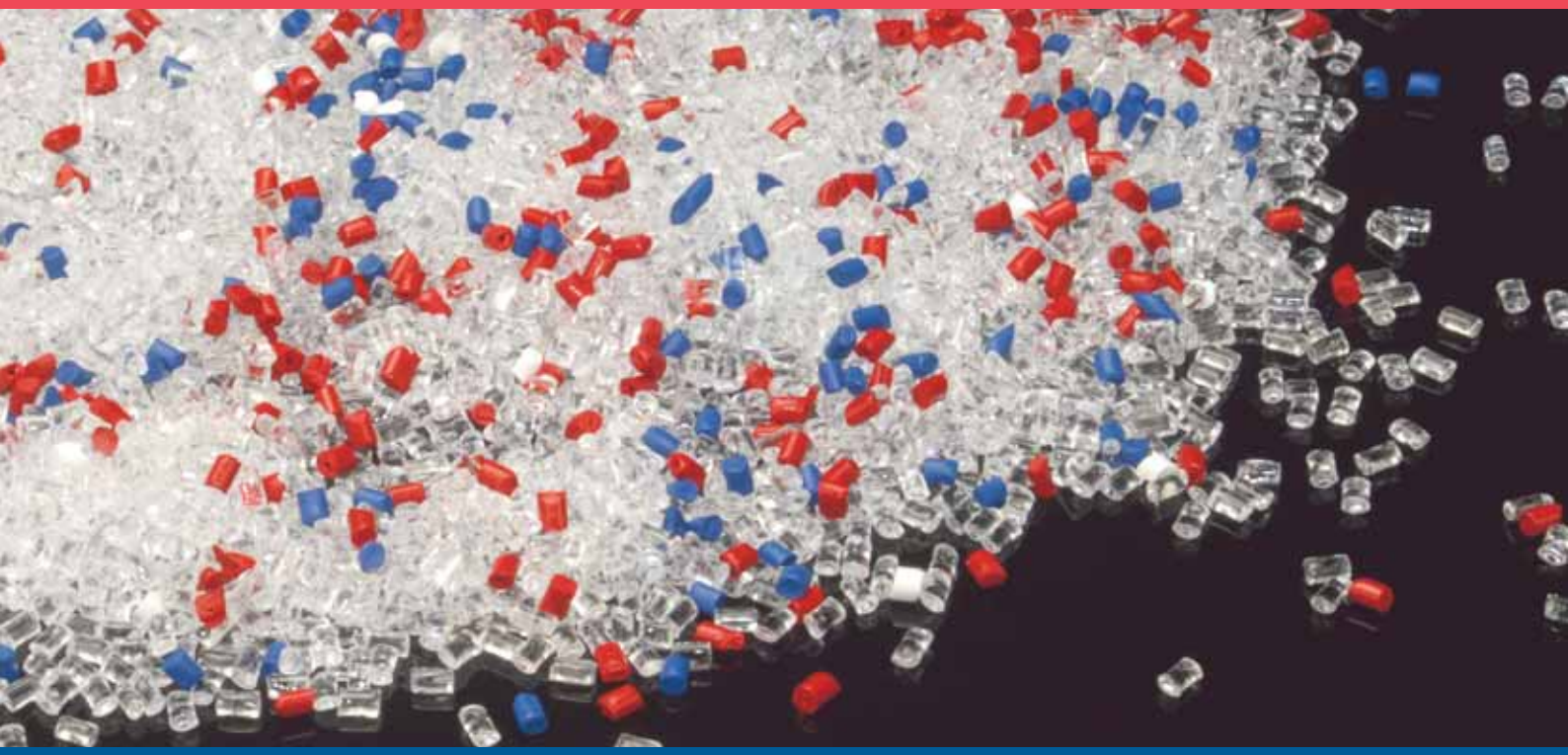
Brabender®

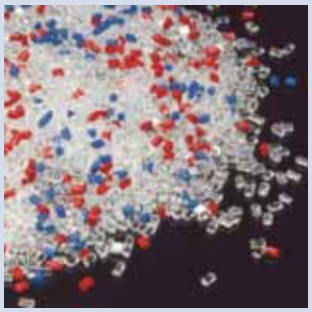


Measuring Mixers

for Material Research
and Quality Control

… where quality is measured.

