The non-monotonic shear-thinning flow of two strongly cohesive concentrated suspensions

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PII: S0377-0257(14)00171-2
DOI: http://dx.doi.org/10.1016/j.jnnfm.2014.09.010
Reference: JNNFM 3586

To appear in: *Journal of Non-Newtonian Fluid Mechanics*

Received Date: 29 May 2014
Revised Date: 16 September 2014
Accepted Date: 17 September 2014

Please cite this article as: R. Buscall, T.E. Kusuma, A.D. Stickland, S. Rubasingha, P.J. Scales, H-E. Teo, G.L. Worrall, The non-monotonic shear-thinning flow of two strongly cohesive concentrated suspensions, *Journal of Non-Newtonian Fluid Mechanics* (2014), doi: http://dx.doi.org/10.1016/j.jnnfm.2014.09.010

September 2014 - revised submission to JNNFM

Keywords: Shear banding, non-monotonic flow, yield stress, shear-thinning.

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Dedicated to Professor Ken Walters FRS in the year of his 80th Birthday.

Abstract

The behaviour in simple shear of two concentrated and strongly cohesive mineral suspensions showing highly non-monotonic flow curves is described. Two rheometric test modes were employed, controlled stress and controlled shear-rate. In controlled stress mode the materials showed runaway flow above a yield stress, which, for one of the suspensions, varied substantially in value and seemingly at random from one run to the next, such that the up flow-curve appeared to be quite irreproducible. The down-curve was not though, as neither was the curve obtained in controlled rate mode, which turned out to be triple-valued in the region where runaway flow was seen in controlled rising stress. For this first suspension, the total stress could be decomposed into three parts to a good approximation: a viscous component proportional to a plastic viscosity, a constant isostatic contribution, and a third shear-rate dependent contribution associated with the particulate network which decreased with increasing shear-rate raised to the -7/10th power. In the case of the second suspension, the stress could be decomposed along similar lines, although the strain-rate softening of the solid-phase stress was found to be logarithmic and the irreducible isostatic stress was small. The flow curves are discussed in the light of