MonTech
Werkstoffprüfmaschinen GmbH

Technical part

Moving Die Rheometer

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1. Technical Part

1.1 The Moving Die Rheometer MDR 3000 Basic

is the easiest to operate and most cost-effective way to determine viscoelastic properties of polymers and rubber compounds before, during and after cure.
The acquired data gives exact information about processability, cure characteristics, cure speed and the behaviour of the compound after-cure, as well as optional pressure measurement for sponge rubber compounds.

The MDR 3000 Basic comes as a complete and ready-to-test set consisting of the Rheometer itself, an external Personal Computer with the latest Windows Operating System, TFT screen, keyboard and mouse.

Like every MonTech Rheometer, the MDR 3000 Basic also features an Ethernet Interface and can therefore be directly integrated in any customer's factory network, guaranteeing the most stable data transfer and communication in any laboratory or factory environment, allowing data access at the instrument and from remote and office workstations, creating a digital process chain and integrated workflow based on a digital data repository, eliminating the need of result printing after each test series.
Designed as a table top instrument utilizing only minimal benchspace, the MonTech MDR 3000 Basic is synonymous with a reliable but easy and efficient testing operation.

The instrument is equipped with the latest PLC-based control and data acquisition electronics, ensuring highest data acquisition precision and reliability, along with superior temperature control - improving overall data significance and laboratory efficiency.
The instrument comes with the MonControl Analysis software for test configuration management, data recording, automated Pass/Fail testing, processing of historical data as well as online statistical process control (SPC), having more than 3500 different datapoints available for selection. With an optional 5.7” instrument touch-control panel, the instrument can even be conveniently operated in stand-alone mode by directly displaying and printing the most essential datapoints - including the possibility to save and archive test data on a USB flashdrive.

The MDR 3000 Basic features an extremely stiff, ultra-rugged loadframe paired with a unique, column-guide-free, accessible testing area along with the most simple single-button operation and integrated multi-color status bar making this instrument truly the most reliable testing system for quality control purposes not only in the laboratory, but also directly in the production area.
Of course various different automation options for increasing testing productivity are available and can be fitted to the instrument at any time.

For highest durability and testing accuracy the MDR 3000 Basic features the industry standard, completely closed, rotor-less, sealed, biconical test chamber system. MonTech test dies are entirely made from stainless steel, precision machined, hardened and ground to utmost precision. The lower die is directly connected to the central shaft and drive system. All these parts and components are also made from solid stainless steel, making the MDR 3000 Basic a cost-efficient, long-lasting and safe investment. The upper die is attached to the reaction torque measurement for immediate recording of the material feedback at the highest precision.

MonTech Moving Die Rheometers are the world-leading instrument series for reliable static and dynamic testing in the rubber industry.

Due to the rugged design and superior design quality, MonTech instruments clearly offer superior accuracy and precision, proven by our certifications and accreditations including ISO 9001:2008 and ISO/IEC 17025:2005.

These calibrations services are offered throughout the world by our highly qualified team of MonTech field engineers in order to make sure that the calibration of your instruments is fully traceable and complies to all local, company as well as international standards.

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Moving Die Rheometer - Overview

