elasticity viscosity

ELASTOMER TESTING

GÖTTFERT
THIS IS RHEOLOGY

BASICS

Elastomer testing

» ELASTOMER TESTING – FOR MORE THAN 45 YEARS! «

VISCOSITY, RHEO-KINETICS, CAPILLARY RHEOMETRY, VULCAMETRY

ELASTOMER TESTING FOR DETERMINATION OF THE PROCESSING BEHAVIOR OF REACTIVE MATERIALS

In order to fulfill the continuous increasing requirements in regard to quality and consistency of rubber products, it is essential to make a comprehensive characterization of the raw compound while processing.

Elastomeric compounds are complex multiple mixture out of main components like polymers, fillers, plasticizes, additives and vulcanizing chemicals.
The interactions of various materials cause a more or less high effect on the material properties and at the same time provide a wider range of characteristics.

The most important processing criteria for the final product are the flow and the vulcanization behavior as well as the filling agent distribution.
While testing these characteristics there should be differenced among the production accompanying testing and the testing during developing phase, for example to simulate application dependent processes.
The production accompanying testing serves primarily for quality control and requires a statistical analysis.

In a growing manner the computerized process models apply for screw and molding definition.
A full rheological characterization of the elastomeric compound already while developing state of the elastomeric product is therefore indispensable.

Our testing machinery is well suited for both testing applications.
We would like to present our systems that meet industrial standards by a robust construction, each with individual features, providing their measuring reliability especially in continuous operation. As usual they could be configured to specific needs.

Under continuous supervision by a certified and approved quality management system, our equipment is developed and manufactured as per the latest technical standards.

Creativity and the long-lasting experience of our team keep our systems improving. Latest up-to-date working circumferences support constructive heads to implement technical expertise in market orientated products.

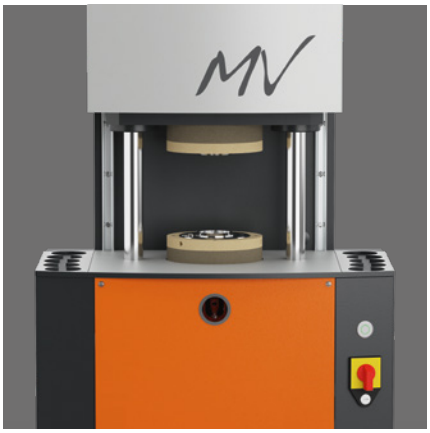
GÖTTFERT does not supply only tailor made machinery as per industrial needs, but also professional support and fast and transparent service along with fundamental data exchange under rheological aspects.

MOONEY-VISKOSIMETER

Rotational shearing disk viscosimeter
Standardized procedure for reliable test results

HIGHLIGHTS

- Standard and dynamic viscosity testing
- Universal handling with one multi function button (status display via color)
- High sensitive and precise torque transducer up to 200 ME
- Constant rotor speed of 2 min^{-1} (optional 0.1 to 5 min^{-1} or 0.1 to 50 min^{-1}, important for relaxation measurements)
- Speed acceleration in steps or linear
- Rotor stop in less than 20 m/s for exact relaxation measurements
- Variable test die with profile standardized ground, top and wall surface
- Variable shear disk diameter (38.1 mm/30.48 mm)
- Pneumatic locking unit of the test chamber with max. 12.7 kN locking force
- Temperature control up to 200 °C, resolution +/- 0.1 °C
- High measuring accuracy by optimized tempering of the test chamber and rotor
- Long-life seals



MOONEY

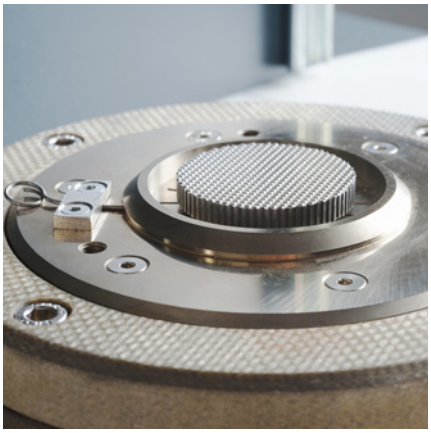
A rotational shearing disk viscometer with closed chamber and rotor, which is used to determine the **Mooney Viscosity, scorch characteristics and stress relaxation** of rubber compounds, pure natural rubber or synthetic rubber.

Measurement procedures are:
- Mooney Viscosity (Plasticity)
- Mooney Scorch
- Mooney Relaxation
- Delta Mooney
- Dynamic testing by variable speed option

According the standards:
- ISO 289 part 1-4
- ASTM D1646
- DIN 53523 part 1-4

SIGNIFICANCE

The test sample consists of two round blanks (formed using a punch), one of it has a bore hole in the center for passing through the rotor. The punched test samples are formed homogeneous. The sample is being sheared in the closed test die under the constant speed turning rotor. With the constant values pressure, temperature and rotation speed the resulting torque is being saved and evaluated.



