



RHEOLOGICAL PROPERTIES

# KINEXUS DSR SERIES

REDEFINING RHEOMETER CAPABILITIES FOR ASPHALT TESTING

# ASPHALT

## CHARACTERIZATION AND CLASSIFICATION TO ASPHALT INDUSTRY STANDARDS



Asphalt, or bitumen, is a petroleum product used in the road (pavement), roofing and construction industries. A mixture of aromatic hydrocarbons (varying with geographical source), this black viscoelastic material is considered to be a complex colloidal system.



Asphalt is used as a binder with aggregates in road (pavement) construction and as such determines performance and lifetime. Additives such as polymers, crumb rubber, oils, waxes, phosphates and pH adjusters are used to enhance mechanical properties in modified asphalt binders. Asphalt emulsions are also used as water-proofing and re-surfacing materials.



### Rheological testing with the Kinexus DSR Series

- Grade testing to industry standards such as AASHTO and EN specifications
- Full characterization of rheological behavior with Master curves
- Formulation development and quality control metrics
- Determination of Mixing and Compaction Temperatures
- Blend testing of Warm Mix, Crumb Rubber and Recycled Asphalt Paving (RAP)
- Solids testing for Fatigue or Accumulated Strain
- Emulsion stability and viscosity profiling
- Benchmarking and comparison of competitive products
- Penetration testing



Rheological characterization by Dynamic Shear Rheometers (DSR) is the standard method of classifying asphalt binders for behavior over time and loading conditions, and in different climates. This is complementary to viscosity and penetration (pen) grading.

# KINEXUS DSR SERIES

Redefining rheometer capabilities for asphalt testing

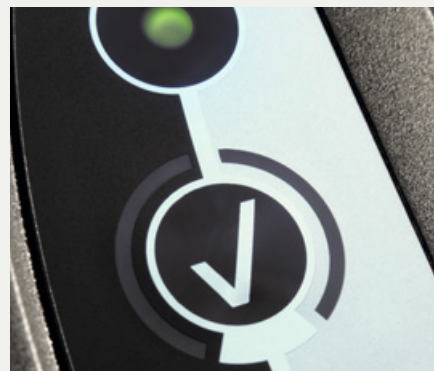
At Malvern, we haven't just redesigned a rheometer – we've redefined the way it interacts with you. The Kinexus DSR Series is the next generation rotational rheometer platform for Asphalt testing that's been developed from extensive market knowledge and feedback, integrating innovative instrument design with a revolutionary software interface, to deliver a solution that will exceed your rheological expectations.

A modular rheometer with true 'plug and play' functionality for all measuring systems and environmental control units. The Kinexus DSR Series enables pioneering Standard Operating Procedure (SOP) based testing with a built-in library of standard test protocols for the Asphalt industry.



## Key benefits of the Kinexus rheometer

- All modes of operation – stress control, shear rate control and direct strain controlled oscillation
- Exceptional vertical travel and gapping capabilities with ultra-responsive and highly sensitive Normal Force for class-leading performance
- Unique rSpace software interface that offers total flexibility of test set-up from sequence-driven Standard Operating Procedure (SOP)-type functionality for simple operation to fully customizable test design for advanced research capabilities
- Wide variety of measurement geometries optimized for rheological characterization of different sample types from liquid binders to solid asphalt cores
- Complete sample history from the point of loading onto the rheometer available in data file as standard – because ensuring reliable rheology data for complex non-Newtonian materials actually starts before a measurement takes place
- Unique 'plug and play' cartridge system for all environmental controllers – all mechanical, power, communication and fluid connections made in one simple action



