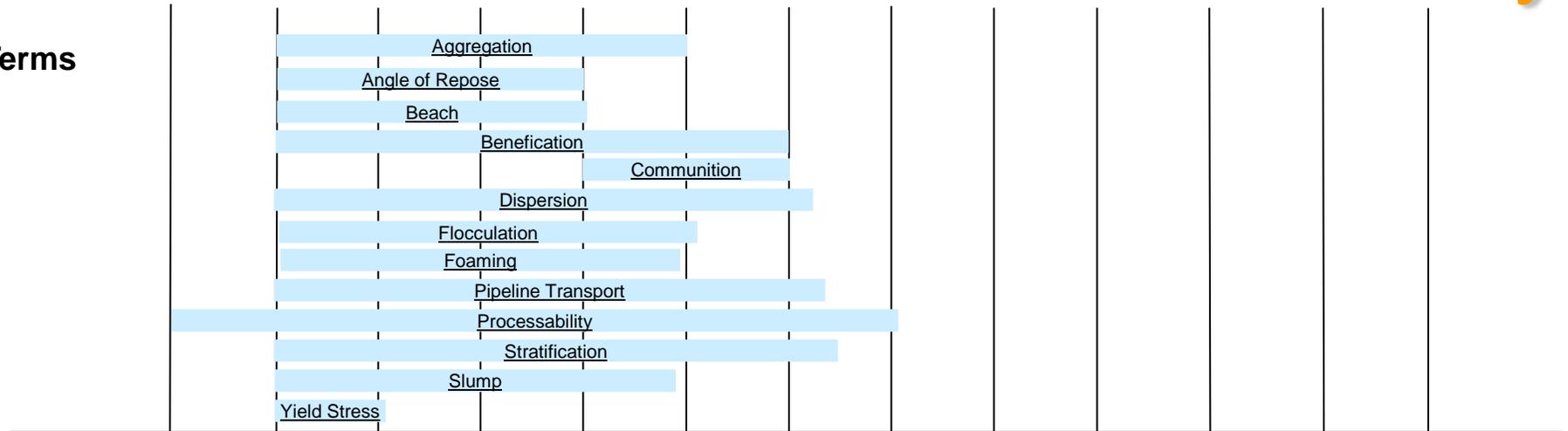
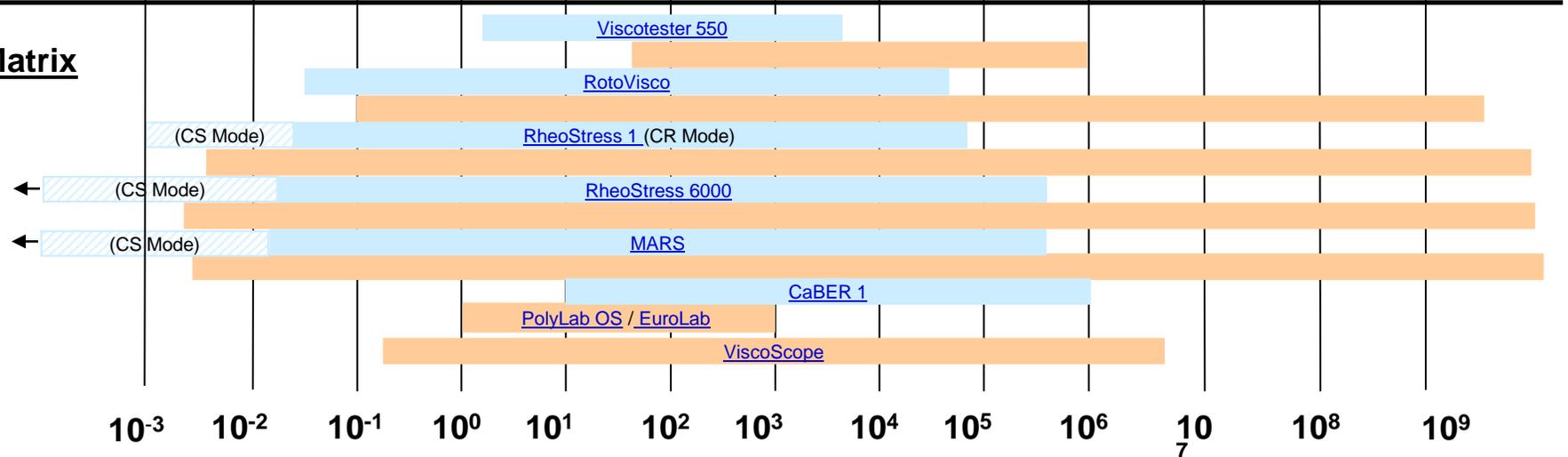


Interactive Mineral Slurries Dictionary

Common Terms



Equipment Matrix



**Rheology
Solutions**

Measuring Range (Shear Rate s⁻¹)
 Measuring Viscosity Range (mPa.s)

- Viscotester, RotoVisco, RheoStress, MARS, CaBER, EuroLab and PolyLab OS are HAAKE product names of Thermo Scientific Instruments.
- ViscoScope is a brand name of Marimex Industries Corporation.