OPTIONS

- Free definable speed from 0.1 to 5 min^{-1}
- Free definable speed from 0.1 to 50 min^{-1}
- Rotor detection
- Chamber cooling/-tempering (Air- or Liquid tempering)
- Torque calibration device
- Volume punch

ELASTOGRAPH

Moving Die Rheometer (MDR)

HIGHLIGHTS

- Measurements with 50 min^{-1} (0.833 Hz)/100 min^{-1} (1,66 Hz) selectable
- Two frequencies by fix or variable strain rates
- Various test die design for different kind of materials (shore, liquid, bi-conical open, closed)
- Extremely fast temperature control and a homogeneous temperature distribution in the reaction die
- Torque recording
- Build-in Ethernet interface for data transfer to a PC

Open test die

Closed test die

ELASTOGRAPH

Deformation Amplitude:
Standard +/- 0.5° (optionally selectable one additional angle between +/- 0.1 up to +/- 1°)

A rotor less rotational shear vulcameter with different test die design, which is used for characterization and vulcanization of rubber compounds in the plasticized condition, during vulcanization phase and in the fully vulcanized sample.

Measurement procedures are:
- Vulcanization
- Isothermal & Non-isothermal measurement procedures

According the standards:
- ISO 6502
- ASTM D5289
- DIN 53529

ELASTOGRAPH-S

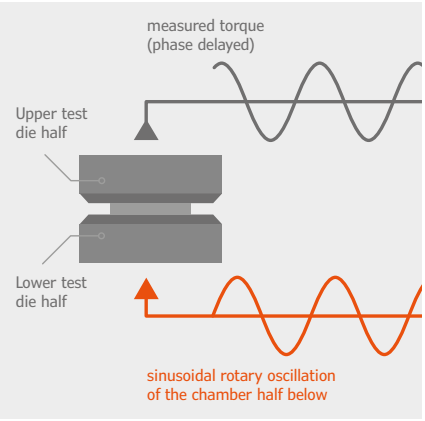
Direct drive system with variable deformation amplitude:
From +/- 0.1° to +/- 10°

Strain rates:
From 1.4 % - 55.8 %

OPTIONS

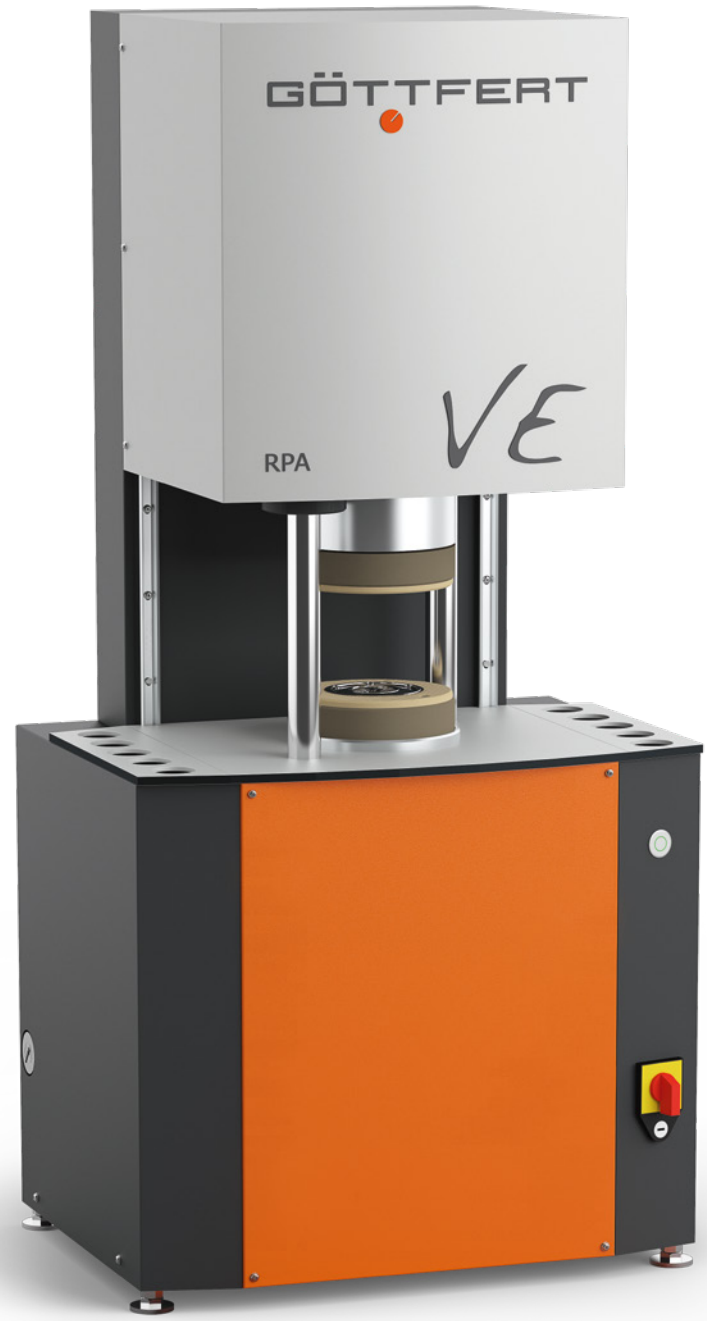
- Normal force measurement
- Air cooling
- Torque calibration device (torsion bar)
- Volume punch
- Autoloader (Automatic sample feeder)

The test sample consists of one round blanks (formed using a punch). The sample is being forced in the lower test die half by a sine rotation oscillation. Torque and phase angle are determined as a function of the measuring time.



