



elasticity



viscosity

ELASTOMER TESTING



BASICS

Elastomer testing

Elastomer Testing - for more than 45 years!
Viscosity, Rheo-Kinetics, Capillary Rheometry, Vulcametry



ELASTOMER TESTING FOR DETERMINATION OF THE PROCESSING BEHAVIOUR OF REACTIVE MATERIALS

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

Elastomeric compounds are complex multiple mixture out of main components like polymers, fillers, plasticizers, 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 vulcanisation behaviour as well as the filling agent distribution.

While testing these characteristics there should be differentiated 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 moulding 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.

GOETTFERT 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.

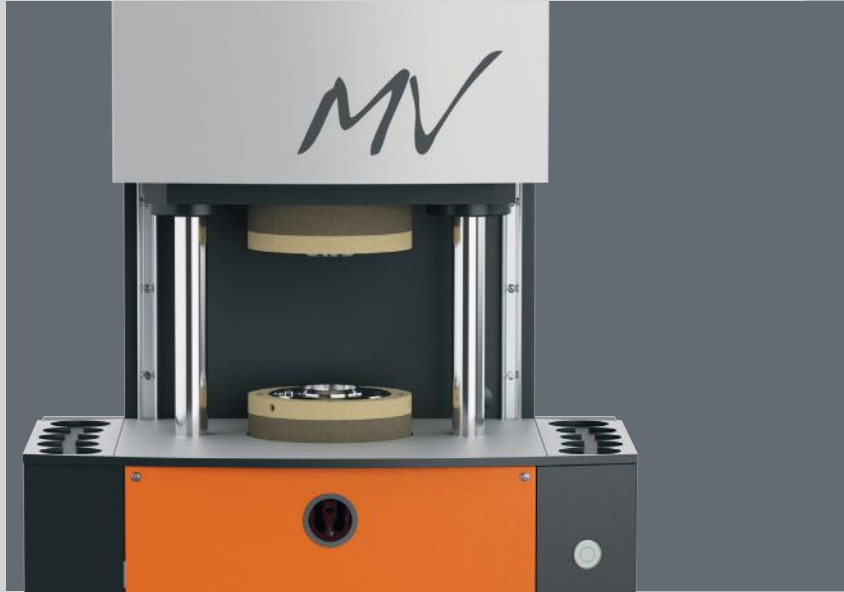
MOONEY - VISKOSIMETER

*Rotational Shearing Disc Viskosimeter
Standardized procedure for reliable test results*



HIGHLIGHTS

- Standard and dynamic viscosity testing
- Universal handling with one multi function button (status display via colour)
- High sensitive and precise torque transducer up to 200 MU
- 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 msec for exact relaxation measurements
- Variable test chamber with profile standardized ground, top and wall surface
- Variable shear disk diameter (38.1mm / 30.48mm)
- 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 disc viskosimeter 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.

The **MOONEY-VISKOSIMETER** can handle the following measuring types

- 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 centre for passing through the rotor. The punched test samples are formed homogenous. The sample is being sheared in the closed test chamber 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 check device
- Volume punch



ELASTOGRAPH

Moving Die Rheometer (MDR)



THE HIGHLIGHTS

- Measurements with 50min⁻¹ (0.833Hz) / 100min⁻¹ (1,66Hz) selectable
- Two frequencies by fix or variable strain rates
- Different test chamber design for all kind of materials (shore, liquid, biconical 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



ELASTOGRAPH

Deformation Amplitude:
Standard $\pm 0.5^\circ$
(optionally selectable one additional
angle between ± 0.1 up to $\pm 1^\circ$)



ELASTOGRAPH-S

Direct drive system with variable
deformation amplitude:
from $\pm 0.1^\circ$ to $\pm 10^\circ$

