

FIG. 1. A well mixed 10% suspension (a) before shearing and (b) after shearing, with the inner cylinder rotating at 9 rpm when the Couette is filled up to 95% of the available gap volume.

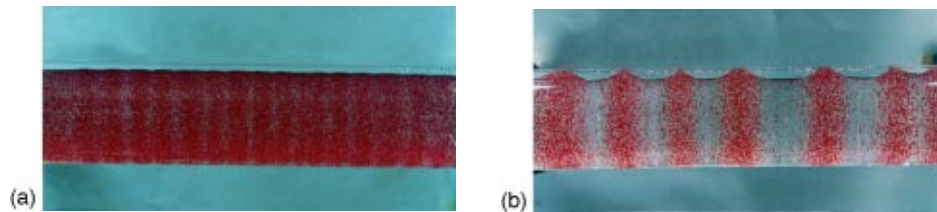


FIG. 2. A 15% suspension at the 95% fill level is sheared at (a) 2.5 rpm and (b) 9 rpm.

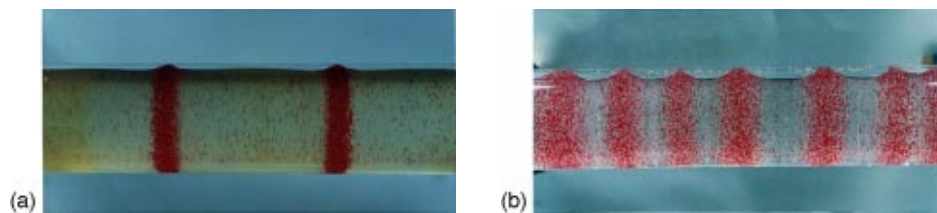


FIG. 3. Segregation and band formation for (a) a 5% suspension at 9 rpm and a 90% fill level and (b) a 15% suspension at 9 rpm and a 95% fill level.

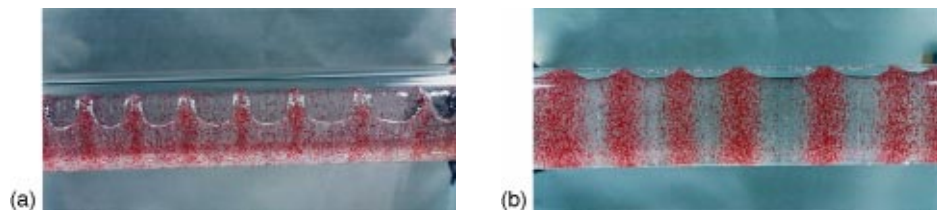


FIG. 4. Segregation for (a) a 15% suspension at a 50% fill level and (b) a 15% suspension at a 95% fill level, sheared at 9 rpm.

PARTICLE SEGREGATION IN MONODISPERSE SHEARED SUSPENSION

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The photographs shown above reveal startling evidence of a new instability¹⁶ in suspensions of monodisperse neutrally buoyant spherical particles in a Newtonian liquid medium being sheared in a partially filled horizontal Couette device. Upon being sheared, the suspension separates itself into alternating regions of high and low particle concentration along the length of the tube. The horizontal Couette device consisted of two concentric cylinders of radius 1.21 cm and 1.90 cm. The outer cylinder was kept fixed and the inner cylinder was free to rotate. The suspending liquid, prepared from a combination of Triton X-100, ZnCl_2 and water, was Newtonian and had a viscosity of 3400 cP (at 23 °C). The dispersed phase consisted of spherical acrylic particles

(colored red for visibility) of mean diameter $462.5 \mu\text{m}$ and had a density equal to that of the suspending liquid (1.174 gm/cc).

Shown in Figs. 1(a) and 1(b) are the photographs of a uniformly mixed suspension before and after it had been sheared at 9 rpm. However, no segregation was observed when the Couette was completely filled. Figures 2(a) and 2(b) show the effect of rotation rate on segregation and band formation on a 15% suspension. At the higher rotation rate the number of bands has decreased but the degree of segregation has been enhanced. The effect of variation in total particle concentration can be seen in Figs. 3(a) and 3(b). When the fill level for the 15% suspension was varied [Figs. 4(a) and 4(b)], the bands were smaller in width and less distinct for the 50% fill level than for the 95% fill level. It is to be noted that such an instability does not arise for pure fluids of comparable viscosity.

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