Chapter 9 Questions

1. What is the general procedure to verify whether wall slip occurs. Discuss the resulting procedure to obtain the real viscosity data for the case of parallel plates.

2. Describe three methods to determine the shear yield stress.

3. Give the definition of compressive yield stress.

4. What is the “Rutgers-Delaware” rule and if it holds, what does this say about the suspension being investigated.

Chapter 9 Answers

1. Wall slip is usually detected by measurements with parallel discs (plates) with different gap sizes. If there is wall slip the viscosities calculated from the measured torques will depend on gap size, more specifically they would increase with gap size. Measurements at different gap sizes and identical stresses at the edge are compared. When the apparent shear rate, calculated while ignoring the presence of wall slip, is plotted versus $1/h$, the inverse of the gap width, a straight line should be obtained. The slip velocity can be calculated from the slope and the real shear rate is given by the intercept.

2. If steady state shear measurements are performed and the stress becomes constant at low shear rates, this value is the *dynamic* yield stress. Other tests that have been used include the overshoot stress during start-up measurements, the stress at the linearity limit or the elastic peak stress when doing oscillatory measurements as a function of strain amplitude (LAOS). A *static* yield stress can be derived from creep measurements and determining the stress at which the sample starts to flow. In all these measurements various complications can occur, and in general, yield stress is dependent on the time of observation and the instrument and method used to determine it. Therefore, it is important to document carefully how reported yield stresses are measured.

3. The *compressive* yield stress determines the compressive load that has to be applied to the particulate network to cause its yielding and resulting in its consolidation. This force should be carried by the particulate network and not by the liquid phase. It represents situations as occur in sedimentation or filtration.

4. The "Rutgers-Delaware" rule is an extended form of the Cox-Merz rule, and states that $\eta^*(\gamma_0\omega) \approx \eta(\dot{\gamma})\big|_{\dot{\gamma}=\gamma_0\omega}$. In words this rule states that the dynamic viscosity at a given amplitude and frequency is the same as would be observed as under steady shear at the equivalent shear rate. Note that this shear rate is the maximum rate during the oscillation cycle and this suggests that the structure observed is determined by this maximum shear rate (and thus, does not recover during the oscillation cycle). This is typical for a thixotropic systems with a long relaxation time that is much longer than the oscillation cycle.