Industry Term: Aggregation

- Process:* Production.
- Definition:* Formation of larger bodies by the joining of several smaller ones, causing an increase in apparent volume fraction. Surface charge of the particle causes the attraction between them (measured as zeta potential). The net result of aggregation can be increases in yield point and viscosity, and an increased propensity of the solids to settle.
- Governing Properties:* Shear viscosity and yield stress, measured on a CR (Controlled Rate) Viscometer using a flow curve (viscosity) and the vane technique (yield point).
- Rheology Solutions Instrument:* HAAKE RotoVisco, HAAKE Viscotester 550



Industry Term: Angle of Repose

<i>Process:</i>	Production (Waste disposal).
<i>Definition:</i>	The maximum angle from the horizontal at which a material will rest without moving further.
<i>Governing Properties:</i>	Measurement of shear viscosity and yield stress, measured on a CR (Controlled Rate) Viscometer using a flow curve (viscosity).
<i>Rheology Solutions Instrument:</i>	HAAKE RotoVisco, HAAKE Viscotester 550.



Industry Term: Beach

- Process:* Production (Waste disposal).
- Definition:* Deposition of waste solids materials (transported as a slurry or a paste) from which the liquid fraction flows.
- Governing Properties:* Beach slope is dictated by the viscosity and yield stress of the slurry or paste. Shear viscosity and yield stress, measured on a CR (Controlled Rate) Viscometer using a flow curve (viscosity) and the vane technique (yield point).
- Rheology Solutions Instrument:* HAAKE RotoVisco, HAAKE Viscotester 550.

Industry Term: Benefication

- Process:* QA/QC.
- Definition:* Benefication is the initial attempt at liberating and concentrating the valuable mineral from the extracted ore. This is typically performed by employing various crushing, grinding and froth flotation techniques. The remaining material is often physically and chemically similar to the material (ore or mineral) that entered the operation, except that particle size reduction has often occurred.
- Governing Properties:* For many benefication operations, the viscosity and yield point of the suspension dictate the efficiency of separation and concentration. Shear viscosity and yield stress can be measured on a CR (Controlled Rate) Viscometer using a flow curve (viscosity) and the vane technique (yield point). On-line measurements of viscosity in tanks and pipes can give valuable information for the process.
- Rheology Solutions Instrument:* HAAKE Viscotester 550, HAAKE RotoVisco, Marimex ViscoScope.



Industry Term: Communion

- Process:* Production.
- Definition:* Crushing or grinding of ore or rock, often in the form of a slurry.
- Governing Properties:* Communion depends on the viscosity and yield point of the slurry in the plant, measured on a CR (Controlled Rate) viscometer.
- Rheology Solutions Instrument:* HAAKE Viscotester 550, HAAKE RotoVisco.



Industry Term: Dispersion

<i>Process:</i>	Production.
<i>Definition:</i>	The reverse of flocculation. Molecules carrying multiple charges (dispersants and surfactants) bind to the surface of particles, giving all the particles in the suspension the same charge, preventing the formation of flocs or aggregates.
<i>Governing Properties:</i>	Surface charge (zeta potential) causes the attraction. The net result of dispersion is a removal (or reduction) of the yield stress and a return to Newtonian behaviour. Shear viscosity and yield stress, measured on a CR (Controlled Rate) Viscometer using a flow curve (viscosity) and the vane technique (yield point) are dictated to some extent by the zeta potential of the system.
<i>Rheology Solutions Instrument:</i>	HAAKE Viscotester 550, HAAKE RotoVisco.



Industry Term: Flocculation

<i>Process:</i>	Production.
<i>Definition:</i>	Artificially induced (by the addition of flocculant eg ions carrying multiple charges or high molecular weight polymers) aggregation.
<i>Governing Properties:</i>	Surface charge (zeta potential) causes the attraction. The net result of flocculation can be increases in yield point and viscosity, and an increased propensity of the solid aggregates to settle. Shear viscosity and yield stress, measured on a CR (Controlled Rate) Viscometer using a flow curve (viscosity) and the vane technique (yield point). The strength of a floc and the rate of flocculation in a small volume can be measured using CS (Controlled Stress) rheometers and a frequency (floc strength) or time (floc growth) sweep.
<i>Rheology Solutions Instrument:</i>	HAAKE RotoVisco, HAAKE Viscotester 550. HAAKE RheoStress, HAAKE MARS.



Industry Term: Foaming

<i>Process:</i>	Production
<i>Definition:</i>	Continuous formation of bubbles having high surface tension which remain beyond the disengaging surface. This is due to the introduction of gas in the material.
<i>Governing Properties:</i>	The longevity of the foam is related to extensional properties, measured with an extensional rheometer, on the viscoelastic properties of the liquid, measured using a frequency sweep on a CS rheometer and on the properties in shear, measured using a flow loop on a CR or CS instrument.
<i>Rheology Solutions Instrument:</i>	HAAKE CaBER 1, HAAKE Viscotester 550, HAAKE RotoVisco, HAAKE RheoStress, HAAKE MARS.



