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Where Does Water Go in OverBased Sulphonate Engine Oil Additives?

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Overbased alkyl benzene sulphonates (OABS) are engine oil additives which have an important role in engine lubrication and cleanliness. The additive consists of a basic core surrounded by alkyl aryl sulphonate surfactants. Acidic combustion products such as oxides of sulphur and nitrogen are readily neutralised by the metal core via base transfer from the additive whilst the surrounding surfactants impart steric stabilisation to the core and also act as detergents. The understanding of the structure, interactions, reaction mechanisms and stability OABS is of significant industrial importance in the development of future generations of lubricants to meet environmental and performance demands and they have been the focus of numerous studies. Though the role of water has been investigated, the research has mainly concentrated on unbound surfactants and it is apparent that further work is needed especially when one recognises that the introduction of water decreases antiwear and neutralisation efficiency. Our studies on OABS are specific to the role of water and we have used a combination of techniques namely Dynamic Light Scattering (DLS), Fourier Transform Infra Red (FTIR) Small Angle Neutron Scattering (SANS) and rheometry. By following water saturated OABS over 10 weeks by DLS we demonstrate that the additive remains stable in the presence of high concentrations of water. Our complimentary FTIR analysis of the hydrated sample shows a regular uptake of water accompanied by shifts of the SO₃ peak to lower wave numbers implying a direct interaction of the water with the hydrophilic species of the surfactant almost certainly through hydrogen bonds. In addition, a SANS profile of a D₂O saturated sample of OABS is fitted to a monolayer of D₂O around the core and only a small viscosity increases are noticed in a water saturated OABS samples when compared to dried samples indicating a negligible increase in particle volume fraction. Hence we have strong evidence for the formation of a monolayer of hydrogen bonded water on the surface of the metal salt core. It follows that steric resistance to flocculation is maintained and water does not interact with the additives by displacing the surfactants on its surface or by forming a competitive site for the surfactants via a microemulsion.