



Review Paper

Molecular attributes of an effective steric agent: Yield stress of dispersions in the presence of pure enantiomeric and racemate malic acids

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ABSTRACT

The effects of pH on the yield stress and zeta potential behaviour of α -Al₂O₃ dispersions with addition of D-, L- and racemate (DL) malic acids were evaluated. Conformational structures and intramolecular hydrogen bonding of the adsorbed malic acids obtained via MM2 modeling were used to explain the surface forces operating in the dispersions. We found that the yield stress-pH behaviour is almost identical for D-, L- and racemate malic acids. At low surface coverage of adsorbed malic acid, the maximum yield stress was reduced by as much as 55%. At complete surface coverage the reduction decreased to ~40%. MM2 modeling showed the presence of intramolecular hydrogen bonding between the hydroxyl and the (free) charged carboxylate group within the malic acid molecule. Intra-molecular hydrogen bonding and the high number of strongly bound water molecules (hydration number of malic di-ionic species) were likely responsible for the di-ionic malic acid species acting as a very effective steric agent. At complete surface coverage, the inter-molecular hydrogen bond formed between the layers of adsorbed malic acid, is responsible for the small rise in the maximum yield stress. Racemate malic acid produced a smaller maximum yield stress at complete surface coverage compared to the pure enantiomers. This may be related to the two different types of hydrogen bonds found in the racemate. Only one type is found in the pure enantiomers.

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1. Introduction

The ability to control surface forces effectively is essential for the efficient processing of suspensions found in many industries such as mineral processing, electronics, food, cosmetics, pharmaceuticals, wastewater treatment and ceramic fabrication [1–4]. These forces govern the suspension behaviour in flow, mixing, sedimentation, consolidation, filtration and flotation. It also deter-

mines the nature of the microstructure formed by the particles in suspension. There are two classes of surface forces; the DLVO and the non-DLVO. Non-DLVO forces such as steric, bridging, patch charge, ‘hydrophobic’ and depletion are normally formed in the presence of additives in particular adsorbed additives. Over the years, our group has deliberately deployed the strategy of using small polar additives with a well-defined and limited number of conformational structures to gain an in-depth understanding of the relationships between the various surface forces in suspensions and specific molecular factors or attributes of the additives such as spatial structure, functional groups location, backbone rigidity, intra- and inter-molecular forces [5–11]. Compounds with

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