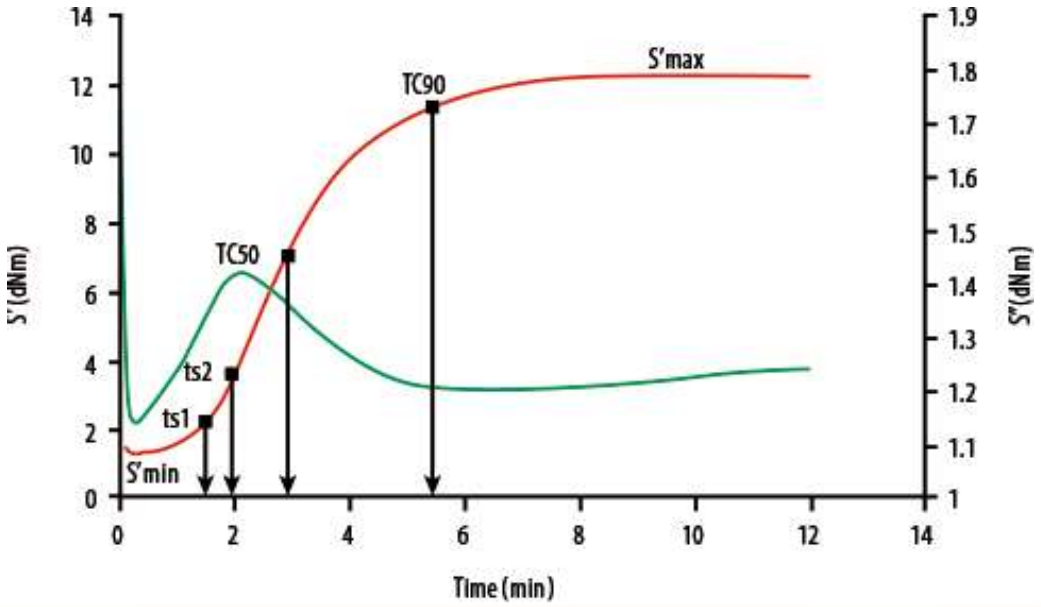
Because of the very high measuring precision of the MDR 3000 Basic, the smallest variations of ingredients can be detected in the test result data, which simplifies quality control and the development of new rubber compounds.
Important advantages for the user are:

- Lower costs per test
- Faster incoming goods inspection and batch release due to easy usability and efficient operation
- Intuitive, simple operation of the MonControl Analysis Software
- Direct display and output off PASS / FAIL information
- No separate sample preparation is necessary

For the best possible determination of all relevant test parameters the MDR 3000 Basic is equipped with a universal test configuration management as well as over 3500 available datapoints.

The following measurands can be determined:

- Torque S' and S"
- Complex torque S*
- Cure rate
- Loss angle δ
- Tangent-delta
- Pressure (optional)



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Technical details and features of the Moving Die Rheometer MDR 3000 Basic:

Rugged housing and ultra-stiff machine frame

The machine frame of every MonTech Rheometers is constructed from aerospace grade aluminum and stainless steel making MonTech Rheometers the most rugged and stable Rheometer systems in the market. Even the MonTech Basic series features this strong and advanced frame design for highest data compliance, testing precision and reliability.

The MonTech Basic series frame design includes strong baseplates of up to 50mm thickness, massive tension columns made from reinforced aluminum with integrated, patented pullbar system, integrated crosshead support and strong sidepanels also made from aluminum. This results in an overall superior instrument stiffness and significantly improving repeatability and result correlation, while reducing signal-to-noise ratio:

This ultra-rigid instrument design has even more advantages:
The whole instrument frame is used as a heatsink for all major electronic components so that the instrument does not need any fans or air ventilation for cooling, allowing the complete electronic cabinet to be sealed against pollution and especially conductive carbon black dust.

As only high-strength aluminum and stainless steel are used for every single component in the instrument, corrosion is no issue at all, making MonTech instruments a secure investment.

Test dies and die closing system

The MDR 3000 Basic is equipped with a biconical die assembly with integrated direct heating and accurate sample temperature measurement and overall superior temperature control with unbeaten accuracy, highest heating and cooling rates as well as minimized response times.
MonTech Rheometer test dies are entirely made from superior, lottraceable stainless steel, hardened, precision ground and polished, making the dies built to last with an extreme stiffness and durability even against the most abrasive rubber compounds.
The test dies are sealed off with easy changeable longlife seals providing superior lifetimes of up to 12 months, minimizing maintenance and instrument downtime.

Every MonTech Rheometer is equipped with a pneumatic die closing system for a reliable closing and sealing of the die cavity.
Optionally, instruments can be equipped with variable closing force, cavity pressure and variable die gap control. In combination with the MonTech loadframe this instrument design guarantees compliant testing results at the highest possible level of accuracy and precision paired with perfect reproducibility and reliability.