Strain rates:
from 1.4% - 55.8%

ELASTOGRAPH

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

Measurement procedures are

- Vulcanisation
- Isothermal & Non-isothermal measurement procedures

According the standards

- ISO 6502,
- ASTM D5289
- DIN 53529



Open
testing chamber

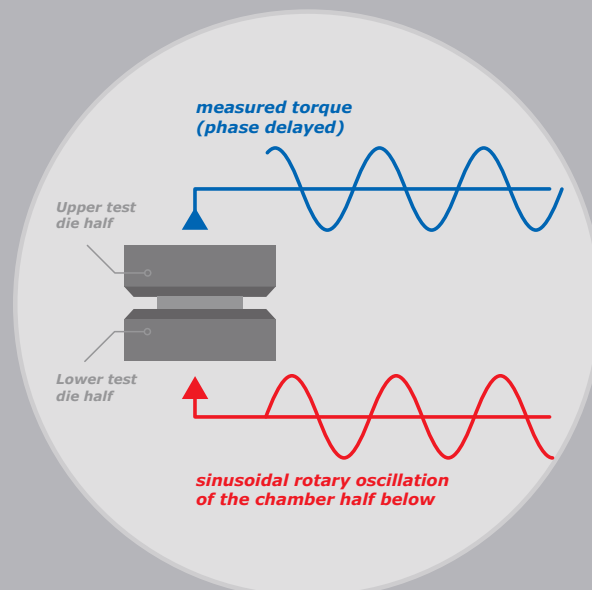


Closed
testing chamber

OPTIONS

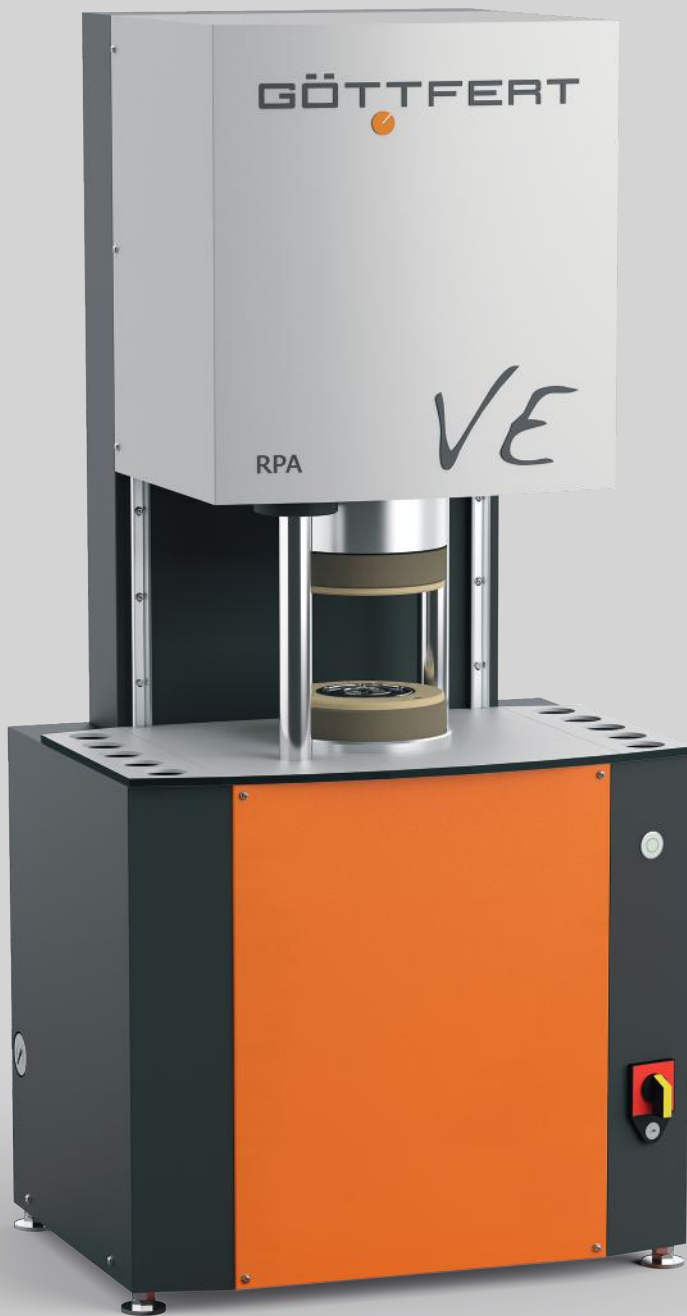
- Normal force measurement
- Air cooling
- Torque calibration unit (torsion bar)
- Volume punch
- Autoloader (Automatic sample feeder)

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.