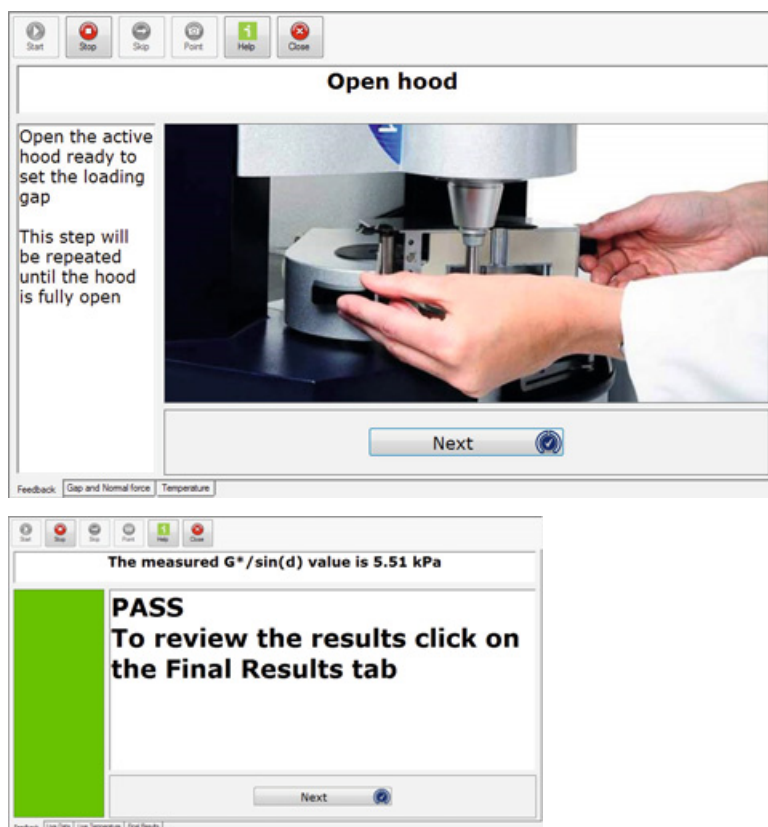
# iSPACE SOFTWARE

Standard Operating Procedure (SOP) driven tests for robust rheological measurements

Malvern's Standard Operating Procedure (SOP) approach to material testing has been a cornerstone to all our technologies, and is now available for the first time on a rheometer system.

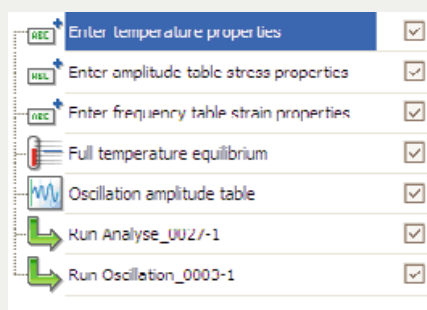
## rSpace can be used for simple QC operation or for advanced rheological testing

- Locked down tests including geometry and parameter set-up using standard user access control
- Continuous feedback and user guidance at all times
- Ensure best rheological practice
- Add specific test controls relevant to your samples
- Produce standard test methods for your samples
- Available for use company-wide
- Consistent testing as standard
- Time-Temperature Superposition for master curve generation
- Automatically reports Pass or Fail based on the appropriate test and test criteria
- Report designer with auto print/PDF generation



rSpace software is driven by 'sequences' – which consist of fundamental rheological actions (or test building blocks) that can be linked together with other test actions, such as user feedback and choices, calculate values, loops and triggers, in order to build 'intelligent' tests.

- Set a sequence to 'run' only, and a user operates under SOP-type conditions with defined test instructions and feedback
- Set user access to 'edit' sequence functionality, and researchers have the full design capabilities at their fingertips



*'What rheological test progression would you like to run?'*

- You think it - Kinexus can run it
- Dedicated and advanced tests exactly to your needs

### Program sequence in Kinexus

- 'Drag and drop' actions and 'Import subsequence' functionality
- Include user choices, calculate values, loops, triggers
- Include specific user inputs and instructions as required



# MEASURING SYSTEMS AND ACCESSORIES

Characterization and classification to asphalt industry standards

## Measuring Systems

- Quick-connect geometries with intelligent auto-recognition
- Geometry constants and test preferences automatically configured
- Lock-down tests to specific geometry to minimize operator error
- Automated geometry lock via software for ease of trimming
- Various material and surface finish options
- Solvent trap compatible
- Disposable options
- Coaxial cylinders (cup and bob) to DIN standard
- Double gap cell and vane tool options
- Geometry adapter allows use of custom geometries with Kinexus (e.g. Penetration probes)
- Automatic temperature calibration device available



## Peltier Cylinder Cartridge (-30°C to 200°C)

### Environmental controller for concentric cylinder-type measuring systems

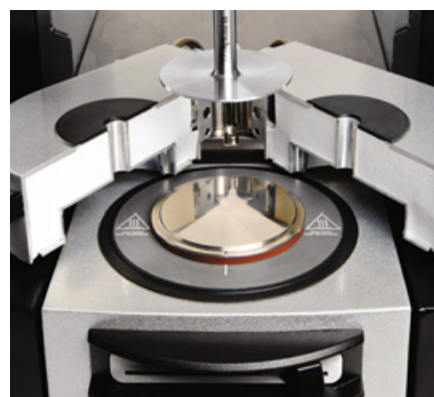
- Options to meet temperature control requirements for fluid-like samples through to solid asphalt cores
- Twin Peltier design for rapid temperature changes and sample equilibration, and minimized thermal gradients
- Various cup and bob sizes available - C14 (DIN), C25 (DIN) and wide diameter C34
- Interchangeable lower cups with removable base for ease of cleaning
- Plate insert provides a 'universal Peltier option'
- Accommodates Solid (Torsion) Fixtures for Dynamic Mechanical Analysis (DMA) testing of solid asphalt cores
- Crumb rubber testing system available



