



**Rheology
Solutions**



RHEOLOGY SOLUTIONS FOR

MINERAL SLURRIES & THE MINING INDUSTRY

RHEOLOGY SOLUTIONS PTY LTD. ACN 082 479 632

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Rheology Solutions offers **material characterisation solutions** to measure monitor and provide reproducible data for quality control and production applications that will improve performance within the mineral slurries application areas.

Improve your process and product performance through:

- understanding your materials characteristics
- identifying process and production challenges
- monitoring and controlling processing parameters.

The terms usually referred to when mineral slurry processes are assessed are diverse and include:

- | | | | |
|------------------|----------------------|----------------|----------------------|
| • aggregation | • angle of repose | • beach | • beneficiation |
| • comminution | • dispersion | • flocculation | • foaming |
| • processability | • slimes | • slump | • slurry |
| • stratification | • suspension | • tailings | • viscosity modifier |
| • yield stress | • pipeline transport | | |

Material characterisation parameters are reliable pointers to determine mineral slurry parameters and are critical factors for processability. Measuring these parameters will improve process and performance within mineral slurries application areas.



◀ **Yield Stress** The minimum force required to initiate movement in a fluid. Measuring the yield point in the slurry or suspension using the HAAKE Viscotester 550 with a vane sensor will provide valuable information about the force required to initiate movement of the slurry or suspension for start of rakes, impellers and so on.

Thermo Scientific HAAKE Viscotester 550 - controlled rate viscometer

▶ **Viscosity Modifier** Used to alter flow properties of mineral slurries. Determining the viscosity before and after addition of viscosity modifiers using a HAAKE RotoVisco 1 allows the engineer to optimise the flow properties of a slurry or suspension to increase productivity and maximise pumping efficiencies and volumes.

Thermo Scientific HAAKE RotoVisco 1 – controlled rate viscometer



➤ **Foaming** Occurs when gas is introduced into the material. A HAAKE CaBER 1 rheometer will measure the extensional properties of the liquid and provide details on the longevity of the foam. This information is valuable in determining if a foam will be produced. The strength of the foam is related to its longevity and its ability to hold up particulate matter in the separation process. Adjustments may need to be instigated to enhance the production process by changing the modifier to either increase or reduce the occurrence of foaming.

Thermo Scientific HAAKE CaBER 1 – extensional rheometer



➤ **Flocculation** The artificial creation of solid aggregates to create clumps of high value minerals for separation from liquid. The HAAKE RheoStress 6000 enables measurement of the strength of a floc and/or the rate of flocculation so the engineer can determine the correct quantity of flocculant required. This minimises the loss of the valuable minerals and optimises flocculant usage.

Thermo Scientific HAAKE RheoStress 6000 – controlled stress rheometer



➤ **Pipeline Transport**

The process of moving slurries or pastes from one location to another by pumping the material through a pipe. Measuring on-line viscosity using a Marimex ViscoScope system will provide constant data monitoring in the pipe or tank so adjustments can be made during the process to maintain the best conditions for pumping.

Marimex ViscoScope – in-line viscometer



➤ **Processability** Typically, processability is related to the amount of energy required to carry out the relevant unit operation. Determining the processability of mineral slurries can be achieved using a HAAKE PolyLab OS and RheoMix by providing information on torque, temperature and rpm inputs which relate directly to the processability of the materials being mixed or transported.

Thermo Scientific HAAKE PolyLab OS with RheoMix – pilot scale torque rheometer with instrumented mixer



➤ **Temperature Control** Rheology Solutions are able to offer you the most flexible, cost-effective temperature control solutions for a multitude of applications. The range covers:

- Refrigerated Bath Circulators
- Heating Bath Circulators
- Open Bath Circulators
- Ultra Low Refrigerated Circulators
- Recirculating Chillers
- Water Recirculators
- Software options
- Extensive range of accessories

Cool Tech Plus - the cost effective refrigerated bath circulator

➤ **Contract Testing Services** 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 Rheology Solutions applications laboratory is equipped with a comprehensive range of equipment and instruments to meet the requirements of material characterisation.

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

- Liquid properties
- Flow curves
- Yield stress
- Viscosity curves
- Viscoelastic moduli
- Creep & recovery tests
- Concentration & 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.

Overview of Rheology-Based Process Challenges for the **Mineral Processing Industries**

Mineral processing involves the transportation and processing of large quantities of materials. Combining solid materials with a carrier fluid (usually water) to create a slurry has long been popular in the industry, principally due to the increased efficiency and alacrity of mineral processing steps through use of a slurry, since the finely ground particles afford greater surface area exposure to the extracting medium. Also, the ease with which the particulate matter can be processed in this form is important for unit processes including grinding, classification, separation processes (settling, thickening, screening, filtration) and transport processes like pump/gravity flow through pipes and launders, mixing, etc. Slurry characteristics pose many engineering challenges. These characteristics include particle settling, pH, bulk/carrier fluid viscosity, particulate flocculation or dispersion, attrition, pipe/fitting/impeller wear, degradation of flocculated or friable solids and the pumpability of the slurry. The effects of these challenges can be further altered by process or environmental variables such as temperature or solids loading.

Wet comminution and classification can be effected by viscosity, particle size distribution, fines concentration etc. For example, hydrocyclone classification is effected by the presence of a yield stress (the minimum force required for a slurry to flow). Often, cut point increases and efficiency decreases with increasing yield stress. Separation processes are influenced by inter-particle attraction and viscosity (how easily the fluid flows once it is in motion). These variables may be manipulated through the addition of modifying agents to the slurry. The key effects of these additions should be monitored through changes in the rheological parameters of the slurry, which are directly related to process performance. In-transit particle settling causes uneven and excessive wear or complete blockage in the transport system. Particle attrition may be a QC matter both for disposal and in-process and, changes in particle size distribution may affect the ability of the particles to remain suspended. Problems with the pumpability of slurries include the high cost of initiating and continuing pumping of fluids with high yield stresses or viscosities.

Rheological techniques can help assess process design and manipulation processes. A range of instruments is available to measure the rheological effects, through knowledge of the characteristic flow properties of the slurry. These rheometers allow the engineer to directly measure and assess the causes and effects listed above. Physical quantities such as yield stress, plastic viscosity and hysteresis (the changes in plastic viscosity and/or yield stress which are due, usually, to particle attrition or settling) can be quantified and predicted with the appropriate equipment.

Sensitive, precise equipment is available for repeatable and reliable measurement of flow properties in the laboratory, and durable, robust units for in-the-field use are also available. These units are of value for both QC and product development.

Contact us now for further information on these **products**, contract testing **services** or to discuss your **application** requirements.



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