



**Rheology
Solutions**



Applications Laboratory and Contract Testing Capabilities Statement

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FOOD CONTRACT TESTING KIT

Table of Contents

- Company Profile
- Applications Laboratory
- Materials Testing for the Food Processing Industries
- Technical Literature available for Food Applications
- Technical Note: Food & Beverage Materials Characterisation: Introduction to the influences of Rheological & Process Parameters
- Applications Laboratory Instruments – Liquid Testing
- Contract Testing Request Form
- Sample Testing Request Form

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Company Profile

Rheology Solutions Pty Ltd is a specialist sales and service organisation dedicated to the science of materials characterisation and are the exclusive Australian distributor for the product names HAAKE, NESLAB and Thermo Scientific from Thermo Fisher Scientific, Optical Control Systems, Marimex Industries Corporation and Schleibinger Geräte range of equipment and instruments.



Rheology Solutions recognises the importance of specialisation and dedication to a specific science and, as such, provides full technical support and service throughout Australia. The Company goal is to integrate industry experience and materials characterisation techniques to provide practical solutions for customers.

Rheology Solutions has an established applications laboratory equipped with a comprehensive range of instruments to meet the requirements of material characterisation. Specialist contract testing services are also available and contracts can be tailored to suit discrete tests or protracted testing requirements

involving a series of tests over a period of weeks or months.

A range of seminars and application specific workshops as well as product launches and demonstrations are provided throughout Australia. The seminars and workshops are designed to meet the needs of specific customer and industry applications.

Rheology Solutions has its head office in Victoria and works with a team of specialist sales and factory trained service personnel throughout Australia. The combined experience of this team ensures that Rheology Solutions are able to provide their customers with access to the products to ensure that the right technical support and service is provided.

The product range exclusively available includes:

- **Materials Testing Equipment**
Rotational viscometers, compact viscometers, freeze/thaw units, shrinkage cones and shrinkage/expansion units.
- **Polymer Testing Instruments**
Micro compounders, torque rheometers, mixers and extruders, chill rolls and winding units, film quality scanning systems, pellet scan system, powder testing system, melt analysis and testing system, optical online quality control mini calendar, stretch roll and winder system, measuring extruder, APLAIRS - online control of cast or blown film, film quality testing system, wide web inspection system, sample testing unit, polyester resin online analysis, pellet analyser, pellet shape and size distribution unit.
- **Process Rheometers**
Melt flow indexers, automated melt flow indexer, continuous melt flow indexer.



- **Process Viscometers**
Sensors for low, medium, high, very high viscosities and custom designed sensors.
- **Rheometers**
Controlled rate, dynamic oscillation, controlled stress, modular
- **Temperature Control**
Immersion circulators, bridge circulators, open bath circulators, shaking water bath, heating circulators, refrigerated circulators, cryostats, immersion coolers
- **Twin Screw Extruders**
Twin screw compounding equipment for laboratory through to production applications
- **Viscometers**
Falling ball, battery operated, rotational for QA or QC applications, micro viscometers

We look forward to discussing your requirements.

Focused on providing our **customers** with materials characterisation **solutions** through knowledge, experience and support.

Applications Laboratory

Rheology Solutions has invested in a fully equipped applications laboratory to further increase the level of customer focus and application support.

Specialist contract testing services are available and contracts can be tailored to suit discrete tests or protracted testing requirements involving a series of tests over a period of weeks or months.

The key areas of responsibility for Tim incorporate:

- Technical support for new and existing Rheology Solutions customers.
- Customer method development & validation.
- Customer training covering rheology theory and practice.
- Development and facilitation of rheology seminars and workshops.

Rheology Solutions has invested in a fully equipped applications laboratory to further increase the level of customer focus and application support. The appointment of our technical manager and the laboratory facilities has proved to be a great asset to new and existing customers. These initiatives are providing a valuable resource to the growing customer base within the field of rheology and material characterisation.