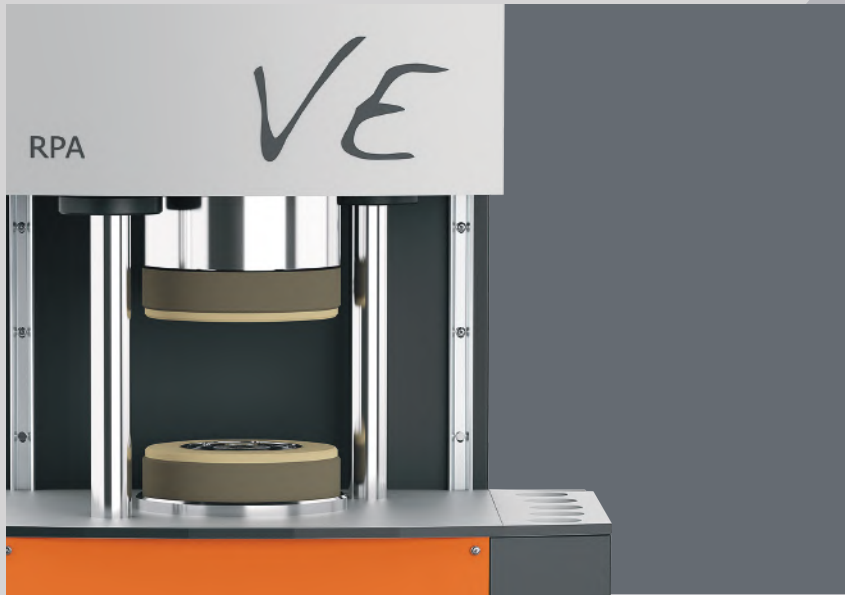
VISCO - ELASTOGRAPH

Rubber Process Analyzer (RPA)



THE 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
- Different test chamber design for all 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 rotorless 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.

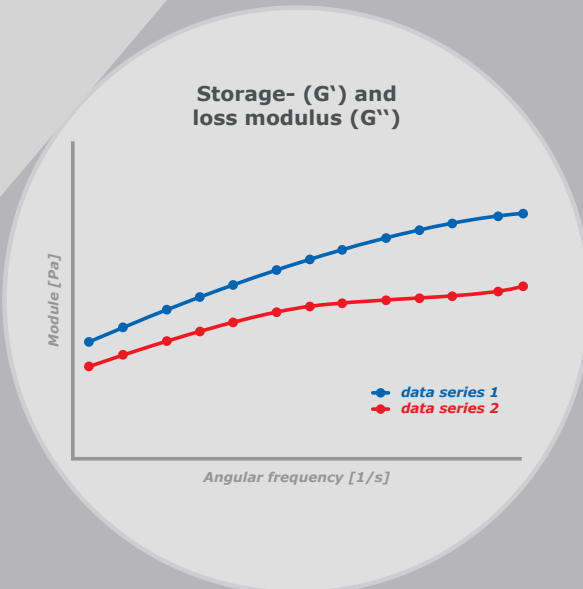
The sample is being forced in the lower test die half by a sine rotation oscillation. Torque and phase angle are determined as a function of the measuring time.

The measurement procedures of Visco-Elastograph 04.12 are:

- Isothermal / Non-isothermal cure
- Frequency sweep
- Amplitude sweep
- Temperature sweep
- Ramp test
- Relaxation test
- Retardation
- Hysteresis

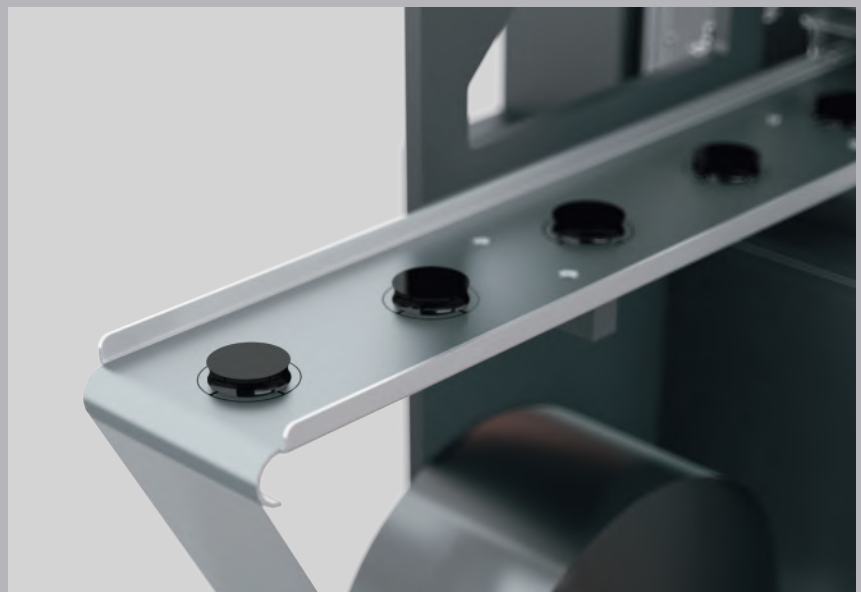
According the standards

- ASTM D5289
- ASTM D6204
- ASTM D6601
- ISO 6502
- ASTM D7050
- ASTM D7605 (different test chamber geometry is required)
- ASTM D6048
- ISO 13145