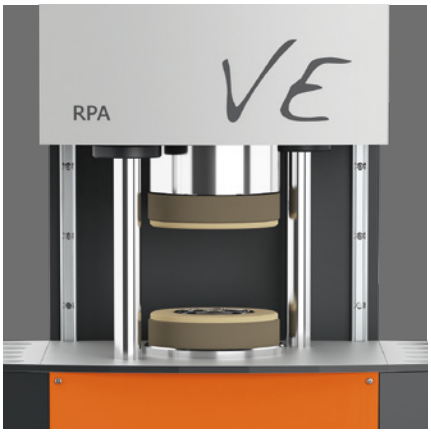
VISCO-ELASTOGRAPH

Rubber Process Analyzer (RPA)



HIGHLIGHTS

- Dynamic testing of rubber compounds
- Wide frequency range
  (0.01 Hz up to 100 Hz)
- Wide amplitude range
  (0.01° up to 90°)
- Temperature range up to 230 °C
  with extreme fast temperature control and homogeneous temperature distribution in the test die
- Various test die design for different kind of materials
- Matrix tests
  Setting of 12 test cycles/per cycle
  – preconditioning:
  50 measurement steps
  => in total 612 sequences
- Automatic run of the measurement steps
- Max. Shear rate 43 s^{-1}



VISCO-ELASTOGRAPH

Our VISCO-ELASTOGRAPH is a Dynamic Rheometer for analysis of Viscoelastic Material Properties.
It is a rotor less shear vulcameter with variable oscillation frequency and amplitude for analysis, characterization and process simulation of raw polymers, basic and ready compounds.
The sensitive testing method is well suited to define polymer properties with highest sensitivity and reproducibility.
Furthermore for development and typify raw polymers and compounds based on their average of molecular weight distribution.

The sample is being forced in the lower test die half by a sine rotation oscillation. Torque and phase angle are determined as a function of the measuring time.

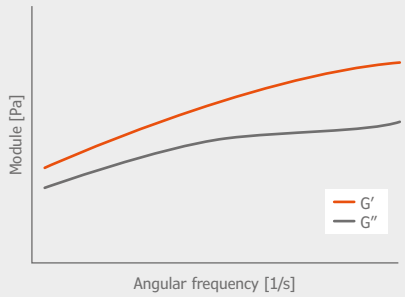
Measurement procedures are:
- Isothermal / Non-isothermal cure
- Frequency sweep
- Amplitude sweep
- Temperature sweep
- Ramp test
- Relaxation test
- Retardation
- Hysteresis

According the standards:
- ASTM D5289
- ASTM D6204
- ASTM D6601
- ISO 6502
- ASTM D7050
- ASTM D7605 (different test die geometry is required)
- ASTM D6048
- ISO 13145

OPTIONS

- Normal force measurement
- Test die cooling (Air cooling VORTEX)
- Torque calibration device
- Volume punch
- Autoloader

STORAGE- (G‘) AND LOSS MODE (G“)



RUBBER CAPILLARY RHEOMETER

„Horizontal" measuring stress controlled

HIGHLIGHTS

- Test under production and processing conditions
- Pressure- or speed controlled
- Test piston force of max. 20 kN or max. 75 kN
- Test piston diameter 20, 30 or 35 mm
- Short test intervals of less than 3 minutes
- High dynamic speed range: 1:800.000
- High dynamic piston acceleration: 0 - 15 mm/s in 0.35 s
- Position acquisition: high resolution encoder (0.00000064 mm)
- Dynamic test mode "constant speed" (3 steps)
- Both versions, including the known RHEOVULKAMETER functions of the previous generation work-speed and stress controlled.

RCR 20

Test piston force of max. 20 kN

RCR 75

Test piston force of max. 75 kN

RCR

Our RCR is an innovative Capillary Rheometer to determine the flow behavior of rubbers under special physical processing conditions.

The RCR operate in two test modes:
- Either "Extrusion mode" (flow behavior)
- Or "Injection mode" (with ramification- and/or spiral mold)