Measuring Mixers



Features

Brabender® measuring mixers stand out for many favorable processing features:

- Easy handling and cleaning through bipartite (with liquid heating/cooling) or tripartite (with electric heating) mixer bowl
- Precise and constant heating / cooling of the mixers with electric heating through three separate, independent heating zones
- Operating temperatures of up to 500°C with electric heating
- Easy cleaning and manifold applications through quickly detachable and par tially interchangeable mixer blades
- Large program of additional equipment like e.g. loading chutes, blade extractors, sealing covers for tests under inert gas or for gas flow measurements, auto-matic precision dosing pumps for adding liquids, etc.

Principle

The measuring principle is based on making visible the resistance the sample material opposes to the rotating blades. The corresponding torque moves a dynamometer out of its zero position.

In compliance with the existing standards and test specifications, a typical '**Plastogram®**' (torque and stock temperature vs. time) is recorded for each sample material.

This diagram shows the relationship between torque (viscosity) and temperature/time in consideration of structural changes of the material.

The measured data are displayed numerically as a table and/or graphically as a diagram during the measurement on the monitor and can be printed and stored.

C.W. Brabender said

"It is only testing, measuring, and recording as a function of time which **efficiently** helps to rise production quality; only this way, certain processes can be recognized which cannot be grasped with static measurements."

Application

With **Brabender®** measuring mixers, you can simulate on a laboratory scale all processes like compounding, mixing, masticating, etc. that are relevant for production and processing of polymers and other plastic and plastifiable materials. Or use them for producing your sample material or for reactive processing.

Brabender® measuring mixers test the processibility of thermoplastics, thermosets, elastomers, ceramic molding materials, pigments, and many other plastic and plastifiable substances.

Blade geometries

Select the optimum blade geometry for your special application from a large program of different blades. These comprise Banbury, cam, and roller blades which have proven successful in industrial application for many decades, but also specially optimized blade geometries for certain measuring tasks as e.g. delta blades for thermosetting materials.

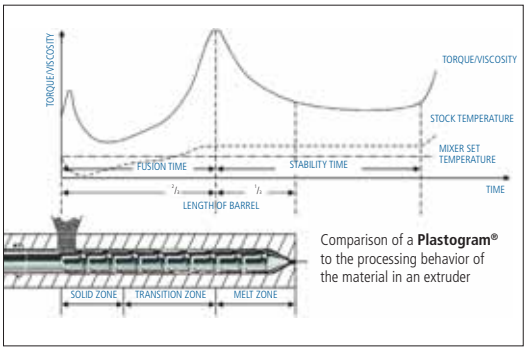
Software

The user-optimized Windows® software provides for evaluation of the measured data in compliance with the latest standards. On-line diagrams give a quick survey of the measured data and evaluation results already during the measurement. Use the advantages of the Windows® environment and save time with real multitasking - run a measurement, display stored data, and write texts, all at a time. The versatile data correlation program makes it easy to directly compare the results of different tests of one or several test series. Mean values and standard deviations are calculated automatically and shown digitally and graphically. Define any measured curves as reference curves and easily check whether your sample material meets certain demands or not. The special correlation program with parameter variation shows the influence of individual parameters like temperature, mixer speed, additives, etc. on the behaviour of your sample material.

Blade type	Applicational examples	Available for type
Banbury (B)	caoutchouc, elastomers	50 and 350
Delta (MB)	thermosets	15, 30 and 50
Cam (N)	caoutchouc, elastomers	50 and 350
Sigma (S)	flour, PVC dry blends	50 and 350
Roller (W)	thermoplastics	15, 30, 50 and 350

- Fusion behavior of PVC
- Heat and shear stability of polymers
- Flow and cure behavior of crosslinking polymers acc. to DIN 53 764
- Automatic evaluation of the black incorporation time (BIT) with selectable zero point
- Flow and cure behavior of elastomers
- Plasticizer absorption of PVC dry blends
- Liquid absorption of powders
- Semi-automatic universal evaluation
- Mixer tests with temperature and speed programming
- Degree of property breakdown

and other.



Comparison of a **Plastogram®** to the processing behavior of the material in an extruder

Mixer type 30 / 50 & type 30 EHT / 50 EHT

The series **type 30** / **type 50** and **type 30 EHT / 50 EHT** measuring mixers can be equipped with different blades. Within a series, the free mixer volume varies depending on the blades mounted. Due to liquid temperature conditioning, these measuring heads stand out for particularly precise and uniform heating/cooling.

