


Chapter 7

IoNanofluids: Bridging Efficiency and Sustainability in Chemistry

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ABSTRACT

This chapter explores the role of ionanofluids—hybrid materials combining ionic liquids with nanoparticles—in advancing sustainable chemical applications. IoNanofluids offer enhanced thermal stability, tunable viscosity, and superior catalytic properties, making them valuable in green chemistry, catalysis, and industrial processes. The chapter is structured into three key sections: (1) their use in sustainable chemistry, focusing on reducing environmental impact and improving reaction efficiency, (2) their role in catalytic applications, where they enhance reaction rates, selectivity, and catalyst longevity, and (3) their integration into process chemistry, including heat transfer, separation, and electrochemical applications. By addressing both scientific advancements and industrial scalability, this chapter highlights the transformative potential of ionanofluids in modern chemical engineering and concludes with future research directions.

INTRODUCTION

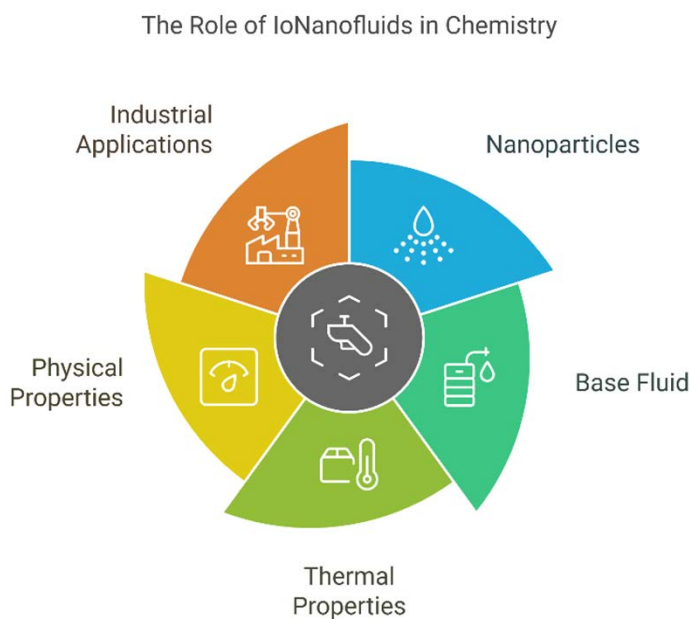
Ionanofluids, an advanced class of hybrid materials that integrate the intrinsic properties of ionic liquids with the enhanced functionalities of nanoparticles. Ionic liquids, defined as salts in the liquid state at room temperature or slightly elevated temperatures, are composed of organic cations and inorganic or organic anions (de Castro et al., 2013; Murshed et al., 2012). These liquids are characterized by their

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remarkable thermal stability, low vapor pressure, and high ionic conductivity. The inclusion of nanoparticles into these ionic liquids forms ionanofluids, yielding materials with synergistic physicochemical properties that surpass those of their individual components(Almutairi, 2023; Murshed et al., 2012).

A distinctive feature of ionanofluids is their high thermal stability, which enables their application in processes requiring exposure to extreme temperatures without significant degradation(Moosavi et al., 2024). This property is particularly advantageous in thermal management systems and high-temperature chemical reactions. In addition, ionanofluids exhibit enhanced thermal conductivity, attributed to the efficient heat transfer facilitated by the dispersed nanoparticles(Pereira et al., 2024). The tunable viscosity of ionanofluids can be modulated by altering the nanoparticle type, size, or concentration, thereby enabling customization for specific industrial processes.

Figure 1. The role of ionanofluids in chemistry



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