It meets following standards:
Operation as Rheovulcameter
- GFT 014-02

Operation as RCR (20 mm piston)
- ISO11443
- ASTM D5099

OPTIONS

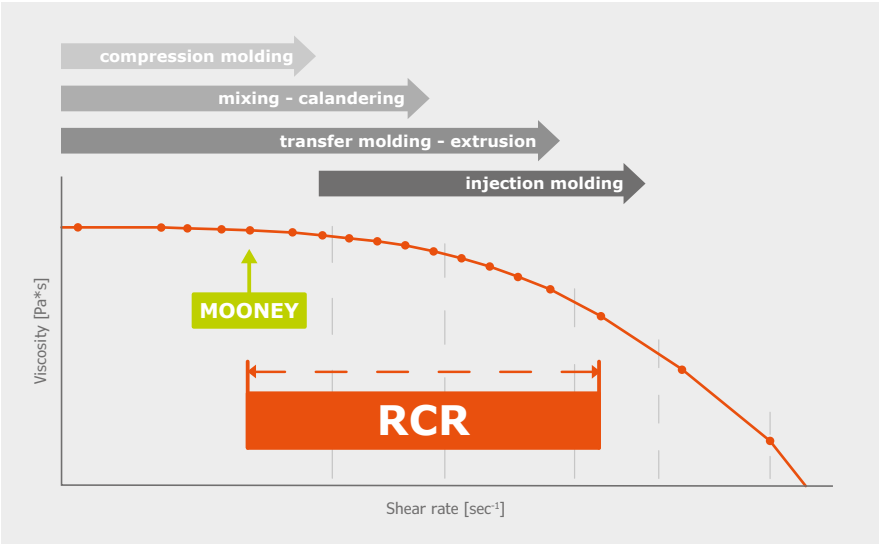
- Different Molds (Injection mode)
- Test die with heat insulation (Injection mode)
- Divided capillaries (Extrusion mode)
- Die Swell Measurement
- Volume punch

Extrusion

Injection

Ramification Mold

Spiral Mold

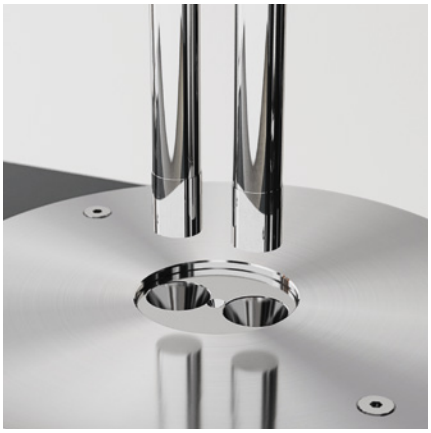


RHEOGRAPH 120

High Pressure Capillary Rheometer

HIGHLIGHTS

- Single, twin or triple test barrel system with different test barrel geometries
- Constant high test force up to 120 kN
- Speed range from 0.00004 mm/s to 40 mm/s (= 1:1000000)
- Servo-drive, high dynamic test piston acceleration from 0 to 40 mm/s in 0.6 seconds!
- Position capture with high resolution encoder (step size 0.0000016 mm)
- Temperature range up to 400 °C (500 °C optional), display resolution 0.01 °C
- Automatic pressure transducer detection and identification „Plug&Test“
- Adaptive signal resolution of 0.005 % from the range of the pressure transducer
- Pressure transducer measurement range up to 2500 bar
- Timer function
- Special “Extrude mode””
- High safety shut down
- Multi monitoring of overload drive, force, pressure, heaters
- Automated Script file functionality



RHEOGRAPH 120

Not only suitable for high polymers – but also for elastomers!

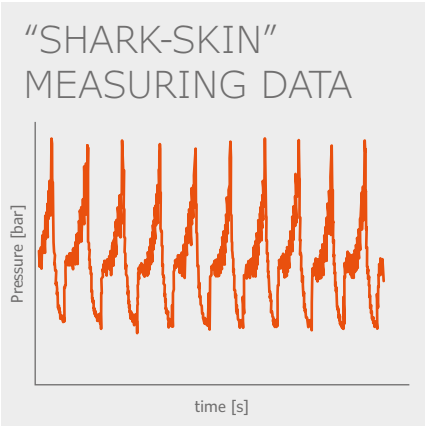
The complete multi-functional **RHEOGRAPH** family is also suitable to determine the flow and viscosity function on rubber compounds.

It can be used as a tool to optimize the development on new blends.

The system allows extensive and process near simulations for material characterization.

Expressive evaluations, e.g. like Mooney correction (wall slip behavior) or flow instabilities (Shark Skin Effect) can be carried out easily.

It meets following standards:
- ISO 11443
- ASTM D 3835
- DIN 54811
- ASTM D 5930 (Option)
- ISO 17744 (Option)
- ASTM D 5099 (Option)



OPTIONS

- Determination of flow instabilities (Shark-Skin effect)
- Thermal conductivity
- PVT, isothermal or isobaric
- Die swell measurement, static and dynamic
- Counter pressure chamber
- Slit die
- Melt temperature via thermocouple
- Corrosion resistant and wear resistant test barrel design
- Advanced tempering of the test chamber
- RHEOTENS and HAUL-OFF-System to determine the melt tensile
- CONTIFEED

OPTIONS

VOLUME PUNCHES

The pre-condition for reproducible tests are test samples with a constant volume.

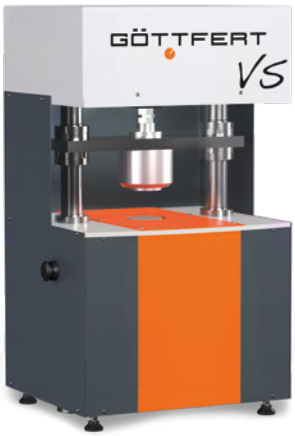
The following volume punches cuts out of an unvulcanized batch with different thickness rates a test sample with a constant volume. Precise components for accurate test results, two-hand operation for user safety.

The punching procedure is being released by a two-hand operation to ensure the safety of the operator. At first, the batch will be compressed - therefore excess material flows out or it is pressed out. Then the actual punching operation is performed. The volume of the sample can be adjusted exactly and the compression time is variable too.