OPTIONS

- Normal force measurement
- Test chamber cooling (Air cooling VORTEX)
- Torque calibration unit
- Volume punch
- Autoloader



RUBBER CAPILLARY RHEOMETER

"Horizontal" measuring stress controlled



THE HIGHLIGHTS

- Test under production and processing conditions
- Pressure- or speed controlled
- Test piston force of max. 20kN or max. 75kN
- 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. 20kN



RCR 75

Test piston force of max. 75kN

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 behaviour)
- or "Injection mode" (with ramification- and/or spiral mould)

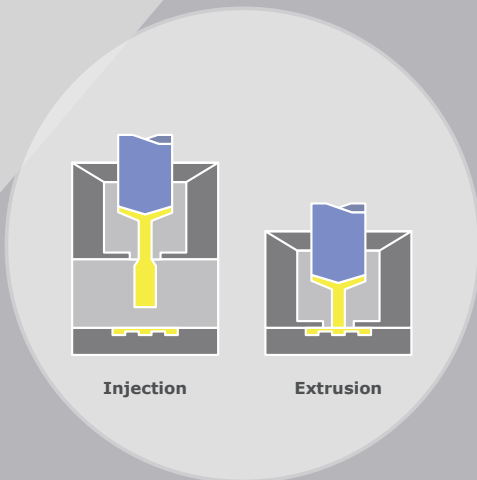
It meets following standards:

Operation as Rheovulcameter

- GFT 014-02

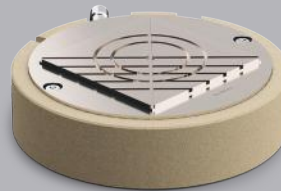
Operation as RCR (20 mm piston)

- ISO11443
- ASTM D5099



Injection

Extrusion



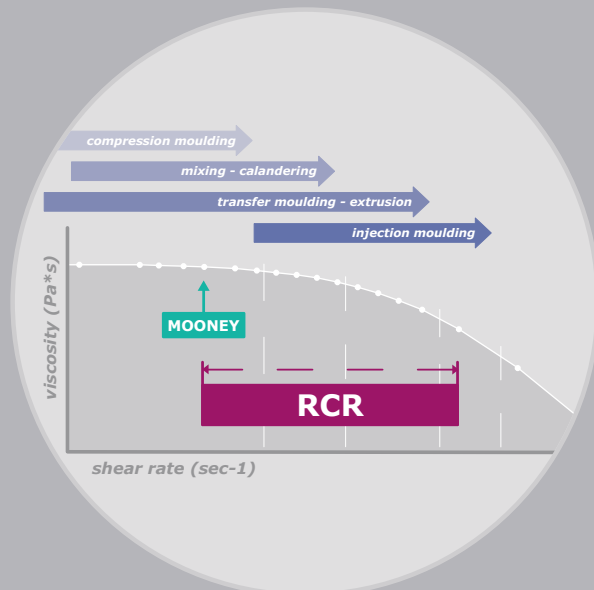
Ramification Mould



Spiral Mould

OPTIONS

- Different Moulds (Injection mode)
- Test chamber with heat insulation (Injection mode)
- Divided capillaries (Extrusion mode)
- Die Swell Measurement
- Autoloader
- Volume punch