Instruments & Equipment in the Applications Laboratory

The Rheology Solutions applications laboratory is equipped with a comprehensive range of equipment and instruments to meet the requirements of material characterisation. The equipment and instruments currently available are:

- Haake RheoStress RS80 – controlled stress rheometer.
- Haake RheoStress RS150 - controlled stress rheometer.



Tim Kealy *setting the zero point on the RheoScope*

- Haake RheoStress RS6000 - modular, high temperature controlled stress rheometer.
- Haake CaBER 1 - Capillary Breakup Extensional Rheometer.
- Haake Melt Flow Indexer.

This combination of instruments and equipment allows the testing and definition of the material properties of most solids and liquids. In this way Rheology Solutions can provide unparalleled expertise and customer advice for sensible instrument and sensor selection as well as consultation and test procedure development.

This range of on-site instrumentation also permits Rheology Solutions to undertake comprehensive contract consulting and sample testing across most applications.

The precision and reliability of all data collected during testing is examined through multiple tests and comparison and dissemination of all data collected is passed to the relevant parties.



The continued reliability of our instruments is ensured through a schedule of regular maintenance and calibration checks, using calibration oils and weights for the fluid and solid testing instruments respectively.

Contract Testing Services

Specialist contract testing services are also available and contracts can be tailored to suit discrete tests or protracted testing requirements involving a series of tests over a period of weeks or months.

Contract testing services specifically for industrial applications is available. A range of comprehensive data can be provided for:

- Liquid properties.
- Creep & recovery tests.

- Viscoelastic moduli.
- Flow curves.
- Yield stress.
- Viscosity curves.
- Extensional properties including:
 - Apparent extensional viscosity.
 - Time to break-up of strands.
 - Extensional constants.
- Concentration and temperature profiles.
- Effects of particle size distribution.
- Effects of additives and viscosity modifiers.
- QA/QC for optimal processing.

These tests will provide valuable information for process design, modification and control. Test results can be provided simply as data files or supplied with complete interpretation and recommendations.

Additionally, Rheology Solutions can facilitate testing at the overseas suppliers laboratories when required.

Focused on providing our **customers** with materials characterisation **solutions** through knowledge, experience and support.

TECHNICAL NOTE:
FOOD AND BEVERAGE MATERIAL CHARACTERISATION:

Introduction to the influences of rheological and process parameters

ABSTRACT



T.Kealy,
*Technical Manager
Rheology Solutions Pty Ltd*

Mechanical and flow (rheological) properties are of crucial importance in the processing, storage and consumption of most solid, semi-solid and fluid foodstuffs. For liquids and semi-solids, these properties include shear viscosity, elasticity, extensional viscosity and yield point. For solid foods, the important parameters include the reaction of the food to imposed compressive or extensional forces. Solid and fluid mechanical properties influence one or more of the three lifecycle stages cited, as do process parameters such as handling, time and temperature. They impact parameters like processability, sedimentation, and mouthfeel.

Viscosity is the resistance of a fluid to flow. During any process unit operation involving fluid transport (pumping, mixing etc) it plays an important part in the energy consumption for that unit operation. The viscosity of most fluids is not constant, even at a single temperature, and usually varies depending on the shear rate it is experiencing (for example the rate of rotation of a pump impeller or agitator). In the case of phase separation through gravitational sedimentation or settling or with hydrocyclones etc, the yield stress of a fluid is also important, it is this property which dominates for settling particulates, if it is high, particles will remain in suspension, or at least the cut point will be elevated. Clearly this property is also critical for storage of fluids containing suspended material, and must be closely monitored to ensure that, after the storage period has ended, as much solid material as possible has

remained in suspension, if that is desirable. The elastic properties of a fluid have some consequences during processing, namely during pumping and mixing, they inhibit the above if they are dominant. As importantly, they influence consumption through their influence on mouthfeel. The perceived texture of highly elastic fluids (or solids) is very different to those having negligible elasticity. Measuring, then manipulating, viscous and elastic properties of a product can enhance mouthfeel considerably. Similarly, extensional viscosity, the 'stringyness' of a fluid has a huge impact both on processing, pouring and especially on the mouthfeel of a fluid during consumption.