Mixers with the extension EHT (electric, high temperature) distinguish by their electric temperature conditioning in three control zones with compressed air cooling. As compared to liquid heated mixers, this extends the operating range to a maximum temperature of 500 °C.

These measuring heads are perfectly suited for materials like PAEK and PEEK with melting temperatures of more than 300 °C.

This makes these mixer types particularly interesting for research and development applications with steadily changing test materials.

The EHT version is available for the series 30 and 50 mixers.

The rotor speed ratio of 2 : 3 (driven to non driven) results in a high torque resolution which allows a better differentiation, especially when testing low viscosity polymers.

Plastograph® EC plus
with measuring mixer type 50 EHT

Mixer W 30 / W 30 EHT	
Application	thermoplastics
Volume of mixer bowl approx. [cm³]	30
Sample weight* [g]	25 - 40
Heating/cooling	liquid, el. heating /air
Torque max. [Nm]	200
Speed ratio driven : idle blade	2 : 3
Operating temperature max. [°C]	250 / 500
Dimensions WxHxD [mm]	700x200x430 / 500x200x430
Net weight approx. [kg]	13 / 17

*depending on the specific weight and bulk density of the sample material

Mixer W 50 / W 50 EHT	
Application	thermoplastics
Volume of mixer bowl approx. [cm³]	55
Sample weight* [g]	40 - 70
Heating/cooling	liquid, el. heating /air
Torque max. [Nm]	200
Speed ratio driven : idle blade	2 : 3
Operating temperature max. [°C]	250 / 500
Dimensions WxHxD [mm]	700x200x450 / 500x200x450
Net weight approx. [kg]	18 / 17

*depending on the specific weight and bulk density of the sample material

… where quality is measured.

Measuring Mixers

W 30 / W 30 EHT

- ASTM D 3795 Thermal flow and cure properties of thermosetting plastics

W 50 / W 50 EHT

- ASTM D 2538 Fusion test of PVC resins

N 50

- ASTM D 3185 General evaluation method for SBR + Oil
- ASTM D 3186 General evaluation method for SBR + Carbon Black
- ASTM D 3187 General evaluation method for NBR
- ASTM D 3188 General evaluation method for IIR
- ASTM D 3189 General evaluation method for Solution BR
- ASTM D 3190 General evaluation method for CR
- ASTM D 3191 General evaluation method for Carbon Black in SBR
- ASTM D 3192 General evaluation method for Carbon Black in NR
- ASTM D 3403 General evaluation method for IR
- ASTM D 3484 General evaluation method for Oil extended Solution BR
- ASTM D 3848 General evaluation method for NBR + Carbon Black
- ASTM D 3568 General evaluation method for EPDM + Oil

MB 30

- DIN 53 764 cure behavior

Mixer type W 50 / W 50 EHT

The **W 50** and **W 50 EHT** with its roller blades is the allrounder among the mixers. It is used for all thermoplastics. The special shape of the rotors, developed by **Brabender®** more than 50 years ago, as well as the tight clearance between rotors and mixing chamber guarantee an intensive, high shear mixing.

Mixer N 50 / N 50 EHT & B 50 / B 50 EHT

The **Brabender® N 50 / N 50 EHT** mixer with its cam blades and the **B 50 / B 50 EHT** with its banbury blades are the standard mixers for testing natural and synthetic elastomers with regard to flow and cure behavior, mastication, compounding with additives such as carbon black, silicic acid, etc., breakdown index, and black incorporation time BIT.

Furthermore, the flow behavior of electrode masses and ceramic molding materials can be determined as a function of temperature and shear, and absorption tests can be run on materials like iron oxide powder, carbon black, pigments, and similar materials with particle sizes in the µm range.

Mixer type MB 30

The mixer has delta-shaped rotors and is used for thermosetting materials.

It was developed and designed by **Brabender®** together with a group of renowned producers and complies with the German standard DIN 53 764.

It is made of a special, hardened steel to prevent abrasion. For an accurate temperature control, the **MB 30** mixer is heated with liquid.