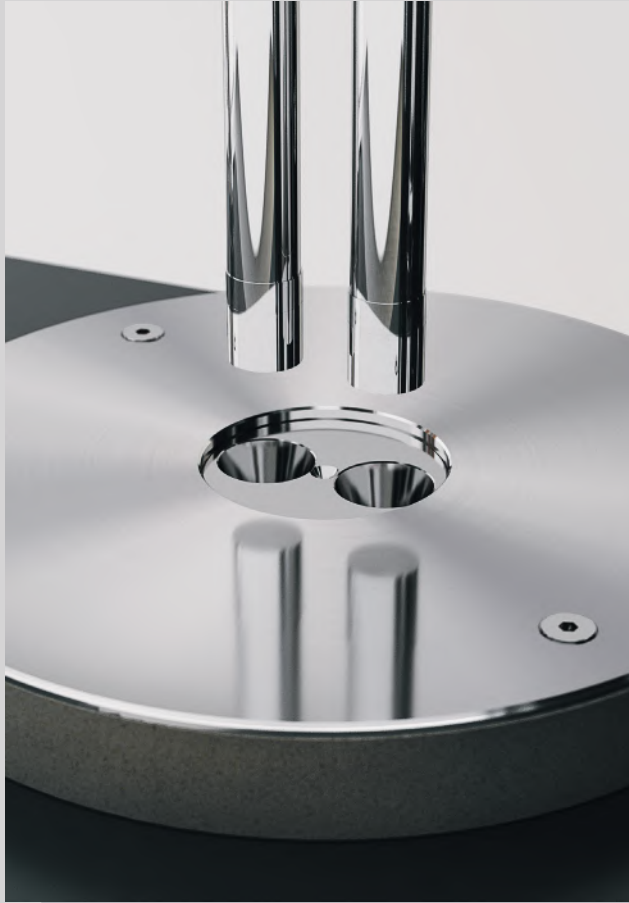
RHEOGRAPH 120

High Pressure Capillary Rheometer



THE 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/sec to 40 mm/sec (= 1:1000000)
- Servo-drive, high dynamic test piston acceleration from 0 to 40 mm/sec 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 multifunctional **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 behaviour) or flow instabilities (Shark Skin Effect) can be carried out easily.

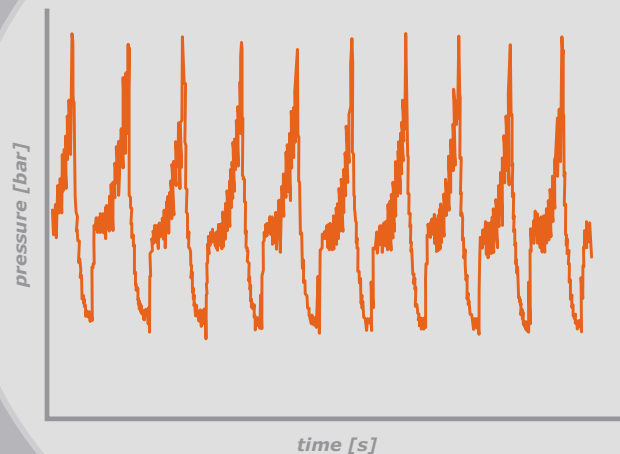
It meets following standards:

- 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

"Shark-Skin" Measuring data



OPTIONS

Volume Punch



VOLUME PUNCH

For reproducible tests the test samples with a constant volume are absolutely required.

The following volume punches cut 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.

Different models available:

Hand-operated Volume Punch
Pneumatic Volume Punch 16.5kN
Pneumatic Volume Punch 13,5kN

Mooney pneumatic Volume Punch
Hand-operated Mooney Volume Punch

Features

- High cutting pressure
- Variable volume range
- Various cutting tools
- Selection hand gear for the sample profile



OPTIONS

Autoloader



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 chamber 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 ...

THE 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 organisation 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 checkboxes 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).

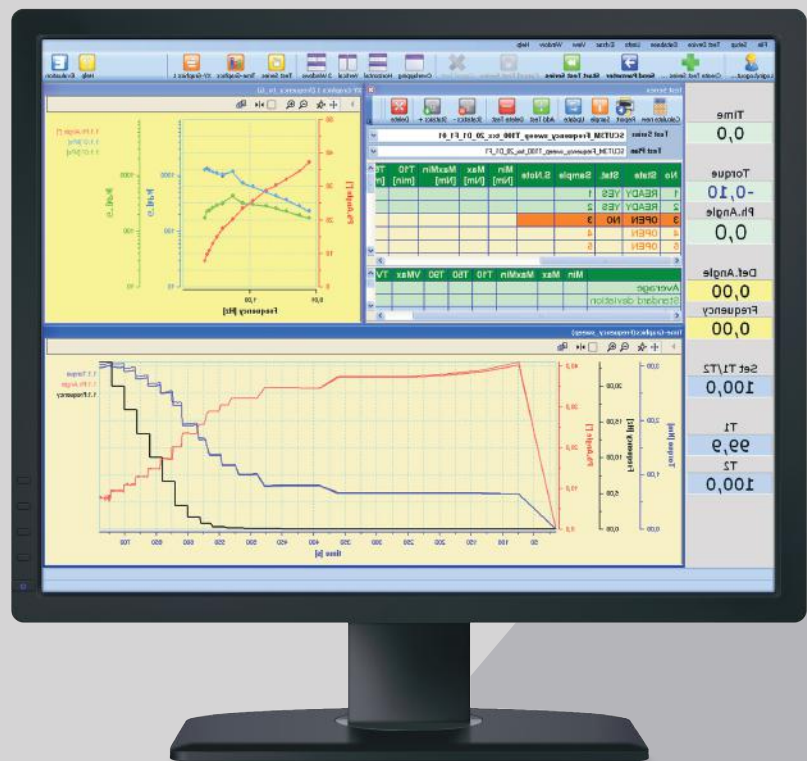
The program is used for parameterization, for control of the measuring procedure as well as for evaluation under a simple to use and clearly represented desktop. Special applications are allowed to implement very quickly.