Our product range contains two different kinds of volume punches:
On one hand the hand-operated-volume punches and on the other hand the pneumatic volume punches.

Hand-Operated Volume Punches:
- Hand-Operated Volume Punch 83.00 (for MDR, RPA, RCR)
- Mooney Hand-Operated Volume Punch (especially for Mooney-Viskosimeter)

Pneumatic Volume Punches:
- Pneumatic Volume Punch 89.00 (for MDR, RPA, RCR)
- Pneumatic Volume Punch 89.17 / max. 18kN (for MDR, RPA, RCR)
- Mooney Pneumatic Volume Punch (especially for Mooney-Viskosimeter)



OPTIONS

AUTOMATIC SAMPLE FEEDER

With the optional Autoloader system, 5 samples linear or up to 30 test samples with one magazine can be transported into the test die and measured automatically step by step between 2 temperature resistant flat films.

The system identifies the filling level as well as the sample position in the magazine.

The tested sample is also being removed after the run. During the test free places can be charged with new ones for a continuous run.

The Software "RubberView" offers the possibility to predefine variable sequences.

Furthermore running test plans can be interrupted and then being continued again.

SOFTWARE „RUBBERVIEW“

Only a short view into the possibilities

HIGHLIGHTS

- Data handling in/out of local or network data bases with converting and compression function
- Automatic read in function of the test device information
- Free arrangement and display of the raw data and evaluation graphic
- Continuous monitoring of the current machine operating status
- Clear structured organization by single packets „test plan“, „test parameter“ and „test criteria“
- Subsequently recalculation and data updating when changing the test criteria, the measurement must not be repeated.
- Self-definable check boxes for time saving selection
- Self-explaining dialog windows and information fields, online help
- Open platform for user application fields, filter for measurements
- Selectable access rights for optimal

RUBBERVIEW

RubberView is the database Software for ELASTOGRAPH, VISCO-ELASTOGRAPH, MOONEY-VISKOSIMETER and RCR (RHEOVULKAMETER).

The program is used for parameterization, for control of the measuring procedure as well as for evaluation under a simple to use and clearly represented desktop. Special applications are allowed to implement very quickly.

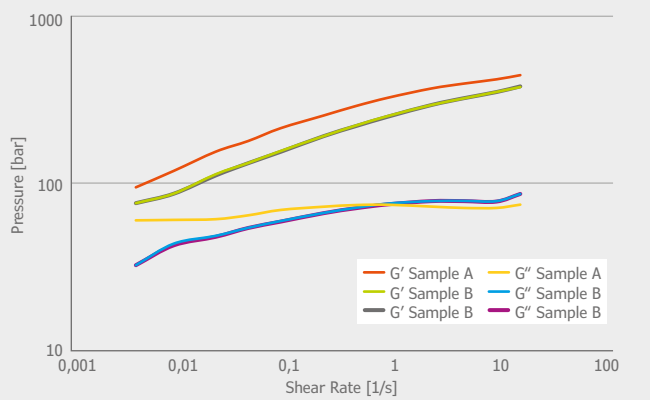
All data sets are being shown in table form and in diagrams, new measurements can be added, existing ones being modified and changed or deleted.

Quick help via safe TeamViewer connection possible!

MORE HIGHLIGHTS OF THE SOFTWARE

- Large portfolio with evaluating methods
- Definable limit curves, single limit values, times, tolerances, units
- Free design, size and placement of all display values
- Predefine menus for a faster parameterization, like e.g. automatic measurement name, user selection
- Data export to Microsoft EXCEL®
- "XML-interface for connection to LIMS systems "
- Report creation
- XML-connection

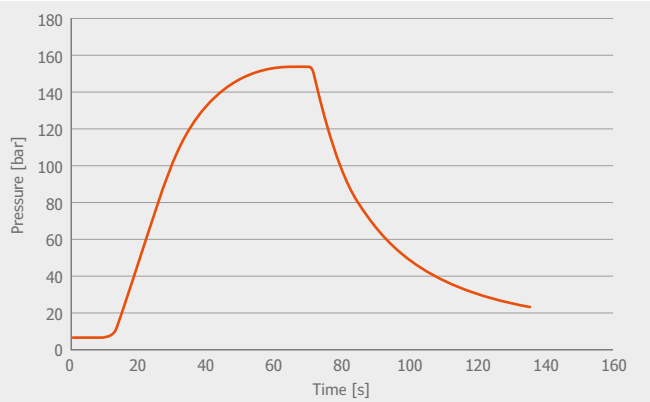
MATERIAL CHARACTERIZATION



STORAGE AND LOSS MODE

The diagram shows the storage and the loss mode of 2 NBR compounds with different raw polymers.
This evaluation serves a comparison between the elastic and the viscous material behavior

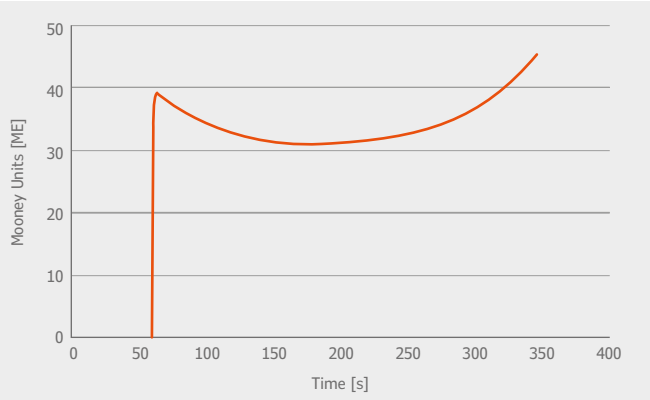
- VISCO-ELASTOGRAPH



RELAXATION

The measurement of the relaxing time is being determined out of a disturbance test.
It characterize the viscoelastic material behavior and is important for process near properties.

