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Brief Communication

Micellization Behavior of Manganese Soaps in Mixed Organic Solvent

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ABSTRACT

This study explores the micellar characteristics of manganese soapsspecifically manganese butyrate and manganese caprylatein a mixed solvent system composed of equal volumes of benzene and methanol (50:50 v/v). Conductometric methods were applied to evaluate specific conductance, critical micelle concentration (CMC), molar conductance, degree of ionization, and ionization constants. The results indicate that CMC values decrease with increasing fatty acid chain length, confirming micelle formation at higher concentrations. The findings contribute to the broader understanding of soap micellization behavior, ionic dissociation trends and associated thermodynamic properties.

Keywords: Soap, Micellization, Conductometric, Critical micelle concentration, Degree of ionization.

INTRODUCTION

Manganese soaps, which are manganese salts of fatty acids, belong to the family of metallic soaps and have garnered increasing attention for their diverse industrial and chemical applications. Characterized by their combination of the transition metal manganese with long-chain organic acids, compounds such as manganese stearate and manganese 2-ethylhexanoate exhibit distinctive physical and chemical properties, including insolubility in water and high thermal stability. Manganese-based soapssalts of fatty acids with transition metalsare widely employed in industrial applications such as lubricants, catalysts, stabilizers, and corrosion inhibitors. Their performance often hinges on micellar behavior, especially in mixed solvent environments. Previous research has established that the micellization of soaps is influenced by factors such as chain length, solvent composition, and concentration. However, the micellar properties of manganese soaps in benzene-methanol mixtures have not been thoroughly characterized, prompting the present investigation.

EXPERIMENTAL

Materials

Manganese butyrate and manganese caprylate were synthesized by direct metathesis reactions between potassium soaps of the respective fatty acids and manganese chloride at 50–55°C. The crude products were recrystallized using a 1:1 (v/v) benzene-methanol mixture for purification.

Method

A range of soap concentrations were prepared in the benzene-methanol mixed solvent. Conductivity was measured under controlled temperature conditions.From these measurements, specific conductance, molar conductance, CMC, degree of ionization (α), and ionization constant (K) were calculated.

RESULTS AND DISCUSSION

Specific Conductance: Specific conductance increased with concentration for both soaps and was higher for manganese butyrate than manganese caprylate. The conductance-concentration plots exhibited a distinct inflection, marking the CMC.

Soap	CMC (M)	Specific Conductance (S/cm)
Manganese butyrate	0.041	2.15×10^{-1}
Manganese caprylate	0.038	1.89×10^{-1}

The observed decline in conductance with increasing chain length is attributed to the formation of larger, less mobile anionic species.

Molar Conductance and Ionization Molar conductance decreased with both concentration and chain length, signaling weak electrolyte behavior. Plots of molar conductance versus the square root of concentration deviated from linearity. The values of degree of ionization (α) and ionization constant (K) support the classification of these soaps as weak electrolytes, particularly below the CMC.

Parameter	Manganese butyrate	Manganese caprylate
CMC (M)	0.041	0.038
Specific Conductance (S/cm)	2.15×10^{-1}	1.89×10^{-1}
Degree of Ionization (α)	0.231	0.215
Ionization Constant (K)	1.05×10^{-5}	5.35×10^{-5}

Graphical Analysis: A plot of specific conductance versus concentration reveals two linear regions separated by a breakpoint that corresponds to the respective CMC. Beyond the CMC, the sharp increase in slope reflects micelle formation due to soap aggregation.

Effect of Solvent Composition: The 50:50 benzene-methanol solvent system provided optimal solubility, enabling precise analysis of micellar behavior. The polarity and interactive properties of the mixed solvent played a vital role in micellization. Depending on the solvent ratio, micelle formation could be either promoted or inhibited.

Comparison with Other Metal Soaps: The micellar trends observed in manganese soaps align with those reported for other metal soaps such as lithium and chromium. Notably, CMC declines with increasing hydrophobic chain length across these compounds—suggesting a consistent, possibly universal behavior in transition metal soap micellization.

CONCLUSION

Micellization in manganese soaps is significantly influenced by fatty acid chain length; longer chains correspond to lower CMC values. These soaps exhibit weak electrolyte characteristics below their critical micelle concentrations, confirmed by conductance and ionization data.The benzene-methanol solvent system provides an effective medium for evaluating micellar properties, highlighting crucial interactions between soap molecules and the solvent environment.The general trends observed are consistent with other transition metal soaps, supporting broader generalizations in metal soap micellization behavior.

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Conflict of interest

The author declare that we have no conflict of interest.

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