

SYNTHESIS OF TRIETHANOLAMINE-BASED ESTERAMINE SURFACTANTS, INVESTIGATION OF STRUCTURE–PROPERTY RELATIONSHIPS, AND APPLICATION PROSPECTS

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This research is devoted to the synthesis and comprehensive characterization of triethanolamine-based esteramine surfactants obtained through the interaction of triethanolamine with higher aliphatic carboxylic acids (C₁₂–C₁₈). The chemical structure of the synthesized compounds is confirmed using FTIR and NMR spectroscopy, while their physicochemical and surface-active properties are evaluated by surface tension measurements, determination of critical micelle concentration, foaming ability, and emulsification efficiency. Particular attention is given to identifying correlations between molecular structure and functional performance. The results demonstrate that controlled modification of esteramine structure enables purposeful regulation of surfactant properties, which is essential for targeted practical applications [1].

The development of efficient and structurally tunable surfactants remains a priority in modern colloid and applied chemistry. Industrial sectors increasingly require surfactant systems with predictable interfacial behavior, stability under variable conditions, and reduced dosage requirements. Triethanolamine-based esteramine surfactants represent a promising class of amphiphilic compounds due to their multifunctional structure, combining ester and amine groups within a single molecule. Studying the structure–property relationships of these surfactants is therefore highly relevant for advancing both fundamental understanding and practical formulation design. The aim of the study is to synthesize a series of triethanolamine-based esteramine surfactants and to investigate how variations in molecular structure influence their physicochemical, surface-active, and application-relevant properties. The study introduces an original and systematic approach to the synthesis and evaluation of triethanolamine-based esteramine surfactants. By linking controlled molecular design with comprehensive physicochemical and performance-oriented assessment, the research establishes clear structure–property relationships that enable objective comparison of surfactant efficiency and functionality. This integrated methodology provides a novel framework for rational surfactant design and evaluation. The obtained results provide a scientific basis for selecting and optimizing triethanolamine-based esteramine surfactants for use in detergent formulations, emulsifying systems, and dispersion stabilization processes. The identified structure–property correlations can be used to reduce experimental trial-and-error in formulation development and to guide scale-up and industrial application of the synthesized surfactants [2].

The study demonstrates that triethanolamine-based esteramine surfactants constitute a flexible and tunable class of surface-active compounds whose physicochemical and functional properties are closely governed by molecular structure. Variations in hydrophobic chain length and degree of esterification have a pronounced effect on key performance parameters, including surface tension reduction, micellization behavior, foaming capacity, and emulsification efficiency. The established structure–property relationships provide a scientific basis for understanding how specific molecular features influence interfacial activity and stability in aqueous systems. The results confirm that a rational, structure-oriented approach to surfactant design enables purposeful regulation of functional characteristics rather than empirical trial-and-error selection. This not only improves efficiency in formulation development but also supports the optimization of surfactant performance for targeted applications. Consequently, triethanolamine-based esteramine surfactants show strong potential for use in detergents, emulsifying systems, and dispersion stabilization processes.

Overall, the research contributes to both fundamental colloid chemistry and applied surfactant science by offering an integrated framework for synthesis, characterization, and performance evaluation. The findings expand the prospects for the effective industrial and technological application of triethanolamine-based esteramine surfactants and provide a foundation for further studies focused on process optimization, environmental compatibility, and application-specific formulation design.

References

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