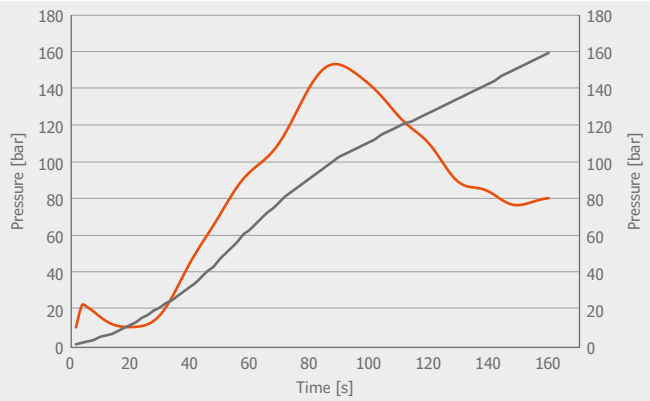
- VISCO-ELASTOGRAPH
- MOONEY-VISKOSIMETER



MOONEY-SCORCH

The Mooney-Scorch mode characterize the scorching (vulcanizing) behavior of a test sample at a higher temperature.
In this case the time is being detected where the viscosity increase by a given value.

- MOONEY-VISKOSIMETER



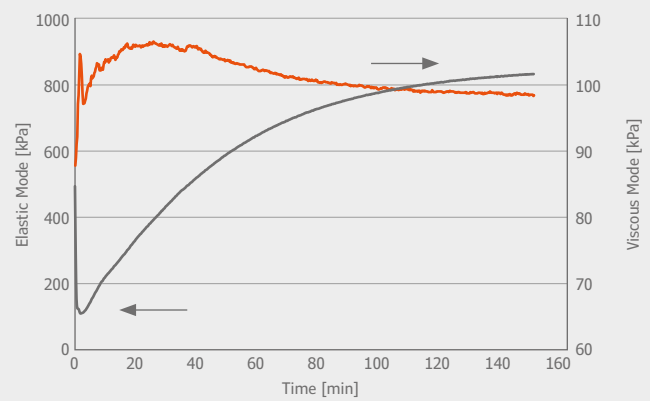
RUBBER CAPILLARY RHEOMETER RCR

The extrusion through a die and the injection into a tool is a process near machining test for extrusion and injection molding.

- RUBBER CAPILLARY RHEOMETER

EVALUATION METHODS

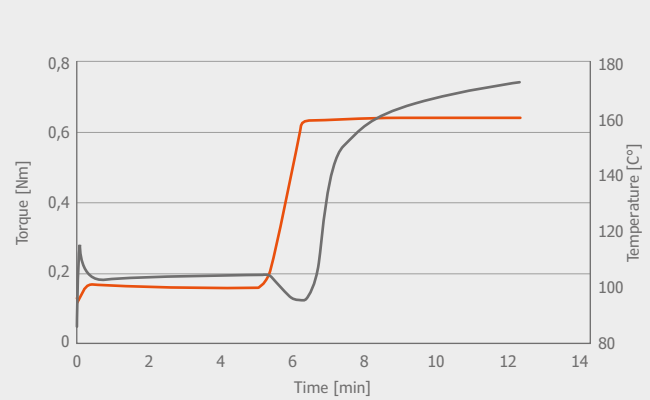
Extractions of the capability



VARIABLE TIME

Comparable with the usual Vulkameter test here the module and the viscosity via the time are being captured at constant amplitude and frequency.

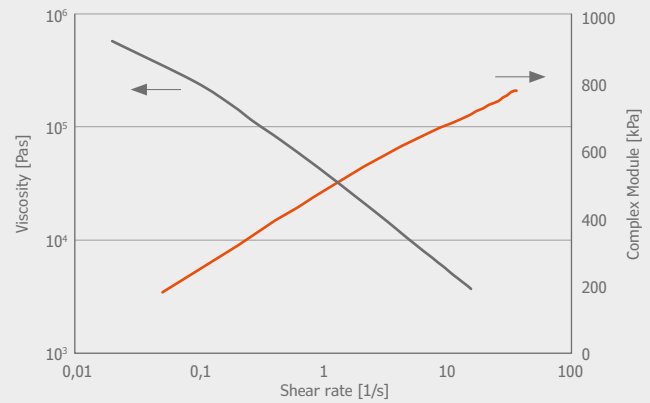
- ELASTOGRAPH
- VISCO-ELASTOGRAPH



TEMPERATURE SWEEP

Via an integrated temperature program definable temperature steps can be individually realized. The example here shows a non-isothermal vulcanization.

