Short Communication

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Transitory note on role of ionic liquids as designer green solvents

Abstract

Solvents have well known importance for the various chemical and biological processes in chemical industries. Apart this, these chemically prepared solvent have been found to reported for their respective hazardous, ill and lethal health impacts along with involving high cost. So, that concept of "green solvents" is manifested the environmental and sustainable driven goal to minimize the environmental negative and ill impacts due to overuse of chemically prepared solvents for various chemical production and active pharmaceutical ingredients. Over last two decades, ionic liquids have found to have pioneering role in chemical science and novel technologies as clean, low toxicity upon synthesis, more efficient, and eco-friendly alternative resource of volatile organic solvents having significant thermal, physical, chemical, biological characteristics and noticeable reproducibility. Ionic liquids have also been reported for their respective green synthesis, negligible environmental impacts and good purity percentage. Hence, ionic liquids are reported to have safe chemical process while they are formulated and synthesized in laboratories and chemical industries with reduced effluent production which in turn having negligible environment impact as well as low production cost. Apart the use of ionic liquids as alternate green solvents, fundamental innovative practices have been initiated to design the novel and functionalized ionic liquids called "task specific ionic liquids" which might be considered more potent for next coming medical and environmental challenges as well as global concern.

Keywords: ionic liquids, green solvents, green chemistry

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Elementary reported data

Ionic liquids have found to be most considered green and non-toxic alternative over volatile organic solvents in terms of their respective biochemical and chemical catalysis involving auxiliaries and catalysts in their synthesis called designer solvents. Ionic liquids are reported as the chemical compounds composed of cations or anions with melting point below 100°C and first ionic liquid named, ethylammonium nitrate was reported by Paul Walden in 1914. Ionic liquids are of two types like simple salts which made up of a single anion and cation and binary ionic liquids which are salts at equilibrium that considered the most exploited green solvents to be used in preparing electrolytes in lithium-ion batteries, supercapacitors, and metal plating baths. The most fundamental characteristics of ionic liquids are non-flammable, conformational flexibility, small lattice enthalpies, having low vapor pressure at room temperatures, noticeable CO_2 capturing solvents and more thermo-stable over wide temperature range. Room-temperature ionic liquids like 1-ethyl-3-methyl- (EMIM), 1-butyl-3-methyl- (BMIM), 1-octyl-3 methyl (OMIM), 1-decyl-3-methyl-(DMIM), 1-dodecyl-3-methyl- docecylMIM) are derived from 1-methylimidazole, i.e., 1-alkyl-3-methylimidazolium and sodium chloride is also a type of the most chosen greener ionic compound.[1,2] Ionic liquids are molten chemicals or designer liquids which are formed exclusively of anions and cations such as salts above its melting points and beside this, molecular solvents like benzene, chloroform, methanol and water are composed of neutral species. Synthesis of the first ionic liquid named, ethyl ammonium nitrate having melting point of 12°C was reported which required neutralization of ethylamine with concentrated nitric acid and also termed as protic ionic liquids because it involves proton transfer during their synthesis. And, aprotic ionic liquid are synthesized from alkylpyridinium chloride and aluminium chloride in which the cations are derived from the alkylation of organic compounds with alkyl halides and 1-butyl-3-methylimidazolium tetrachloroferrate is also coined to observed a worthy designer magnetic ionic liquid.[3,4] Thermal stability of proteolytic enzymes were also found significantly acceptable in the presence of water-miscible aprotic ionic liquids like 1-ethyl-3-methylimidazolium salts. Imidazolium-based ionic liquids (ILs) have been investigated with acetate, formate, and chloride anions for the pretreatment of lignocellulosic biomass as aprotic and protic forms which significantly enhanced enzymatic hydrolysability of the pretreated biomass.[5,6] A milestone in green chemistry was the discovery of water-stable ionic liquids containing imidazolium cations, hexafluorophosphate, tetrafluoroborate, sulfate, nitrate, and acetate anions.[7] The most focused green chemistry involves cost-worthy and eco-friendly biochemical reaction conditions comprised of air, water, supercritical fluids, fluorous solvents driven chemical reactions.[8,9] The fundamental characteristics like solubility, bioavailability, permeation, polymorphism, and water as well as thermal stability associated to solid-state pharmaceuticals have more raising demand for effective clinically concerned safe and cost-effective solutions. Hence, to overcome these kind of problems, ionic liquids have been exploited as green co-solvents, cost effective emulsifiers, non-toxic reagents in the formulation and crystallization of various active pharmaceutical ingredients to be considered as greener liquid therapeutics practices to develop more improvised drug-delivery tools and vehicles.[10,11] Variety of oligomeric ions are found to be used for carrying out hydrogenation driven liquefaction process of neutral acid-base complex and solid ionic liquids by modifying the stoichiometry of the ions to make them more stable and complex via the formation of liquid co-crystals. It was carried out by involving the potent ionic liquid strategy with chosen prodrug strategy to improve the delivery

of solid water soluble active pharmaceutical ingredients using tunable hydrophilic-lipophilic balance based designed ionic liquids as eco-friendly and safe delivery agents via trapping a drug in a micelle. Ionic liquids also found to have applications in novel development strategies for the preparation of advanced eco-friendly batteries, dye-sensitized solar cells, double-layer capacitors, actuators, fuel cells, thermo-cells, and water splitting as highly efficient carbon capture resource and sustainable storage alternatives to solve present global environmental and health concerned problems.[12,13] Ionic liquids have also opted by chemical scientist and biochemist for electrochemical polymerization to prepare blended conducting polymers as more safe and potent plasticizers, electrolytes dispersed in polymer matrices and porogens. Ionic liquids are also opted to be used as green polymeric additives in polymer science to prepare polymeric components like plasticizers, components of polymer electrolytes, and porogenic agents, polymeric gel granules, of templates of porous polymers and novel worthy electrochemical polymerized electrolytes. Ionic features observed by porous ionic liquid could be considered for formulation of novel ionic liquid based membranes consisted of stable framework and porous architecture which can further used as versatile base to fabricate advanced materials by decorating them with chosen functional moieties like catalytically active anions and Hence, these observed characteristics of designer porous ionic liquids membranes have essential applications in green catalysis, CO_2 adsorption and decantation of products, formulation of sensors and actuators as templated ordered 3D macroporous ionic liquid photonic membranes consisted of porous solid ionic materials and porous liquid molecular materials which can be directly employed for optical sensing.[14,15] Highly efficient electrochemical devices were also designed using ionic liquids which found to observed to high ionic conductivity due to prevention of electrolytes from drying during working operational conditions, non-flammability and non-corrosiveness[16] just leaving apart the tediousness in recovery of the catalysts and decantation of ionic liquid in alcoholic phase using transition metals as well with hydrogenation reactions.[17,18]

Conclusion

In this notched note, a scientific strive been made to favor the green chemistry to become more greener and sustainable via using of worthy and environmental friendly designer ionic liquids. Because the ease of more flexibility and deliverance to modify properties of ionic liquids in their exhibited structure and framework to furnish the newly designed chemical components and catalysts. Hence, the new advanced innovative and sustainable technologies should be considered to formulated more designer, greener and stable ionic liquid over more desirable conventional volatile costly and hazardous solvents to be used in physio-chemical, biochemical and chemical catalysis by exploring their respective enormous possible applications in medicine, clinical practices, pharmaceutical preparation like active pharmaceutical ingredients as well as in industrial production of chemical solvents and their decantation processes.

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Conflicts of interest

The author declares that there is no conflict of interest.

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