All of the above rheological parameters may in turn be influenced by process or environmental variables, such as shear history, rest time and temperature. Because rheological properties are generally governed by the extent of structural build-up on microscopic levels, processing and handling with incorrectly operated - or the wrong type of - equipment can have startling effects. The structure of a fluid may not fully recover after subjection to high shear, or extremely long periods of time may be necessary for this recovery to become apparent. An example of such a fluid is tomato ketchup, which has significantly different flow properties before and during shear, but which quickly recovers its internal structure. During processing, temperature effects may be just as important, it is well known that viscosity changes markedly with temperature, and other mechanical or rheological properties display similar tendencies. As such, processing at ambient temperature can lead to wildly differing performances of unit processes depending upon the time of the prevailing conditions at that time of the day, or season. Similarly, during consumption, temperature effects can heavily influence the texture and feel of a fluid, and these parameters need to be



optimised to maximize consumer satisfaction.

The mechanical properties of solid and semi-solid foods such as pastes, bread, fruit etc can also be measured and their brittleness, deformation under applied load and response to different cutting, compressing or elongational tools can be related to otherwise subjective quantities like masticability, mouthfeel etc.

Sensitive, high precision versatile equipment is available for repeatable and reliable measurement of all flow properties in the laboratory. These rheometers measure shear viscosity, yield stress, thixotropic hysteresis loops and visco-elastic properties of liquid or multiphase foods. Recently, extensional rheometers have become commercially available, for the first time, which are ideal for measurement of extensional rheology, which also has a large impact on mouthfeel and processability of

many foods. These units have been shown to be of value for both quality control (QC) and product development. Additionally, solid and semi-solid food manufacturers have been interested in the mechanical properties of their product, and texture analysers, a version of the commonly encountered universal tester, are becoming more common in QC and research laboratories.

Key words: Rheology, rheometry, food materials characterisation, solid food, semi-solid food, liquid food, process effects, ingredients.

The full technical note, *"Food and beverage material characterisation. Introduction to the influences of rheological and process parameters"*, is available by request.

Ref Rheo025TP

Technical Literature Available for Food Applications

Rheology Solutions Pty Ltd has a variety of literature and documentation available for the food industries. This information comes from a variety of sources including the instrument manufacturers and also Rheology Solutions.

Ref No.	Title	Ref No.	Title
HA-047	New Measuring cell for UV assisted thermal curing at elevated temperatures	RF-110902-JO-01	Characterisation Of The Thixotropic Behaviour Of Semi-Solid Foodstuffs
Rheo 025TP	Food And Beverage Material Characterization – Introduction To The Influences Of Rheological And Process Parameters.	RF-120902-DE-01	Calculation Of The Shear Viscosity From A-Carrageenan In Aqueous Media By Using Molecular Parameters.
Rheo027	Comparison of Rheological Techniques for the Characterisation of Semi-Solid Foods	RF-120902-US-01	A New Flexure-Based Microgap Rheometer (FMR) Case Study: Micro Rheology Of Mayonnaise
Rheo042	Microrheology – Study The Structural Behaviour Of Food Under Deformation	RF-130502-JP-01	Rheological And Structural Characterisation Of K-Carrageenan Weak Gel
Rheo 049TP	Application of Liquid and Solid Rheological Technologies to the Textural Characterisation of Semi-Solid Foods.	RF-170902-PL-01	A Novel Method For In Situ Investigation Of Thermochemical Properties Of Food Materials Over Wide Ranges Of Pressures And Temperatures.
Rheo051	QC Measurements for Liquid Food Products and Packaging	RF-180902-US-01	Comparison Of Drying Operations On The Rheological Properties Of Derivatized Whey Protein Thickening Ingredients
Rheo253	Tim's Top Tips – Explanation And Evaluation Of Mouthfeel	RF-190902-BR-01	Structure, Rheological Properties And Gelatinization Kinetics Of Yam
Rheo254	Tim's Top Tips – Explanation And Evaluation Of Shelf Life	RF-190902-CA-01	Time-Temperature Studies Of Gellan Polysaccharide Gelation In The Presence Of High Levels Of Co-Solutes
Rheo255	Tim's Top Tips – Explanation And Evaluation Of Processability	RF-200902-AU-02	The Development Of New Methods For Quantitative Determination Of Amorphous Lactose By TGA/SDTA And C Solid-State NMR
Rheo256	Tim's Top Tips – Explanation And Evaluation Of Cohesiveness, Cohesion Strength And Cohesive Quality		
Rheo358	Tim's Top Tips – How to measure flow and Viscosity curves for Food Industries		
Rheo360	Tim's Top Tips – How to Measure Thixotropy for Food Industries		
Rheo362	Tim's Top Tips – How to measure Yield Stress for Food Industries		