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!

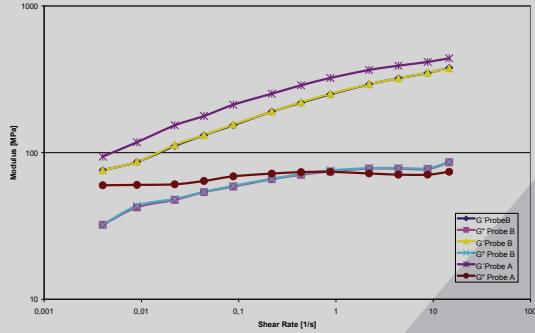
MORE HIGHLIGHTS OF THE SOFTWARE:

- Large portfolio with evaluating methods
- Definable limit curves, single limit values, times, tolerances, units, ...
- Free design, size and placement of all display values
- Pre-definable 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

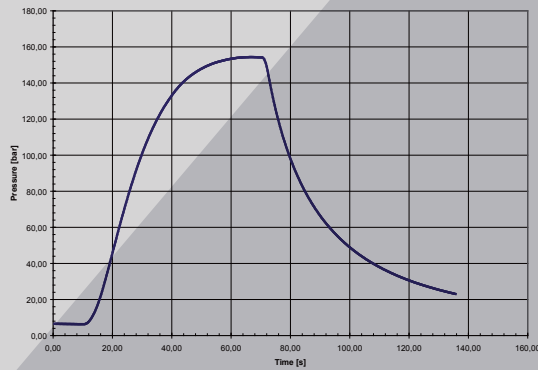
MEMORY AND LOSS MODULUS



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

- **VISCO-ELASTOGRAPH**

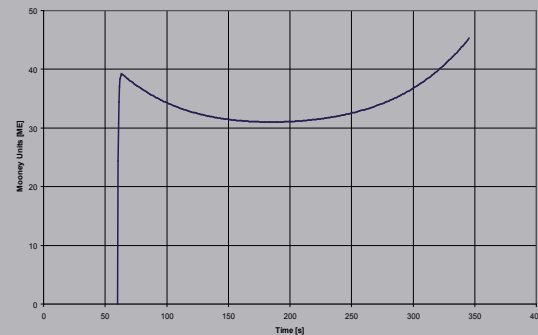
RELAXATION



The measurement of the relaxing time is being determined out of a disturbance test. It characterizes the visco elastic material behaviour and is important for process near properties.

- **VISCO-ELASTOGRAPH**
- **MOONEY-VISKOSIMETER**

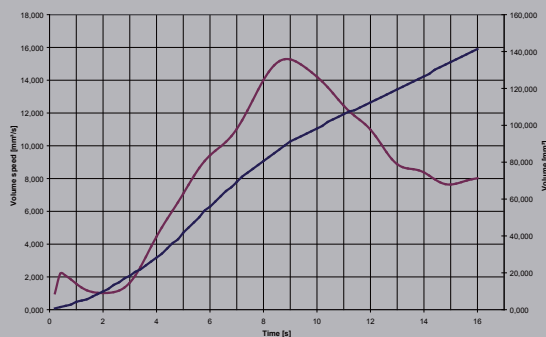
MOONEY-SCORCH



The Mooney-Scorch mode characterizes the scorching (vulcanizing) behaviour 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



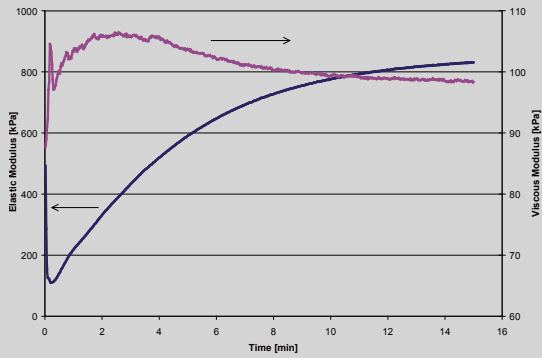
The extrusion through a die and the injection into a tool is a process near machining test for extrusion and injection molding.