The temperature control of both electrically heated test dies is made by the MonControl Analysis Software with an independent control system for each test die. The temperature measurement is performed using PT100 resistance thermometers. The die heaters are film heaters with special spiral shaped heating elements having relatively uniform watt densities. When applied to the dies, these heating elements ensure uniform die temperature.

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Integrated calibration routines and diagnostics

MonTech Instruments feature internal diagnostic and condition monitoring routines for every critical process, enabling the instrument to detect, report and even solve problems before they occur.

Along with MonTech precision calibration tools, customers are guided through a software sequence, making the verification of the instrument really easy in order to always guarantee and prove the highest instrument precision and most accurate test data.

Once the verification process is completed, a detailed PDF Report with all critical verification and calibration is generated assuring tracebility to any reference standard used. Readings of most reference standards and performance parameters are taken by the software, minimizing operator involvement for providing objective results.

Precision torque measurements and transducer systems

Torque / force transducers and loadcells are the most critical part when it comes to precision of the instrument as raw torque and force signals, as well as derived modulus and viscosity signals are directly used for test result calculation. This is exactly the reason why MonTech designs and manufactures all transducers in-house. This guarantees the widest measurement ranges along with clean-room applied strain gauge technology paired together in ultra-rugged and stiff assemblies.

MonTech's intelligent transducer technology possesses various unique features such as variable amplifications, stiffness control and temperature compensation − proof again that MonTech systems are the most advanced testing systems available; guaranteeing the highest accuracy and precision from smallest Milli-Newton torque readings to highest dynamic loads over the complete torque range.

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Integrated data processing

Programmable Logic Controllers form the backbone of every MonTech testing instrument, providing customers with proven technology and the highest system reliability. The highly complex set of stress, strain and other raw data streams and results that are all time-critical to each other are analyzed online with the most advanced 24-bit electronics and a 10kHz high speed data sampling rate. This superior oversampling technology paired with the superior signal to noise ratio eliminates the need for data filtering or further data processing, providing the user with actual true measured data and results.

MonTechs advanced rubber testing machines support customers with as much valuable material information as possible, with features including measurement of higher harmonics, nonlinearities, and behaviour at extreme processing conditions.

Every MonTech Instrument is equipped with a rugged, well-proven and reliable Programmable Logic Controller (PLC) system as well as standard automation components.
In addition every instrument is directly equipped with a Ethernet interface, allowing direct integration of the machine into the customers network as well as linking host systems and computers by standard TCP/IP protocol with extremely high datarates and throughput.

Intelligent drive technology

MonTech Rheometer systems are equipped with latest, closed-loop digital drive technology. The quality and performance of the instruments‘ rheological measurements are highly influenced by the precision of the applied deformation and thus the motor positioning.

The MDR 3000 Basic instrument is equipped with a geared, brushless DC motor with integrated drive control systems, digitally connected to the instrument PLC unit, making this drive the ideal system for static testing at fixed frequencies.

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Technical Features and Specification MDR 3000 Basic:

Applicable Standards	- ISO 6502	Moving Die Rheometer
	- DIN 53529	Moving Die Rheometer
	- ASTM D5289	Moving Die Rheometer
Die System	Bi-conical, fully sealed, longlife seals standard	
Die Gap	0.45 mm nominal, variable die gap and closing force optional	
Sample volume	Approximately 4.5cm³ For sample preparation a R-VS 3000 sample cutter is highly recommended	
Drive System	Brushless DC Servo drive with integrated controller	
Die Closing system	Soft closing to prevent foil rips and damage of test samples	
Oscillation frequency	1.667 Hz (equals 100 cpm)	
Oscillation amplitude	0.5° (equals 7% strain) Others oscillation angles by mechanical adjustment / eccentric change optionally available: 0.1°, 0.2°, 1.0°, 3.0° (equals 1.4%, 2.8%, 14%, 42% strain)	
Torque measurement	In-line Reaction transducer in upper platen	
Torque range	0.01 to 235 dNm With integrated overload protection	
Die pressure range (optional)	10.000kPa (1450lb/in²) Resolution: Automatic Tare:	1 kPa (1lb/in²) at test start

