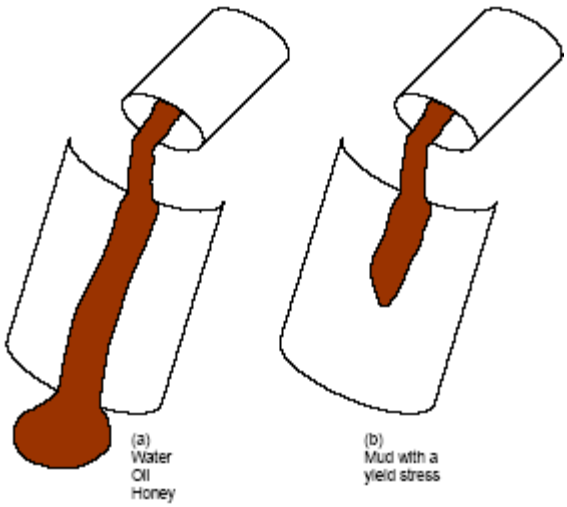
What is Paste?

Rheology is the study of the change in form and flow of matter, including such subjects as viscosity, elasticity and plasticity. When matter flows, such as water or a tailings suspension, there is internal friction caused by the interaction of water molecules and fine solids. This friction affects the form and flow rate of the tailings stream. At high solids concentrations the internal friction is great enough to prevent the suspension from flowing unless sufficient pressure is applied. All fluids have an internal friction and equipment used to handle a fluid, such as pipelines, pumps, thickeners, and filters must be designed with rheological properties in mind. A paste thickener is designed with an understanding of paste rheology. In fact, paste rheology is the differentiation that separates paste thickeners from the more commonplace high-rate thickener.

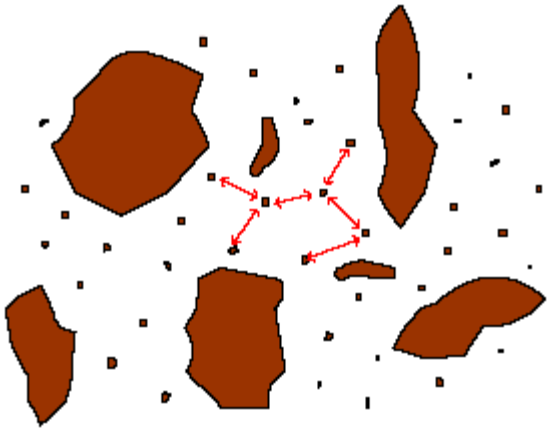
Viscosity is a rheology term that is a measure of the internal friction of a fluid. In a mineral tailings stream, as the concentration of solids rises the viscosity increases. For example, slurry of copper tailings at 50% solids concentration will have a lower viscosity than at 55% concentration. When mineral tailings are concentrated to a paste consistency the viscosity may increase dramatically. Friction can be visualized as layers of fluid sliding across each other. A force is required to make the layers move and as the friction increases, a greater force is required. The force may be produced by a pump, or by gravity. The movement produced by this force is called “shear”. Shearing is produced whenever a fluid moves. For example, a tailings suspension flowing in a pipe experiences shear. A mixer also produces shear.

Yield Stress is one of the defining characteristics of a paste, it defines the increasingly solid-like behavior as the tailings become more concentrated. Unlike slurry, which is basically a liquid (Newtonian fluid) that assumes the shape of any container in which it is held, a paste will hold its shape to a degree determined primarily by the solids concentration. A pressure is required to make the paste flow. This pressure is a rheological term called ‘yield stress’ which is another property of non-Newtonian fluids.

Considering the flow down an inclined trough offers another visualization of yield stress. When poured onto an inclined trough, oil, honey, and settling minerals slurries will

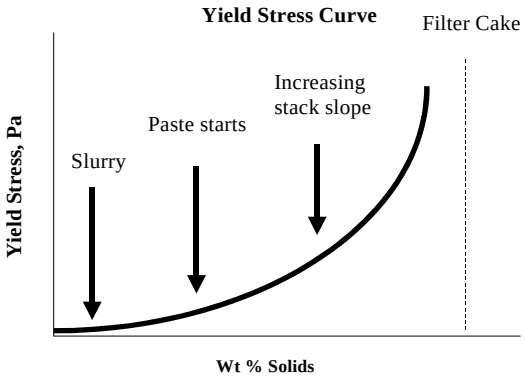


eventually flow to the bottom of the trough. Although the viscosity of these fluids may be relatively high, there is no or very little yield stress and the force of gravity, imposed by the inclination of the trough, is sufficient to make the fluids flow. When a fluid with a yield stress such as minerals tailings is paste poured onto the inclined plane the paste may or may not flow. Flow occurs only when the force of gravity applied by the inclination of the trough is sufficient to overcome the yield stress.



The physical explanation for the presence of a yield stress involves the particle size distribution. When suspensions of solids become sufficiently concentrated, the fine particles, typically less than 20 micron, form bonds through electrostatic interaction. The theory is not well understood and several researchers have investigated and proposed mechanisms. This bonding results in a continuous network that breaks only when a minimum pressure is applied. This minimum pressure is the yield stress.

The concept of a network of bonded fine particles accounts for other properties of a paste. The coarser particles are inhibited from settling by the fine network which acts like a net to hold particles in suspension. This phenomena account for the non-settling and non-segregating nature of pastes which is important for surface stacking design.



Yield stress is dependent on many properties including, temperature, liquor and solids density, mineralogy, pH, and solids concentration. Given a constant set of properties, the most important data required for the paste thickener designer shows how yield stress changes with a change in solids concentration. This correlation is typically shown in a yield stress curve. The curve is developed by using a viscometer to measure the yield stress of a series of different concentrations of solids. The exact shape of the curve and position on the yield stress/solids concentration axes varies for different tailings streams. As the solids concentration increases, the yield stress increases, more particles become non-settling. At sufficiently high solids concentrations the paste becomes in essence a solid with characteristics similar to a filter cake.