## Active Hood Cartridge (-40°C to 200°C)

### Environmental controller with minimized thermal gradients for plate measuring systems

- Applicable to the measurement of highly thermally-sensitive samples, and for temperature-critical testing where the temperature range is significantly above or below ambient
- Proprietary design combines Peltier elements with additional heaters to actively control radial and vertical thermal losses from the local sample environment
- Low thermal mass components for rapid response
- Inlet for inert gas feed into sample environment



# KINEXUS DSR SPECIFICATIONS

If you are unsure as to specifying an appropriate rheometer model for your application, Malvern recommend contacting us for further advice and/or a sample test and evaluation report.

	DSR+	DSR
Rheometer platform	Meeting research and development requirements for the Asphalt sector	Meeting quality control requirements for the Asphalt sector
Standard operating modes	Direct strain control; Shear rate control; Shear stress control	
Torque range – Viscometry (rate and stress control)	10nNm – 200mNm	20nNm – 200mNm
Torque range – Oscillation (strain and stress control)	2nNm – 200mNm	10nNm – 200mNm
Torque resolution	0.1nNm	0.1nNm
Position resolution	<10nrad	<10nrad
Angular velocity range	10nrad/s <sup>-1</sup> to 500rad/s <sup>-1</sup>	10nrad/s <sup>-1</sup> to 325rad/s <sup>-1</sup>
Step change in strain	<10ms	<10ms
Frequency range	6.28μrad/s <sup>-1</sup> to 942rad/s <sup>-1</sup> (1μHz to 150Hz)	6.28μrad/s <sup>-1</sup> to 942rad/s <sup>-1</sup> (1μHz to 150Hz)
Motor inertia	13μN.m.s <sup>2</sup>	13μN.m.s <sup>2</sup>
Normal Force range	0.001N - 20N (50N optional)	0.001N - 20N (50N optional)
Normal Force resolution	0.5mN	0.5mN
Normal Force response time	<10ms	<10ms
Vertical lift speed	0.1μm/s <sup>-1</sup> to 35mm/s <sup>-1</sup>	0.1μm/s <sup>-1</sup> to 35mm/s <sup>-1</sup>
Vertical lift range (measurable)	230mm	230mm
Gap resolution (over full vertical lift range)	0.1μm	0.1μm
Fully configurable vertical profiles	By speed and by Normal Force	
Raw instrument variables	5kHz constant streaming data	
Complete sample history	Data available from loading to unloading as standard	
Instrument interface	USB2 – plug and play	
rSpace software	Sequence-driven user interface enabling Standard Operating Procedure (SOP)-type test functionality and fully customizable test designs	
rSpace package	Standard Asphalt + Rheometer package	Standard Asphalt package
<b>Dimensions</b>		
D x W x H (Weight)	485mm x 490mm x 680mm (47kg)	

# KINEXUS DSR SPECIFICATIONS

DSR+ and DSR	
Measuring systems (geometries)	
Quick-connect upper geometries	Plug and play; auto-recognition and configuration in software
Material	Stainless Steel 316 as standard Other options are available e.g. for chemical compatibility e.g. Titanium
Plate and cone diameter	20mm through to 60mm as standard size range - other sizes on request 4mm, 8mm and 25mm plates specifically designed for Asphalt testing
Cone angle	0.5°, 1°, 2° and 4° variants – other angles on request
Interchangeable lower plates	Varying diameters & surface finishes (to match upper geometries)
Concentric cylinders	C 14 (DIN), C 25 (DIN), C 34 as standard
Interchangeable cups	Quick release/engage mechanism
Surface finish options	Roughened (sand blasted); Serrated; Splined or grooved (cup and bobs)
Vane tools	C 14 and C 25 vane tools
Disposable option	Upper and lower disposable plate options for curing materials
Crumb rubber kit	Shallow C 25 cup for use with C 14 vane tool – other bobs available
Solids Fixtures	Solid fixtures for use with cylinder cartridge for testing rectangular or cylindrical solids (Asphalt cores)
Environmental controllers	
Quick-connect cartridge system	Plug & play; auto-recognition and configuration in software
Active Hood Peltier plate cartridge	Temperature range -40°C to +200°C Maximum heating rate* 30°C/minute Maximum cooling rate* 20°C/minute
Peltier cylinder cartridge	Temperature range -30°C to +200°C Maximum heating rate* 15°C/minute Maximum cooling rate* 15°C/minute
Temperature resolution	0.01°C
Temperature stability	Better than ±0.1°C

\* Temperature range dependent.



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