These articles may be requested direct from our website: <http://www.rheologysolutions.com/articlerequest.html>



Ref No.	Title	Ref No.	Title
RF-200902-US-01	Rheological And Microstructural Analysis Of A Model Rennet Casein Gel As Influenced By Cooling Rate	V229	Solvent Trap and Double Cone System for Reproducible Results in Rheological Measurement of Low Viscous Volatile Fluids
V016E	Contribution To The Assessment Of Some Rheological Properties Of Wheat Gluten	V230	Rheological Methods for Determining Molecular Weight and Molecular Weight Distribution
V033E	Dynamic Measurements Of Jello		
V035E	A Method For Monitoring Coagulation		
V041E	Tracking The Curing Of Epoxy With A Rotational Viscometer		
V042E	Mozzarella Cheese Elasticity, And Eating Pizza		
V045E	Cappuccino In The Lab? Don't Disturb The Foam!		
V051E	Measuring The Effect Of Gels Upon Mouth-Feel		
V077E	The Viscoelastic Properties Of Chewing Gum		
V107E	Modified HP-Starches: Advantages In Manufacturing And Texture Of Processed Food		
V108E	Wheat Fiber-A Natural Functional Ingredient		
V127E	Determining The Yield Point Of Food Products		
V132E	Monitoring Flow Properties Of Food Gels		
V136E	Viscosity Measurements On Liquid Chocolate With The VT550		
V138E	Measurement Of Butter - Complications And Possibilities		
V141E	Applied Rheology In Food Technology		
V172E	Texturizing Mayonnaise With Custom-Made Pectin Product		
V187E	Rheological Behavior Of Hydrogels In Dependence On Concentration Of The Polymer And Type Of Neutralizing Agent		
V194E	Greases: Rheological Measurements In Rotational Mode		
V222	Breaking Strength of Chocolate		

Materials testing for the food processing industry



T.Kealy,
Technical Manager
Rheology Solutions Pty Ltd

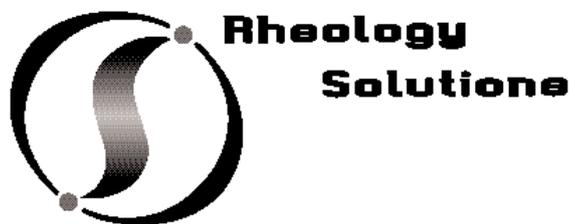
Specifically for the food processing industries, materials characterisation is of critical importance in many processes (including fluid related issues like sedimentation, flotation, time related structural decay or build-up, mouthfeel, and solid food issues like brittleness, hardness, strength - compressive & extensional – elasticity, crispness, staleness, crustiness etc). These processes depend on fluid rheological parameters such as viscosity, elasticity, creep and recovery, thixotropic tendencies and yield stress, and solid material properties such as extensional and compressive behaviour under various loading conditions.