Industry Term: Pipeline Transport

<i>Process:</i>	Production.
<i>Definition:</i>	The transfer of material from one location to another using a pump and pipeline. The material is invariably a paste or slurry.
<i>Governing Properties:</i>	The ease of transfer of the material is usually dictated by both the yield stress and by its viscosity. On-line viscosity measurements are possible. Yield stress is measured using the vane technique and a CR viscometer and the viscosity of the material can be measured using a flow curve on a CR viscometer.
<i>Rheology Solutions Instrument:</i>	HAAKE Viscotester 550, HAAKE RotoVisco, Marimex ViscoScope.



Industry Term: Processability

<i>Process:</i>	Production.
<i>Definition:</i>	Related to the amount of energy required to perform the relevant production steps on a material.
<i>Governing Properties:</i>	Depending on the process, small scale machines (mixers etc) can be used to estimate (through their relative torque, temperature and rpm inputs) the relative processability of different materials. Direct measurement of viscoelastic properties, eg frequency or temperature sweeps, using a CS rheometer and of the behaviour in shear using flow curves from a CR viscometer - can all provide valuable information for predicting the processability of a given material.
<i>Rheology Solutions Instrument:</i>	HAAKE Viscotester 550, HAAKE RotoVisco, HAAKE RheoStress, HAAKE MARS, HAAKE PolyLab OS & RheoMix, Marimex ViscoScope.



Industry Term: Slump

<i>Process:</i>	Production (QC).
<i>Definition:</i>	Historically, the primary test for determining the possibility for pumping, raking and depositing mineral slurries, though it is in fact a combination of more than one material property. Understanding yield stress and viscosity are making slump tests less relevant.
<i>Governing Properties:</i>	Viscosity and yield stress. High yield and high viscosity materials will exhibit low slump. Yield stress and viscosity can be measured using a CR viscometer (viscosity) and the vane technique (measure yield stress).
<i>Rheology Solutions Instrument:</i>	HAAKE RotoVisco, HAAKE Viscotester 550.

Industry Term: Stratification

<i>Process:</i>	Production (pumping).
<i>Definition:</i>	Phase separation in the pipe where the solid fraction tends to separate and concentrate in the pipe, flowing in layers, usually with the liquid phase flowing more quickly above it. Particle size and density dictate stratification.
<i>Governing Properties:</i>	The transport properties of yield stress and fluid viscosity can be used to reduce stratification. Yield stress is measured using the vane technique and a CR viscometer and the viscosity of the material is measured using a flow curve on a CR viscometer.
<i>Rheology Solutions Instrument:</i>	HAAKE RotoVisco, HAAKE Viscotester 550.



Industry Term: Yield Stress

<i>Process:</i>	Production.
<i>Definition:</i>	The yield stress is the minimum force required to initiate movement in a fluid, (for example for pumping or raking).
<i>Governing Properties:</i>	Usually depends on the solids loading in the slurry or suspension and the interaction between them. The presence of viscosity modifiers in the slurry can also effect yield point. Measured using the vane technique and a CR viscometer.
<i>Rheology Solutions Instrument:</i>	HAAKE RotoVisco, HAAKE Viscotester 550.



Equipment Type

EQUIPMENT NAME

Viscotester VT550
RotoVisco
ViscoScope
RheoStress
MARS
CaBER 1
PolyLab OS / EuroLab

TYPE

Rotational Viscometer
Rotational Viscometer
Torsional Motion Rheometer
Controlled Stress Rheometer/s
Modular R&D Controlled Stress Rheometer
Extensional Rheometer
Mixers, Extruders

NOTES:

- The PolyLab OS and EuroLab, are laboratory / pilot scale mixers and extruders and therefore exhibit the same range of shear rates which occur in full-scale processing. Therefore a shear range is not a relevant quantity for this equipment.
- The CaBER 1 is an extensional rheometer and does not exert shear rates or stresses, but rather extensional ones.
- The shear rate of the rotational instruments (Viscotester, RotoVisco, RheoStress, MARS) can be expanded using alternative sensors geometries.
- The ViscoScope continuously measures a single point viscosity in the pipe or tank at approximately 4 s^{-1} .

Disclaimer:

All of the products included in this document are correct at the time of printing. These products may alter or be discontinued at a later stage.



Shear Rate Table

INDUSTRY TERM	SHEAR RATE
Aggregation	0.01 - 100 s ⁻¹
Angle of Repose	0.01 - 10 s ⁻¹
Beach	0.01 - 10 s ⁻¹
Benefication	0.01 - 1000 s ⁻¹
Communiton	10 - 1000 s ⁻¹
Dispersion	0.01 – 1000 s ⁻¹
Flocculation	0.01 - 100 s ⁻¹
Foaming	0.01 - 100 s ⁻¹
Pipeline Transport	0.01 - 2000 s ⁻¹
Processability	<0.01 - 10000 s ⁻¹
Slump	0.01 - 100 s ⁻¹
Stratification	0.01 - 2000 s ⁻¹
Yield Stress	0.01 - 1 s ⁻¹