B 50 / B 50 EHT	
Application	caoutchouc
Volume of mixer bowl approx. [cm3]	70
Sample weight* [g]	40 - 70
Heating/cooling	liquid, el. heating /air
Torque max. [Nm]	200
Speed ratio driven : idle blade	1 : 1,11
Operating temperature max. [°C]	200 / 500
Dimensions WxHxD [mm]	700x200x450 / 500x200x450
Net weight approx. [kg]	18 / 17

*depending on the specific weight and bulk density of the sample material

N 50 / N 50 EHT	
Application	caoutchouc
Volume of mixer bowl approx. [cm^3]	80
Sample weight* [g]	40 - 80
Heating/cooling	liquid, el. heating /air
Torque max. [Nm]	200
Speed ratio driven : idle blade	2 : 3
Operating temperature max. [°C]	250 / 500
Dimensions WxHxD [mm]	700x200x450 / 500x200x450
Net weight approx. [kg]	18 / 17

*depending on the specific weight and bulk density of the sample material

Plasti-Corder® Lab-Station
with measuring mixer type 350 E

Mixer type 350 / 350 E

Mixer heads of the **350** series are available with liquid heating/cooling and with electric heating and air cooling. Due to the large mixer volumes of 370 to 440 cm³, these mixer heads are frequently used for producing sample compounds for subsequent tests. The material can easily be taken out and rolled out to sheets or pressed to plates.

Control and document the entire compounding process from your computer. Or implement and profit from an optional step-control of each individual mixing step.

Of course, these mixers can also be applied for material testing (e.g. of rubber compounds).

Step-controlled Measuring Mixer

The series **50 and 350** measuring mixers can be equipped with a tep-control which offers special advantages for recipe development.

Define a sequencer control with up to 20 mixing steps from your computer keyboard. The individual mixing steps can be switched as a function of registered units like

• Time / • Stock / • Temperature

energy input in AND/OR functions. Additionally, several optional sensors e.g. for measuring the electric conductivity of the sample material can be connected.

This makes step-controlled mixers the optimum tools for the production of elastomer compounds.

MB 30	
Application	thermosets
Volume of mixer bowl approx. [cm3]	25
Sample weight* [g]	20 - 40
Heating/cooling	liquid
Torque max. [Nm]	200
Speed ratio driven : idle blade	3 : 2
Operating temperature max. [°C]	200
Dimensions WxHxD [mm]	700x200x430
Net weight approx. [kg]	13

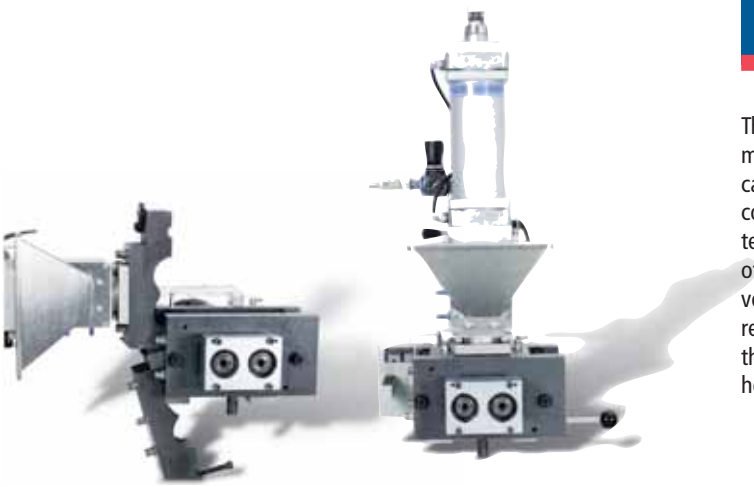
*depending on the specific weight and bulk density of the sample material

W/N/B/S 350 W/N/B/S 350 E	
Application	various
Volume of mixer bowl approx. [cm³]	370 - 440
Sample weight* [g]	250 - 500
Heating/cooling	liquid, el. heating /air
Torque max. [Nm]	400 / 150 (S)
Speed ratio driven : idle blade	3 : 2 / 1 : 1,11 (B)
Operating temperature max. [°C]	250 / 300
Dimensions WxHxD [mm]	550x260x400 / 650x260x400
Net weight approx. [kg]	44 / 46

*depending on the specific weight and bulk density of the sample material

… where quality is measured.

Measuring Mixers



Special Mixer type 350 S

The special mixer **type 350 S** is mainly used in the rubber and caoutchouc industry for mixing and compounding tasks or for material testing. The large free mixer volume of 370 to 440 cm³ has proven favorable for proportioning of the recipe components. Taking out of the mixing good is facilitated by the horizontal division of the middle part of this mixer. Just tilt the upper and lower halves open for removing the material and use it for subsequent tests.