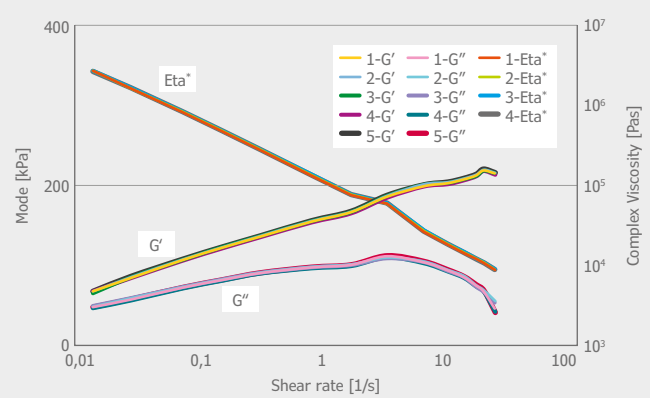
- ELASTOGRAPH
- VISCO-ELASTOGRAPH



FREQUENCY SWEEP

The swinging deformation of the lower chamber half can be controlled exactly between 0.1 to 50 Hz. Torque, module and viscosity are being measured at preselected amplitude. Classic test to determine the flow curve.

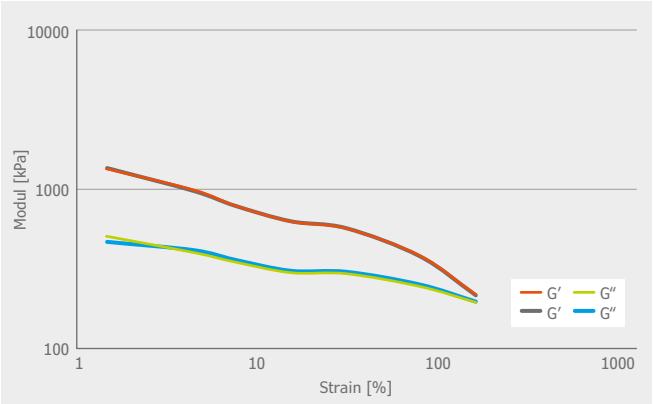
- VISCO-ELASTOGRAPH



MULTIPLE REPRODUCTION

Frequency sweep of a flour elastomer compound, 5 times reproduced.

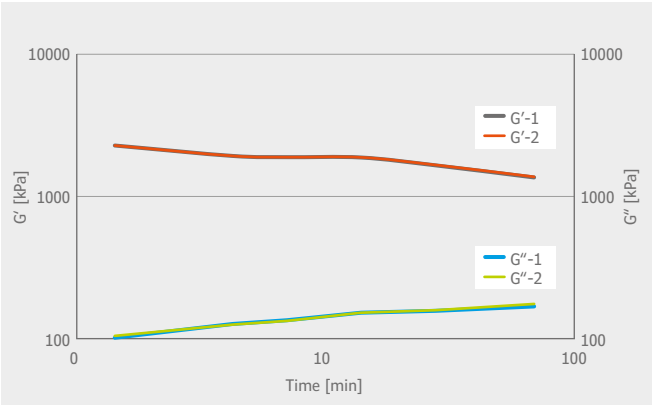
- VISCO-ELASTOGRAPH



AMPLITUDE SWEEP NON VULCANIZED

With this measurement variable ramified polymers can be differentiated to various active filling additives (here at an example of a flour elastomer compound).

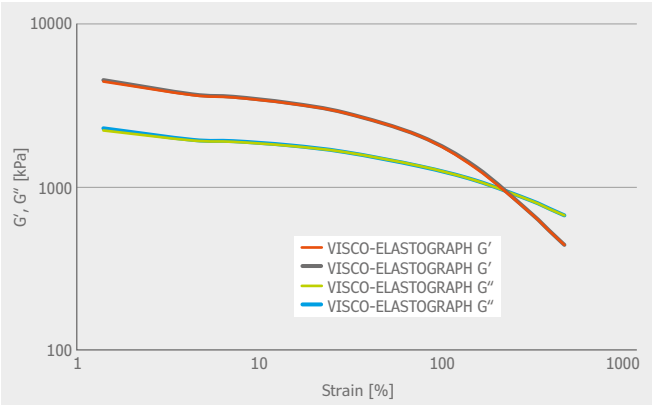
- VISCO-ELASTOGRAPH



AMPLITUDE SWEEP VULCANIZED

Is being used to judge the network which is raised during the vulcanization.

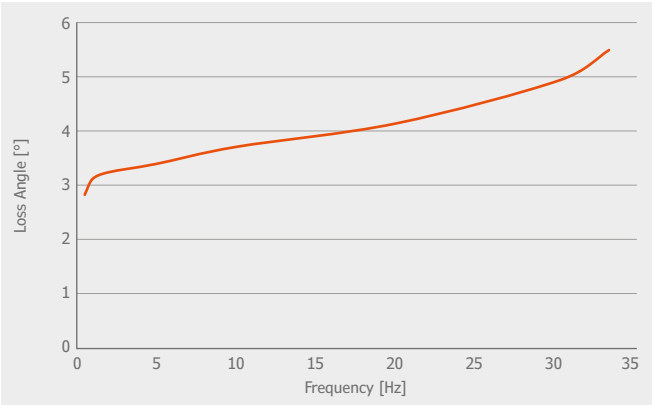
- VISCO-ELASTOGRAPH



PAYNE-EFFECT

An amplitude sweep at an non vulcanized compound shows the Payne effect. The crossing point of G‘ and G‘‘ helps judging the filler medium network.

