

TEMPERATURE AND CONCENTRATION INDUCED COMPLEX BEHAVIOR IN TERNARY MICROEMULSION

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ABSTRACT:

Viscosity measurements were performed in water/AOT (sodium bis(2-ethylhexyl) sulfocinate)/isooctane microemulsions as a function of temperature between 25 and 55°C, molar ratio W_o = water/AOT ranging from 3 to 45 and three values of AOT/isooctane volume fractions (Φ_m = 0.1, 0.15, and 0.2). It was shown that microemulsions behaved as Newtonian fluids in the studied range of shear rate. For a critical molar ratio, W_{oc} , the corresponding viscosity, η_{oc} , was shown to be constant with temperature but dependent on the micellar concentration. For $W_o < W_{oc}$, the solutions behaved as simple fluids and the temperature dependence of viscosity was described by an Arrhenius law. The total activation energy was found to be dependent on W_o with a maximum for $W_o = 5$. A correlation between the microscopic structure of the reverse micelles and the total activation energy was proposed. However, a complex fluid behavior was observed for $W_o > W_{oc}$, where the viscosity increased with temperature. For some values of W_o , the viscosity reached a maximum, which could be explained by attractive interdroplet interactions and formation of droplet clusters.

ZUSAMMENFASSUNG:

Es wurden Viskositätsmessungen an Wasser/AOT (Natrium bis(2-ethylhexyl)sulfocinat)/Isooktan-Mikroemulsionen als Funktion der Temperatur zwischen 25 und 55°C, molares Verhältnis W_o = Wasser/AOT zwischen 3 und 45 und drei verschiedenen AOT/Isooktan-Volumenanteilen (Φ_m = 0.1, 0.15 und 0.2) durchgeführt. Es wurde gezeigt, dass sich die Mikroemulsionen wie Newtonsche Fluide in dem untersuchten Schergeschwindigkeitsbereich verhielten. Bei einem kritischen molaren Verhältnis, W_{oc} , war die entsprechende Viskosität η_c temperaturunabhängig, aber abhängig von der Mizellenkonzentration. Für $W_o < W_{oc}$ verhielten sich die Lösungen wie einfache Fluide. Die Temperaturabhängigkeit der Viskosität wurde durch ein Arrhenius-Gesetz beschrieben. Die gesamte Aktivierungsenergie hing von W_o ab, wobei der Maximalwert bei $W_o = 5$ gegeben ist. Eine Korrelation zwischen der mikroskopischen Struktur der Gegenmizellen und der gesamten Aktivierungsenergie wird aufgestellt. Jedoch wurde für $W_o > W_{oc}$ das Verhalten eines komplexen Fluids beobachtet, bei dem die Viskosität mit der Temperatur zunimmt. Bei einigen W_o -Werten nahm die Viskosität ein Maximum an, das durch attraktive Wechselwirkungen zwischen den Tröpfchen und der Bildung von Tröpfchen-Clustern erklärt werden kann.

RÉSUMÉ:

Nous avons mesuré la viscosité des microémulsions du système eau/AOT (bis (2-éthylhexyl) sulfosuccinate de sodium)/isooctane en fonction de la température (de 25 à 55°C), pour des fractions molaires W_o = eau/AOT allant de 3 à 45 et pour des fractions volumiques d'AOT et d'isooctane (Φ_m = 0,1; 0,15 et 0,2). Il a été montré que les microémulsions se comportent comme des liquides Newtoniens dans la gamme de vitesse de cisaillement précisée dans l'article. Pour une fraction molaire critique, W_{oc} , la viscosité critique, η_{oc} , est indépendante de la température mais dépend de la concentration des micelles. Pour $W_o < W_{oc}$, les solutions étudiées ont un comportement de fluides simples et la dépendance en température de leurs viscosités est bien décrite par une loi de type Arrhenius. Il a été aussi montré que l'énergie d'activation totale dépend de W_o et atteint son maximum pour $W_o = 5$. La variation de l'énergie d'activation totale en fonction de W_o a été corrélée à la structure microscopique des microémulsions d'après les travaux de la littérature. Un comportement de fluides complexes a été observé pour $W_o > W_{oc}$ où la viscosité augmente sous l'effet de l'élévation de la température. Pour certaines valeurs de W_o , la viscosité atteint un maximum que l'on suppose lié à de fortes interactions inter-micellaires responsables de la formation d'agrégats micellaires.

KEY WORDS: microemulsion, micellar concentration, viscosity, temperature, percolation, aggregation

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independence of viscosity with temperature at the critical value W_{oc} . This behavior could be explained by a balance of attractive and repulsive forces between micelles.

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