 500
Approx. 700
Approx. 345
200
(200)
(95)

Options

400 M Capability

347-20931-11 (60 Hz)
347-20931-12 (50 Hz)

Mooney viscosities up to 400 M can be measured.
(Only compatible with SMV-301)

Small Rotor

347-21104-11

Used for samples with high viscosity.
(Results in different values from those using the large rotor)

Rectangular-Section Groove Die

347-20927-30 (Set of upper and lower dies)
347-21109-10 (Upper die)
347-21107-30 (Lower die)

Die with rectangular section grooves compliant with JIS K 6300 (1994)
to JIS K 6300-1 (2001).

PC Control Software (USB cable provided)

347-26080-02 (English)
347-26080-03 (Chinese)

Allows SMV-301/301RT units to be connected to a PC for configur-
ing test conditions, displaying data, and analyzing data.

Automatic Calibration Unit (Automatic Weight Calibration Unit)

347-20926-01

Allows using simple operations via the touch panel to calibrate actual
weights and check weights quickly after calibration.

Casters

344-87850-12

The casters make moving the instrument easy.

Anti-topple attachment

347-24975-03

Installed on both sides of the unit to prevent tipping.

Graphic Printer (Printer cable provided) A

347-20928-02 (For 120 V)
347-20928-03 (For 230 V)

Graphic printer for printing measurement data, test conditions,
statistical calculation results, graphs, and so on, on 110 mm
wide paper.
Smaller and faster than an inkjet printer.

Cannot be used at the same time as the A4 size inkjet printer.
Cannot be used in combination with the PC control software.

Signal Tower B

347-21260-10

Allows the user to confirm the instrument power ON, testing,
and error status from a distance.

SMV-301/301RT
Mooney Viscometer

Related Products

Electromagnetic Fatigue and Endurance Testing System
Servopulser EMT Series

Constant Test Force Extrusion Type Capillary Rheometer Flow Tester
CFT-EX Series

Table-Top Precision Universal Tester
AGS-X Series

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