Extensive software packages are available for material tests like e.g. the determination of the black incorporation time (BIT).

Planetary Mixer P 600

- DIN 54 800 Preparation of PVC pastes
- DIN 54 802 Determination of the plasticizer absorption of vinyl chloride (VC) polymer compounds
- DIN EN/ISO 4612 Preparation of a paste from PVC paste resins

Planetary Mixer P 600

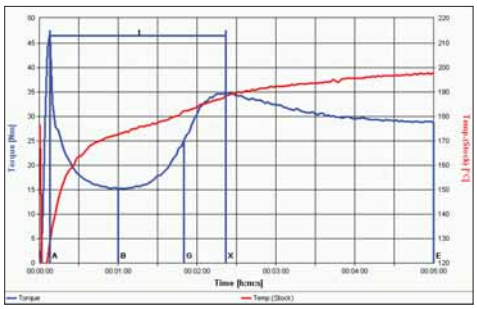
The **Brabender® planetary mixer P 600** is used for testing the properties of powders like e.g. the liquid absorption and the plasticizer absorption rate of PVC powders in compliance with international standards or the pourability of PVC dry blends, further for preparing PVC pastes for tests in compliance with DIN 54 800 and for testing PVC pastes in compliance with ISO 4612.

A special rotor runs in a planetary motion in the mixer bowl.
A revolving scraper prevents the sample material from sticking to the mixer wall.

	Mixer P 600	W/N/B/S 350 S
Application	powders	various
Volume of mixer bowl approx. [cm3]	2500	370 - 440
Sample weight* [g]	variable acc. to DIN/ISO	250 - 500
Heating/cooling	liquid	liquid
Torque max. [Nm]	5	400 / 150 (S)
Speed ratio driven : idle blade	-	3 : 2 / 1 : 1,11 (B)
Operating temperature max. [°C]	150	250
Dimensions WxHxD [mm]	300x420x550	450x410x200
Net weight approx. [kg]	11	90

*depending on the specific weight and bulk density of the sample material

Examples for mixer applications and evaluations: WINMix software
WINMix for Windows 95, 98 and NT



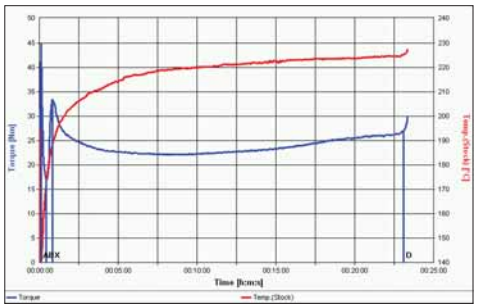
Fusion behavior

Thermoplastics: PVC, PE, PP...

Use this evaluation method for testing the fusion behavior of thermoplastic polymers. Measure material-specific **Plastograms®** which also permit to draw conclusions as to the history of the material.

The WINMix software analyzes the curve and determines, among others, the extreme values in the torque curve (as a measure for viscosity), fusion time, gelation speed, and the mechanical energy input.

These material characteristics are valuable data for incoming and final inspection or for the configuration of production processes.



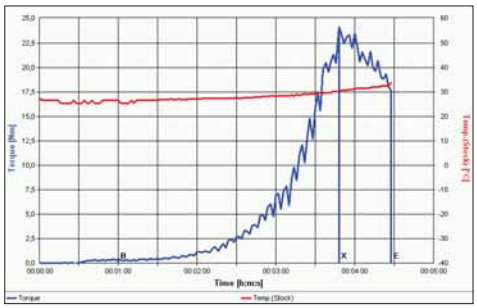
Heat and shear stability

Thermoplastics: PVC, PE, PP...

During processing of thermoplastic polymers, stability against thermo-mechanical-oxidative stress plays an important role.

It determines, among others, the maximum residence time within the production machine. Therefore, conditioning of polymers with stabilizers is of decisive importance for the production process.

Use this evalution method within a test series for determining (among others) beginning of decomposition fusion time decomposition time and optimize your material reliably and reproducibly.



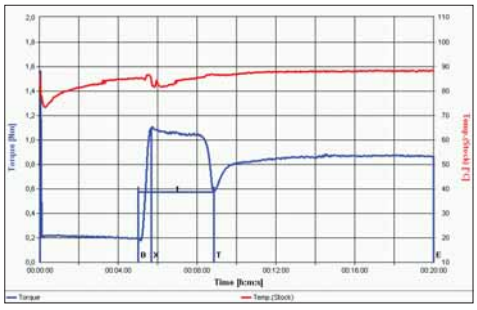
Liquid absorption

PVC, flour, silicic acid ...

