Properties and Colloid Science of Fire-Fighting Foams

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Fluorosurfactants used in fire-fighting foams have historically been produced by two different methods: electrochemical fluorination (ECF) and telomerisation [1]. ECF-based fluorosurfactants break down to form PFOS (perfluorooctanesulphonate) and PFOA (Perfluorooctanoic acid), which are recognised to have negative impacts on the environment and human health due to pronounced persistence, variable degrees of bioaccumulation potential and toxicity [1, 2]. For these reasons, and as a result of legislative pressures, in 2002 many countries including EU started to phase out the use of ECF-based fluorosurfactants in the fire-fighting industry. Nowadays, all modern fire-fighting foams contain fluorosurfactants produced by telomerisation, also known as fluorotelomers [3]. Fluorotelomers have proved to be a good alternative, by delivering fast control and extinction under a diverse range of flammable liquid applications, as well as helping to minimise spread of fire, prevent reignition and reduce the amount of airborne smoke pollution. As well, fluorotelomer based AFFF (aqueous film-forming foam) products do not bioaccumulate, do not concentrate up the food chain, are not harmful to organisms and have been shown to be non-toxic. The breakdown of fluorotelomers leads to the formation of a 6:2 fluorotelomer sulphonate (not PFOS or PFOA), which although persistent, is neither bioaccumulative or toxic [3].

The known theory underpinning the use of fire-fighting foams is primitive and largely empirically based; few attempts have been made to model or investigate the behaviour of foam formulations from a chemical perspective. Here we have began to study the properties of three industrial fluorotelomer surfactants found in a typical AFFF by force tensiometry, dynamic foam analysis and SANS. Initial tensiometric analysis results have shown similar low γ_{CMC} values to their perfluorinated counterparts. By understanding how these different materials work both individually and as mixed systems, it will be possible to start to understand at a more profound level the processes that are occurring during the extinguishment of flammable liquids. Additionally, this will not only potentially hasten the development process, but also allow the use of more environmentally benign chemicals (low-F or H-surfactant analogues). Therefore, it is important to develop a more fundamental understanding of how these fluorosurfactants behave, both individually and as mixed systems in mimics of the real formulations.

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