- **RUBBER CAPILLARY RHEOMETER**

EVALUATION METHODS

Extractions of the capability

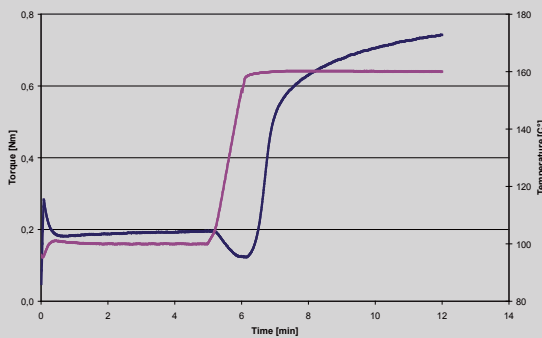
VARIABLE TIME



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**

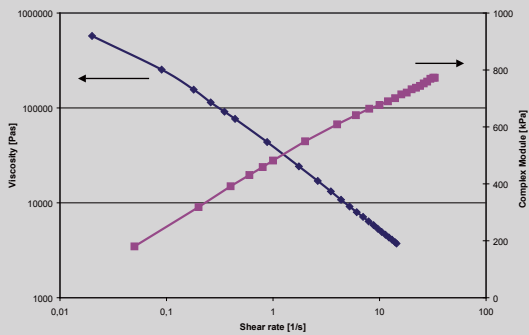
TEMPERATURE SWEEP



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

- **ELASTOGRAPH**
- **VISCO-ELASTOGRAPH**

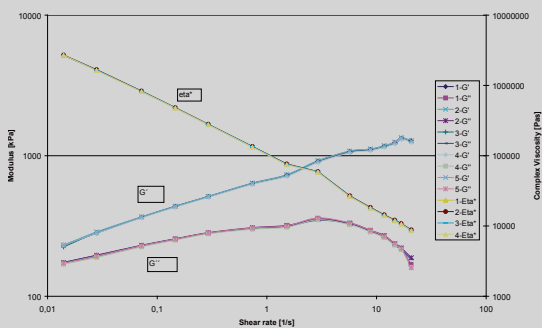
FREQUENCY SWEEP



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**

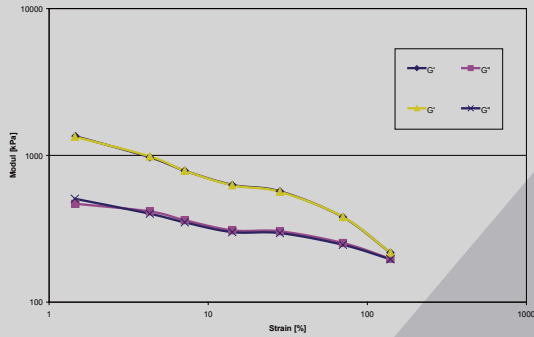
MULTIPLE REPRODUCTION



Frequency sweep of a fluor-elastomer-compound, 5 times reproduced.