For this test method, the powdery material is premixed one minute in a planetary mixer, sigma, or cam mixer. After this premixing time, the software starts a dosing pump which feeds the liquid at a constant and selectable dosing rate into the mixer. The diagram shows the torque increase up to the absorption maximum and, if further liquid is added, the torque decrease by saturation.

From the dosing rate, sample weight, and the dosing time, the liquid absorption is determined for each point of the diagram.

Like with all other evaluation methods, the mechanical energy input is calculated as well.



Plasticizer absorption

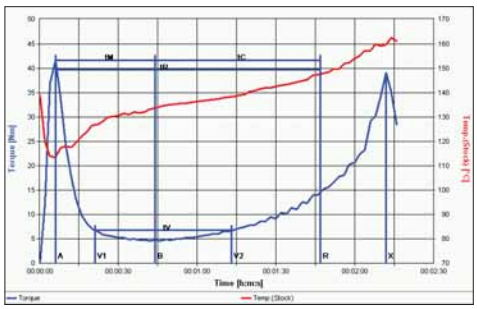
PVC dry blends, Plastigels ...

The plasticizer absorption of e.g. PVC dry blends can be characterized on the basis of the torque maximum, dry point, and the plasticizer input up to the dry point. These values are calculated automatically during the analysis of the diagram and can be used for material control and development of plastisols and plastigels.

Apart from that, the final torque is a measure for the material viscosity - an important characteristic for optimizing the actuating variables of a production line.

... where quality is measured.

Measuring Mixers

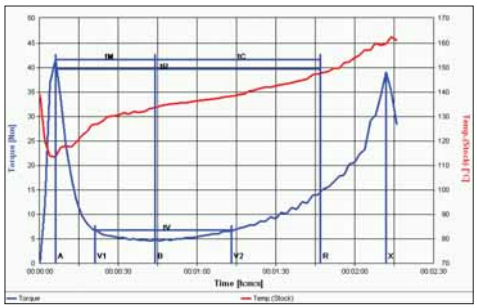


Flow and cure behavior in compliance with DIN 53 764

Thermosets: EP, MUF, PF...

The most important values of this evaluation are the torque minimum, which describes the melt viscosity, the melting time, curing time, and reaction time.

With this test, you can monitor the development and production of thermosetting materials, measure and record the properties and influence of different additives and fillers onto existing recipes, check uniformity of production, classify thermosetting molding materials with regard to their flow and cure behavior for different production methods.



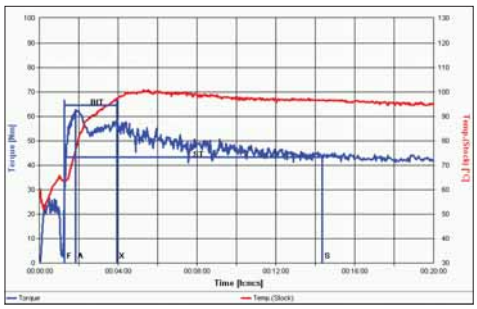
Flow and cure behavior of elastomers

Elastomers: NBR, SBR, IR...

The diagram shows the loading peak, the flow behavior of the blend in the torque minimum, and the increase of the curve up to the torque maximum which is due to vulcanization.

Profit from the possibilities of the correlation program - determine the first derivative of the torque curve, evaluate the curing speed in each point of the rising curve, and plot the results as a separate curve. The mechanical energy input is calculated by integration of the area below the torque curve.

The application range of this test method corresponds to that of the thermoset evaluation.



Black Incorporation Time (BIT)

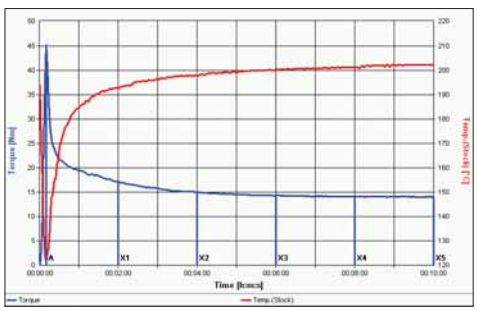
Carbon black: HAF, GPF, XCF...

