

The complex association behavior of the polysorbates Tween 20® and Tween 80®

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Polysorbates (PS, Tweens®) are frequently used surfactants consisting of a sorbitan core that is associated with up to four ethylene oxide chains of variable length. One, two, three or even four chains can potentially be esterified with fatty acids of variable lengths. Their function in pharmaceutical formulations is to stabilize biologicals in solution and solubilize otherwise insoluble, active ingredients. This study gives insight into the complex association behavior of different quality grades of the polysorbates PS20 and PS80, which differs tremendously from that of single-component surfactants.

Isothermal titration calorimetry (ITC) provides a powerful tool to investigate the micellization behavior of surfactants simply. For this purpose, the evaluation of serial ITC demicellization experiments with different PS concentrations is sufficient. Their experiment-dependent heats of titration are translated into a common function of the state of a sample, the micellar enthalpy $Q_m(c)$. This function demonstrates the presence of initial micelles already at the lowest concentrations investigated, 2 μM for PS20 and 10 μM for PS80. These micelles consist mainly of the surfactant components with the lowest individual critical micelle concentration (CMC). An increase of concentration triggers the other PS components to enter these micelles successively in the sequence of increasing individual CMCs and hydrophilic-lipophilic balance. The assignment of concentration ranges with pronounced slopes of $Q_m(c)$ to the uptake of the major components of the PS products is cautiously plausible. Formation of micelles and the variation of micelle properties proceeds up to at least 10 mM PS.

Hence, so far published CMC values or ranges of PS20 and PS80 may be referred to certain, major components that are incorporated into and form specific micelles. An interpretation of these values leading to the statement, micelles are absent below these and constant properties is in disagreement with the here presented model, i.e. surface activity of the micelles above these ranges. The micellization enthalpy curves differ significantly between PS20 and PS80 and, to a lower extent, between individual quality grades.