The Rheology Solutions applications laboratory has state of the art equipment, capable of measuring all of the above parameters, and of providing interpretation of the results when necessary. Laboratory equipment includes highly sensitive, specialised, modern instrumentation and sensor systems, for measuring complex or difficult fluids such as those with very low viscosity (such as some supernatants or beverages), or those with a highly settling solid phase, or highly elastic liquids. Solids performance according to various international standards can also be monitored.

Information such as shear viscosity curves, thixotropic behaviour and flow curves may be obtained for interested clients. Additionally, of importance to the food industry, when scientifically assessing changes in mouthfeel due to temporal or ingredient issues, viscoelastic moduli as a function of either shear rate or strain can be assessed. Structural decay and recovery under very low shear (like in the case of storage, gravity settling, chewing etc) or very high shear (pumping, mixing etc) are possible using the advanced equipment and sensors available at the laboratory of Rheology Solutions. These measurements may be obtained as a function of temperature, solids density, or to monitor the effects of changes in additive/ingredient species or concentration.

With this information the scientist or engineer may change the process, or design new unit operations or products to maximise the potential benefits to be obtained from the physical properties of the processed fluid.

Rheology Solutions is pleased to provide this information to interested parties, and to make our rheological expertise available to the food processing community. Our range of testing and interpretation services is further supported by customised workshops, training and seminars to cover the needs of individuals, businesses or industry sectors, covering introductory, intermediate or advanced theory and practice of rheology. This can be supplemented by application specific workshops.



Applications Laboratory Instruments, Liquid Testing

(as at July 2010)

Instrument:	CaBER1	RS6000	RS150	RS80	VT550	VT6/7
Measurement Technique:						
Controlled Rate (CR) measurement	NO	YES	YES	YES	YES	YES
Controlled Stress (CS) measurement	NO	YES	YES	YES	NO	NO
Step Strain (Extensional) measurement	YES	NO	NO	NO	NO	NO

Commentary

The CaBER1 is a capillary break-up extensional rheometer. CS measurements allow a variety of tests to be performed, which are not possible on CR units, these include measurement of G' and G'' , and complex viscosity, but also the most precise yield stress measurements can be made using CS measurements only.

Measuring Geometries:

Plate & Plate*	YES	YES	YES	YES	YES*	NO
Cone & Plate*	NO	YES	YES	YES	YES*	NO
Cup & Bob	NO	YES	YES	YES	YES	NO
Vane	NO	YES	YES	YES	YES	NO
ASTM D4287-88	NO	NO	NO	NO	NO	YES
Capillary	NO	NO	NO	NO	NO	YES

Commentary

(*) VT550: Extra fixtures are required, and computer controlled closing of the geometry is not possible.

Test Types:

Oscillatory Tests	NO	YES	YES	YES	NO	NO
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Commentary

Oscillatory tests allow a range of amplitudes and/or frequencies of oscillation, for both destructive and non-destructive testing.

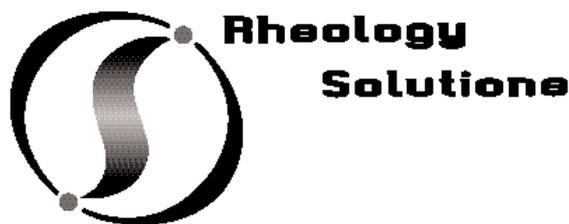
Rotational Tests	NO	YES	YES	YES	YES	YES
Creep/Recovery*	NO	YES	YES	YES	NO	NO
Extensional Tests	YES	NO	NO	NO	NO	NO

Commentary

* This measures the extent of, and time taken for, structural recovery to be measured.