The mechanical properties of elastomer compounds are decisively determined by the activity of incorporated fillers, e.g. carbon black.

For determining the time up to full incorporation and activation of the carbon black particles within the caoutchouc matrix, the "black incorporation time" (BIT) is determined.

On the basis of the black incorporation time, the operating parameters of a compounder can be optimized and a constant high product quality be ensured.

The program automatically determines the BIT during evaluation of the measured data. Apart from that, other parameters like the mechanical energy input are calculated.



Universal evaluation

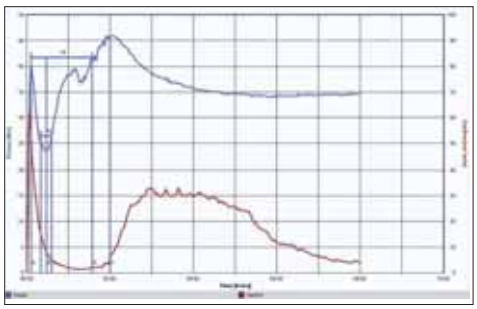
Ceramics, polymers...

Call this evaluation program and define up to 20 evaluation points of the **Plastogram®** that make sense to you for calculation - torque minima and maxima, torque changes due to additive addition, or any other significant points in the diagram.

The evaluation of these points will give you the torque and temperature values as well as the mechanical energy input from the beginning of the test and from the previous evaluation point up to this point.

The universal evaluation is the basic tool for evaluating a **Plastogram®** and belongs to the standard equipment of each Lab-Station.

MIXCor32 for Windows 95, 98 and NT

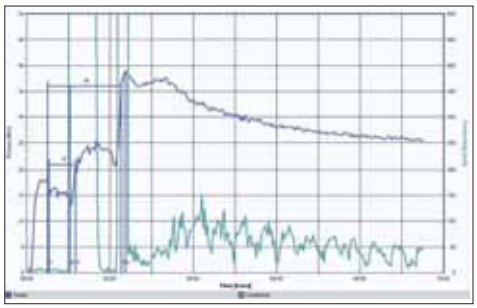


Conductivity measurement

Polymers with: Carbon black, C-fibers ...

Brabender® measuring mixers can be equipped with optional sensors. One example is the application of a conductivity sensor for monitoring the compounding process and determining the conductivity as a material characteristic with electrically conductive polymers. Running these measurements with different concentrations of the conductive additive allows to plot conductivity as a function of the additive concentration (percolation curve).

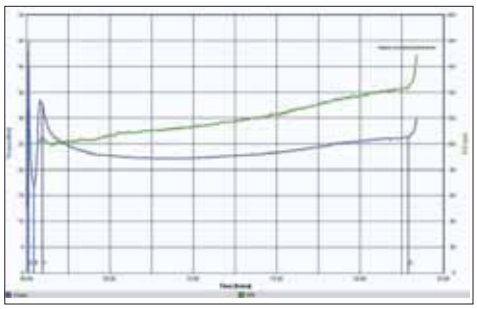
This correlation enables the determination of the critical concentration which first creates a continuous current flow through the additive particles. This evaluation is done in addition to the usual **Plastogram®** evaluation.



Measurement of gas flow

Polymers: Reactive processes, foaming agents...

Another example for optional sensors is the application of a gas flow detector in a gas-tight measuring mixer. This detector permits to investigate e.g. the effect of physical and chemical foaming agents in various concentrations and at different mechanical and thermal stresses. In case of reactive processes with gas development running during the mixing process, you can record a gas flow curve which enables statements about material conversion and reaction kinetics.

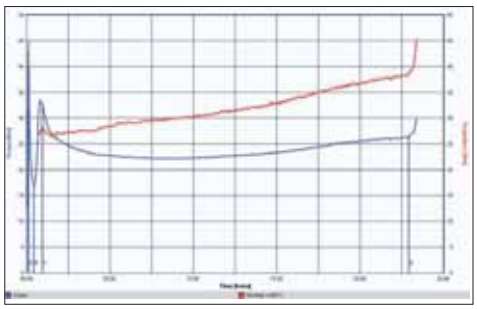


Determination of isothermal torque curves

Ceramics, polymers...

All **Plastograms®** can be additionally evaluated e.g. for the calculation of "iso-thermal torque curves".