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Closing System	Soft closing to reduce breakage of film and distortion of sample
Temperature Control System	Ambient to 232 °C, precision +/- 0.03 °C, Max. heating rate: 85°C/min, digital, microprocessor controlled
Temperature Check System	Recordings of the temperature gradient on the screen, microprocessor monitored
Measured Data	Torque (dNm, lbf.in, kgf.cm), Temperature (°C, °F), Pressure (bar, kg per cm2), Time (min - min / min - sec), Frequency (Hz, cpm), Shear rate (1/s, rad/s), Strain (deg, %), Cure rate (1/min, 1/sec)
Test types	Isothermal, Non-Isothermal optionally available.
Calculated Data	S´, S˝, S*, tan δ, phase angle, cure speed, ...
Data interface	Ethernet (10/100 MBit), USB (int.), CF card (int.), RS232 (opt.)
Data points	Over 3500 data points available for each static subtest Including S‘ Min, S‘ Max, TS 1, TS 2, TC 10, TC 30, TC 50, TC 90, …

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Output / Input Display	5.7” Color-Touch-Screen (optional)
Output languages	English, French, German, Russian, Spanish, Hungarian, Chinese, … (others available on request)
Electrical (please specify at order)	100/110/120/130 VAC +/- 10%, 60 Hz +/- 5 Hz, 8 amp single phase *OR* 200/220/240/260 VAC +/- 10%, 50/60 Hz +/- 5 Hz 5 amp single phase Ground connection required. Deviations from these ranges may affect performance.
Pneumatics	4,5 bar (= kg/cm²) / 60 psi
Dimensions (net)	Width 58 cm Height 93 cm Depth 50 cm
Weight	160 kg gross / 115 kg net
Setup	Table-top, a suitable table with at least 150kgs load capacity needs to be provided by the customer.
Available instrument options	- Instrument control panel with 5.7” touchscreen display and printer - Torque transducer for low-viscosity torque range - Normal force / Pressure measurement - Single channel forced air cooling system - Low-temperature cooling system MCool 10 - Autoloader 5 or 10 sample linear - Autoloader with 24 or 48 sample tray - R-VS 3000 constant volume sample cutter - Instrument table or cart - Forced aspiration system - Compression torque standard for instrument verification and calibration

Setup and installation requirements of the MDR 3000 Basic:
(to be provided from the customer at installation)

- One table 200cm length, 70cm depth, permissible load min. 150kgs
- 4 power sockets 200-260 Volts, 16 Amps
- 1 line of dry, oil-free class 2 instrumentation compressed air, 5 Bars min
  Flexible tube with internal diameter of 10 to 13mm

For instrument equipped with a cooling system in addition:
- 1 additional, independent line of dry, oil-free class 2 instrumentation compressed air, 5 Bars min, Flexible tube with internal diameter of 10 to 13mm

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2.1 Moving Die Rheometer MDR 3000 Basic

including:

- Personal Computer, 19’ TFT Screen, Keyboard, Mouse
- Ethernet Interface (10/100)
- Software MonTech MonControl
- Standard accessories
- Automatic front shield
- Calibration certificate
- Installation and training at customer site by German engineer

Optionally available:

- **Normal force measurement / Axial force transducer system**
  Features a combined torque / forced transducer to measures torques as well as the pressure within the test chamber.
  Before each test, the transducer and amplifier is balanced automatically. The system also includes a second channel amplifier system for realtime simultaneous measurements of torque and normal force.

- **Instrument control panel "Online edition"**
  5.7" color Touch control panel fitted to the right side of the instrument.
  The control panel continuously displays status information on the current test as well as allows the user to setup and execute static tests. Furthermore the control panel features calibration and diagnostic functions for a computer independent operation.

- **MonTech Volume sample cutter R - VS 3000**
  Pneumatic operated with 2-hand safety control for the fast and easy preparation of Rheometer test samples.

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