

TECHNICAL PAPER

CoMic™ – Do Surfactant Chemicals Form Mixed Micelles?

BACKGROUND Corrosion inhibitors used in the oilfield are generally formulations which consist of multiple chemical components. The surfactant molecules which provide the corrosion protection can contain different carbon chain lengths and / or different head groups (e.g. imidazoline, quaternary amine). CoMic™ detects micelles when a fluid contains surfactant above the critical micelle concentration (CMC) but what is the impact of the presence of multiple species? Do mixed micelles form where micelles are comprised of different surfactant molecules or do multiple CMCs exist?

TESTING The CMC of two quaternary ammonium chemicals were determined using the CoMic™ methodology, these contained carbon chain lengths of 12 and 14 and are referred to as C12 and C14, respectively. A 180 ppm solution of C12 was prepared and C14 was added in increasing concentrations from 0 to 50 ppm in 5 ppm increments; the fluids were analysed and the CMC calculated. An equation was then used to estimate the CMC of the mixture and compare with the experimentally measured CMC.

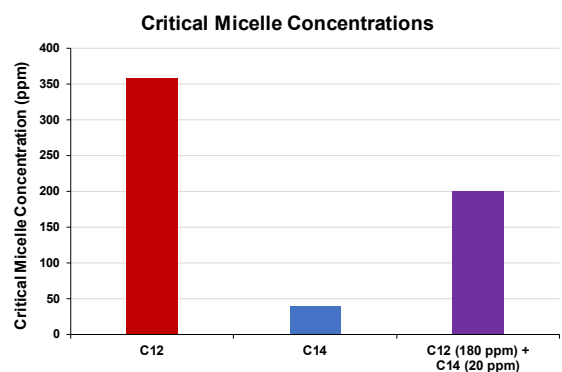
RESULTS The CMC for C12 was 357 ppm and for C14 it was 39 ppm. The CMC of the mixture was 200 ppm, comprising of 180 ppm C12 and 20 ppm C14. Only one CMC was observed.

The observation of only one CMC agrees with the literature on mixed micelle systems and it is common for the CMC of a mixture to lie between the CMC of the individual components. An equation can be used to estimate the CMC of a mixture (*Ref: Surfactants and Polymers in Aqueous Solutions, Holmberg, 2002, Wiley and Sons*).

$$\frac{1}{\text{CMC}} = \frac{\chi_1}{\text{CMC}_1} + \frac{\chi_2}{\text{CMC}_2}$$

χ = mole fraction of surfactant

CMC estimated using equation = 203 ppm
 CMC measured experimentally = 200 ppm



CONCLUSIONS Only one CMC was observed when two surfactants were mixed together and analysed with CoMic™, this finding is supported by literature research. The CMC for the mixture was between the CMCs for the individual components. When multiple surfactant components are present, for example at a comingled point of two production systems, they will converge and create mixed micelles. The levels of inhibitor in each separate system will not be determinable after comingling, but the mixed micelles can be detected by CoMic™ and thereby provide information on the corrosion inhibitor availability in systems.



A game changing service to help achieve optimal usage of corrosion inhibitor

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