- VISCO-ELASTOGRAPH



FREQUENCY DEPENDENCE OF THE PHASE ANGLE

On the basis of the trend of the phase angle a conclusion about the damping behavior of the compound can be given (the test here at a completely vulcanized compound)

- VISCO-ELASTOGRAPH

Rev. C - 07/2019

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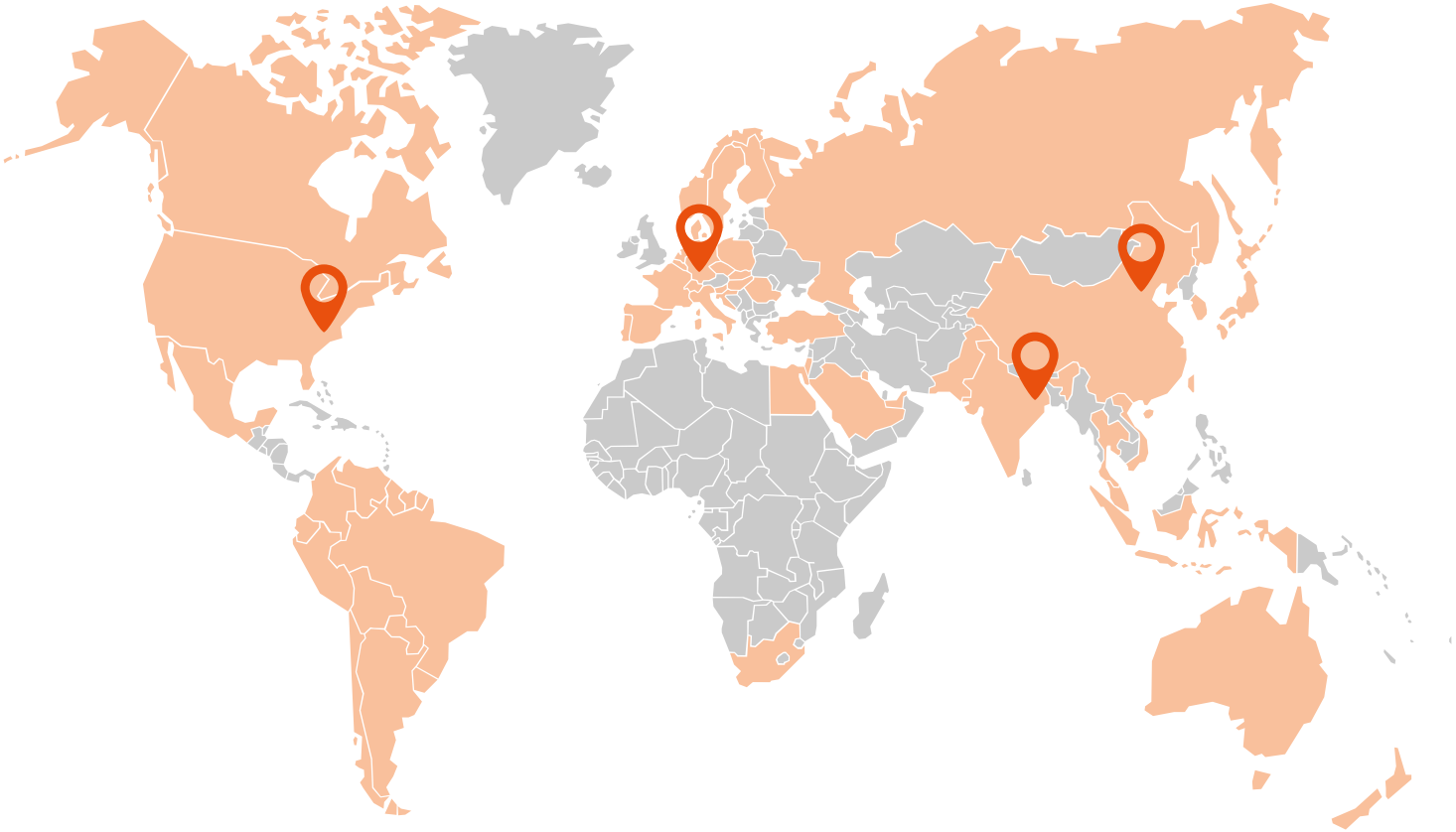

GÖTTFERT | Werkstoff-Prüfmaschinen GmbH
74722 Buchen
+49 (0) 62 81 408-0
info@goettfert.de

GOETTFERT Inc.
Rock Hill, SC 29730
USA
+1 803 324 3883
info@goettfert.com

GOETTFERT (China) Ltd.
Beijing 100027
CHINA
+86-10-848 320 51
info@goettfert-china.com

GOETTFERT | Dataphysics Instruments India Pvt. Ltd.
Kolkata - 700 010 - INDIEN
+91-9339867536
info@gdinstruments.co.in