Information:

Yield Stress	NO	YES	YES	YES	YES	NO
Thixotropy	YES	YES	YES	YES	YES	NO
Flow Curve*	NO	YES	YES	YES	YES	NO
Viscosity Curve*	YES	YES	YES	YES	YES	NO
Elastic Modulus, G' #	NO	YES	YES	YES	NO	NO
Viscous Modulus, G'' #	NO	YES	YES	YES	NO	NO



Commentary

- (*) VT6 and VT7 are ASTM D4287-88 units, they can only measure 'true' viscosity or flow curves for Newtonian fluids. Non-Newtonian fluids give comparative data only. The CaBER 1 measures apparent extensional viscosity, not shear viscosity as measured by rotational instruments.
- (#) G' & G'' are critical for measuring structural changes over time, eg gelation/decomposition, without disturbing the internal structure of the sample.

Instrument:	CaBER1	RS6000	RS150	RS80	VT550	VT6/7
Useful for:						
QA/QC	YES	YES	YES	YES	YES	YES
R&D	YES	YES	YES	YES	NO	NO

Commentary

The rotational instruments are documented in order of decreasing sensitivity and operating window size. The RS6000 is the most sensitive of these instruments with the largest operating window. The VT6/7 is the least sensitive of these instruments with the smallest operating window.

Portable	NO	NO	NO	NO	YES	YES
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Commentary

RS6000 and RS150 weigh 40kg, VT550 and VT6/7 are portable on their own, but refrigerated circulator & laptop are recommended for all units.

Other:

Precision*	HIGH	VERY HIGH	VERY HIGH	HIGH/MODERATE	MODERATE	LOW
Temperature Control necessary	YES	YES	YES	YES	YES	YES
Clean & Dry air necessary	NO	YES	YES	YES	NO	NO
Controlled closure of geometry#	YES	YES	YES	YES	NO	NO

Commentary

- (*) The RS6000, RS150 and RS80 have air bearings, allowing higher sensitivity for all measurements.
- (*) The VT550 has a mechanical bearing (low friction), but not essentially frictionless like RS units.
- (*) The VT6/7 have mechanical bearings (higher friction than the VT550).
- (#) This feature is critical to reduce the disturbance to the sample, and to help repeatability since manual closure of the gap for thixotropic fluids results in variable initial strain on the sample.

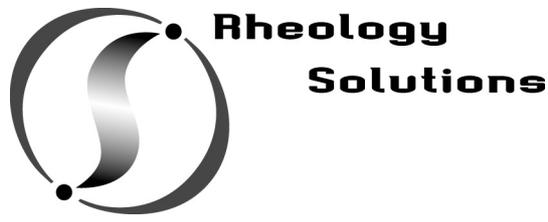
KEY:

The equipment in the applications laboratory is a combination of last and current generation viscometers and rheometers. These instruments are widely in use for R & D through to QA & QC applications.

The CaBER 1 Capillary Break-Up Extensional Rheometer measures extensional properties which govern filling, spatter, misting, fibre spinning and other processes, which have an elongational or extensional component.

The RheoStress (RS) 80, 150 and 6000 controlled stress rotational rheometers measure shear and dynamic properties which govern pumping, stirring and other processes where the acting forces are shearing the fluid.

The ViscoTester (VT) 550 and 6/7 viscometers measure shear properties only, which govern the viscous part of pumping, stirring and other processes where shearing forces act on the fluid.



Contract Testing Request Form

Date: Confidentiality Agreement Required Yes No
Name:
Company:
Phone Number: Area Code: State:
Email Address:

REASONS FOR TESTING

- Sample Characterisation
 Process Development / Problems
 Other:

INFORMATION WILL BE USED BY

- QA
 R&D
 Productions

PROCESS INFORMATION

If there is a problem, how does it manifest itself?

(Please provide basic process details before, during and after point of detection)

SAMPLE INFORMATION

Samples Name / ID:
No. of Samples:
Corrosive: Yes No Toxic: Yes No
pH:
Particle Size Distribution:
Concentration *(solids / polymer / ionic etc.)*:

Other:
Is an MSDS Sheet included for each different sample? Yes No
Special Disposal Requirements? Yes No
If Yes, Details:

Samples Name / ID:

Sample Handling / Storage: (eg. refrigeration, temperature, mixing, shelf life, air tight etc.)