- **VISCO-ELASTOGRAPH**

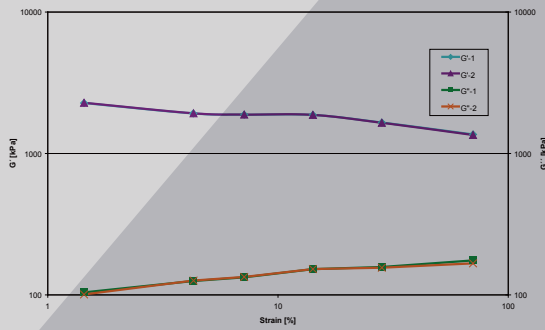
AMPLITUDE SWEEP, NON VULCANIZED



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

- **VISCO-ELASTOGRAPH**

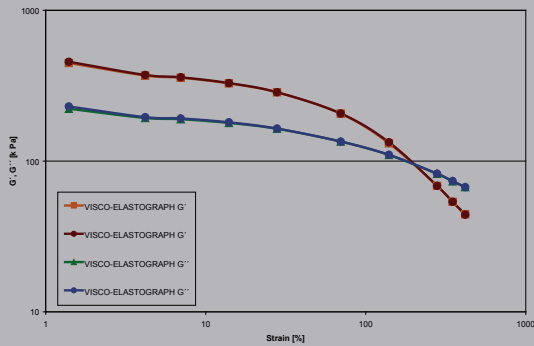
AMPLITUDE SWEEP, VULCANIZED



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

- **VISCO-ELASTOGRAPH**

PAYNE-EFFECT

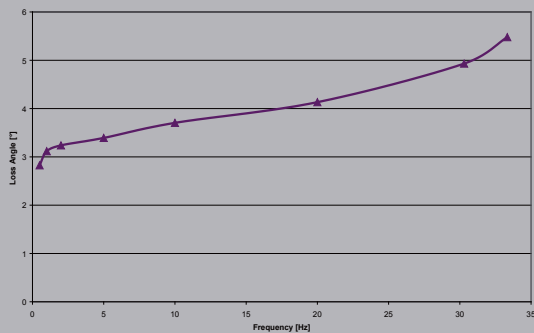


An amplitude sweep at a non vulcanized compound shows the Payne effect.

The crossing point of G' and G'' helps judging the filler medium network.

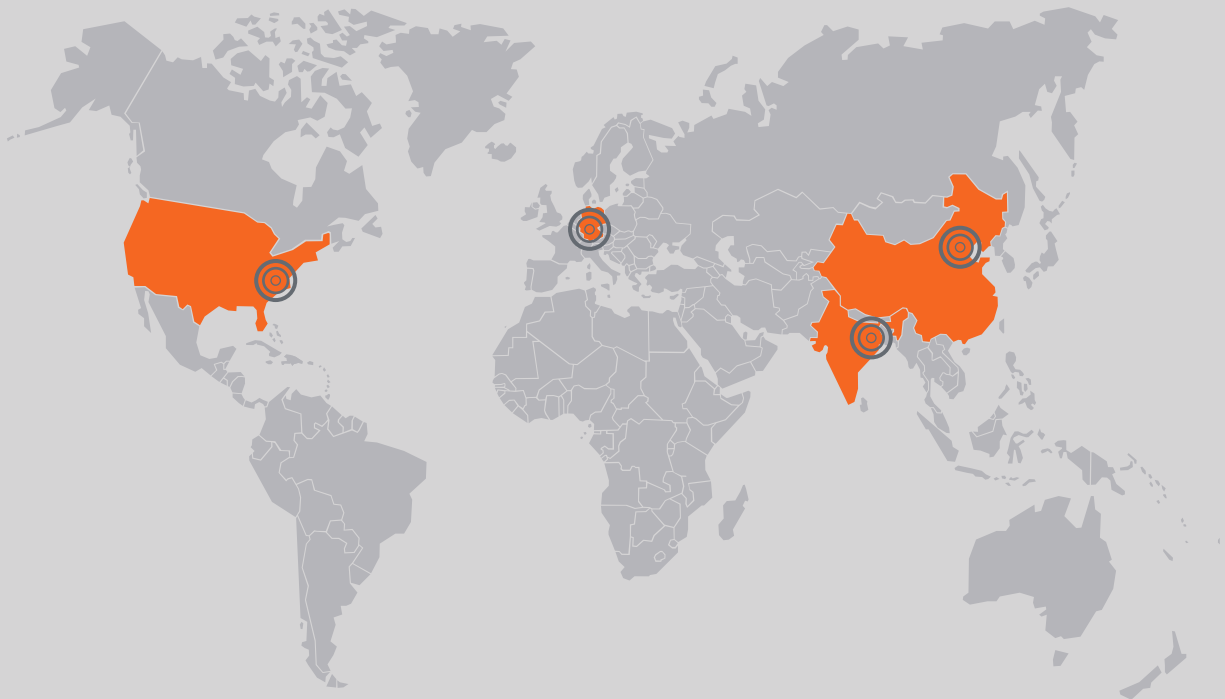
- **VISCO-ELASTOGRAPH**

FREQUENCY DEPENDANCE OF THE PHASE ANGLE



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

- **VISCO-ELASTOGRAPH**



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