By means of physical temperature shift functions, the nonisothermal torque curve measured is converted into an "isothermal" curve at a selectable reference temperature. Represent and evaluate all structural changes without considering the influence of dissipation heat and increase the precision of your results especially in case of reactive processes.



Determination of the degree of property breakdown

Ceramics, polymers...

One example for the application of isothermal torque curves is the determination of the degree of property breakdown (DPB).

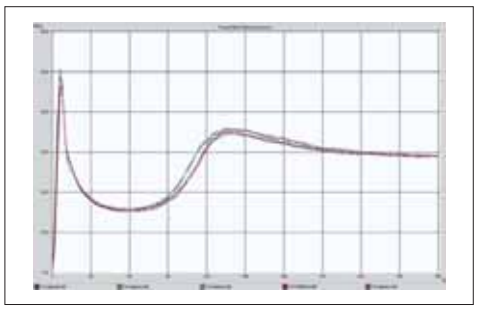
The DPB curve mirrors the structural build-up and degradation processes during the mixing process which result from thermo-mechanical stress and/or the effect of reactive components.

This evaluation is a valuable tool in particular for material development which completes the usual **Plastogram®** evaluation.

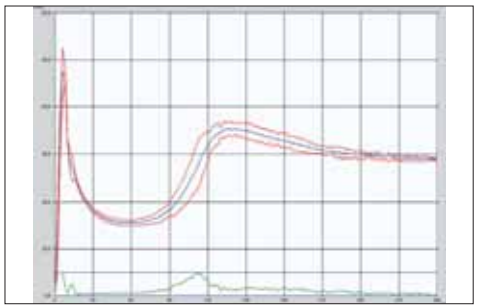
Use this program e.g. for precisely determining the beginning of vulcanization with rubber compounds or the beginning of a decomposition process.

... where quality is measured.

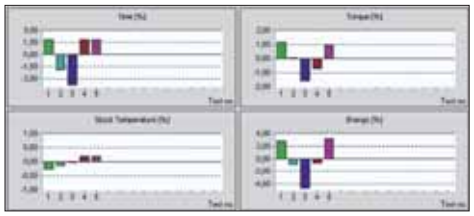
Measuring Mixers



Conductivity measurement



Measurement of gas flow



Determination of isothermal torque curves

Correlation program MIXCor32

The WINMix software saves all test data in MS Access databases. This enables editing of stored data with commercial Office programs and easy importing of the data into your own reports.

Frequently, however, expressive results can only be obtained by comparing the individual tests of a test series with each other. For this purpose, the correlation program MIXCor32 was created.

Profit from the power of graphics and get a quick survey over a test series by correlating all tests within a single diagram. Zoom interesting areas of the diagram and switch over between different views with a single keystroke. Set a linear or logarithmic scaling according to your needs. With a simple keystroke, you get statistical calculations like

- Mean values
- Standard deviation
- Minimum and maximum values

of all measuring values which can be plotted in clear color diagrams.

Get even more information from these statistical calculations by creating a reference curve. In a first step, this reference curve is represented by the mean value curve and the envelope curve of the stored tests. In a second step, you can edit this reference curve according to your specific needs. By comparing this reference curve with a measured **Plastogram®**, you can easily recognize whether your sample material meets certain criteria or not.

With such reference curves, you have the ideal tool on hand for incoming and final inspections as well as for quality control parallel to production.

Furthermore, the correlation enables a statistical comparison of the evaluation points. For each evaluation point, you get a separate table of the measuring values recorded within the test series. These tables also include the mean values and standard deviations for each measuring value.

Depending on the selected evaluation method, this statistical correlation may comprise up to 20 different evaluation tables. A summary table allows you to get a quick survey of the results. Here, all measuring values are represented together with the mean values and standard deviations within a single table.

Of course, you can get a graphical representation of this statistical evaluation of your test data. A simple keystroke represents the percentages of deviation from the mean value as bars and enables quick assessment of a test series.

A "snap shot" function is standard for all graphics in the MIXCor32 software. With this function, you can easily import your diagrams from the Windows clipboard into other applications.

Made in Germany

Brabender® GmbH & Co. KG

Kulturstr. 51-55 · 47055 Duisburg · Germany
Tel.: +49 203 7788-0 · Fax: +49 203 7788-102
E-Mail: plastic-sales@brabender.com
www.brabender.com

GLC CERTIFIED ISO 9001

25061-E / Brabender C / Messkneter / 09 / 2010