Sample Preparation for Testing: (eg. pH, mixing, other additives, ingredients, temperature etc.)

Cleaning Requirements: (eg. solvent, detergent, water etc.)

CURRENT TESTING PROCEDURES:

Is there an existing test procedure available? Yes No

Is a copy of the test procedure attached? Yes No

Are test results for this product attached? Yes No

TESTING / RESULTS REQUIRED:

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DISSEMINATION OF RESULTS:

- | | |
|--|---|
| <input type="checkbox"/> Data Only | <input type="checkbox"/> Interpretation & Recommendations |
| <input type="checkbox"/> Data & Interpretation | <input type="checkbox"/> Other eg: Presentation |

COMMENTS:

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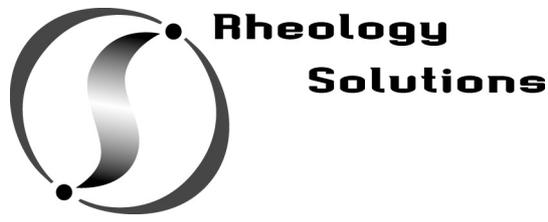
NOTE:

We will advise within 48 hours of receipt of this form if further information is required. Additionally, we will provide an overview of the work we would carry out including an estimate of the projected time scale and associated fee. Any costs associated with special sample disposal requirements will be paid and arranged by the client.

Customer Signature:

Request Submitted by:

We suggest you submit this form by fax 03 5367 6477



Sample Testing Request Form

Date: Confidentiality Agreement Required Yes No
Name:
Company:
Phone Number: Area Code: State:
Email Address:

DATE REQUIRED BY

Urgent - 1 Week Low Priority - 3 Weeks
 High Priority - 2 Weeks Other:

REASONS FOR TESTING

Instrument Evaluation / Recommendation
 Other:

INFORMATION WILL BE USED BY

QA
 R&D
 Productions

PROCESS INFORMATION

If there is a problem, how does it manifest itself?
(Please provide basic process details before, during and after point of detection)

SAMPLE INFORMATION

Samples Name / ID:
No. of Samples:
Corrosive: Yes No Toxic: Yes No
pH:
Particle Size Distribution:
Concentration (*solids / polymer / ionic etc.*):

Samples Name / ID:

Other:

Is an MSDS Sheet included for each different sample? Yes No

Special Disposal Requirements? Yes No

If Yes, Details:

Sample Handling / Storage: *(eg. refrigeration, temperature, mixing, shelf life, air tight etc.)*

Sample Preparation for Testing: *(eg. pH, mixing, other additives, ingredients, temperature etc.)*

Cleaning Requirements: *(eg. solvent, detergent, water etc.)*

CURRENT TESTING PROCEDURES:

Is there an existing test procedure available? Yes No

Is a copy of the test procedure attached? Yes No

Are test results for this product attached? Yes No

DISSEMINATION OF RESULTS:

- | | |
|---|---|
| <input type="checkbox"/> Data Only | <input type="checkbox"/> Interpretation & Recommendations |
| <input type="checkbox"/> Data & Interpretation | <input type="checkbox"/> Other eg: Presentation |
| <input type="checkbox"/> Report to Customer | <input type="checkbox"/> PDF of Report |
| <input type="checkbox"/> Report to State Distributor/Office | <input type="checkbox"/> Hard Copy of Report |

COMMENTS:

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NOTE:

We will advise within 48 hours of receipt of this form if further information is required. Additionally, we will provide an overview of the work we would carry out including an estimate of the projected time scale and associated fee. Any costs associated with special sample disposal requirements will be paid and arranged by the client.

Customer Signature:

Request Submitted by:

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