Introduction on Special Issue: Ionic Liquids

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One may ask what is the reason for this special issue of the Journal of Solution Chemistry being dedicated both to the fashionable topic of ionic liquids and to the memory of Prof. Eduard Hála. A prominent personality and internationally renowned thermodynamicist, Prof. Hála is the author of more than 50 original papers and, more importantly, of two seminal and timeless monographs [1, 2]. In the early 1960s, while he was still a young pedagogue at the Institute of Chemical Technology Prague, he wrote with his faculty colleague and longtime friend Arnost Reiser the first modern Czech textbook of physical chemistry that was inspired by similar university textbooks published in English. Later, he summarized his deep knowledge in a book entitled Vapor–Liquid Equilibria, which is commonly called “a chemical engineer’s cookbook”. Shortly after its publication in Czech, Vapor–Liquid Equilibria was translated into English and published by Pergamon Press. Since then this publication has become compulsory reading material of every thermodynamicist and engineer dealing with distillation processes. Prof. Hála was also among the first in Czechoslovakia to have grasped the importance of computer programming in science and later of the increasing significance of statistical thermodynamics. As an outstanding university educator and co-founder with Prof. Reiser of the so-called Prague School of Physical Chemistry, Prof. Hála is therefore worth remembering time and time again. Prof. Hála passed away in 1989 and even though ionic liquids were already a known class of compounds at that time, a pronounced interest in their properties and applications only started to show itself in the early 1990s. However, Prof. Hála was known throughout

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his professional life as a scientist with an unusually broad outlook and almost visionary approach to his work. Had he lived longer, he would have no doubt decided at some point to study ionic liquids and to contribute with his deep knowledge of thermodynamics to a better understanding of their properties. We take this opportunity to point out that Prof. Hála would have turned 95 years old in 2014 when we began work on this issue, and we therefore dedicate this special issue on ionic liquids to his memory.

During these last two decades, an exponential increase and development of interest in ionic liquids has been shown in works by numerous industrial and research groups around the world. This may be attested to by a simple literature survey using the keywords “Ionic Liquid” in Scopus, which provided more than 39,000 original articles to date. An analysis of the number of publications and patents both by academia and industry has merited ionic liquids to be further investigated and then implemented in real chemical processes. Currently, these materials are defined as molten salts with a melting temperature below 100 °C that can be broadly classified into two groups, protic and aprotic ionic liquids. The expanding range of applications is not surprising, given that there are approximately 10^{18} possible anion–cation combinations to generate ionic liquids, and thus these liquids can be classified as true designer materials, particularly since many of these designs include built-in functionalities. Therefore it is possible for them to have properties suited to a particular application. For example, their negligible vapor pressure has been well noted even if their distillation has been demonstrated. Their biodegradability and toxicity have been evaluated, showing clearly that not all ionic liquids are “green” or “environmentally friendly” even though some ionic liquids are suitable for nutritional or pharmacological applications. However, carefully designing a processes involving ionic liquids from the original synthesis to the end application may lead to greener alternatives to the already existing ones, in spite of the relatively high toxicity of some ionic liquids. The tunability of their properties has, in fact, fascinated the curiosity and then the interest of a wide range of researchers. For instance, while some ionic liquids can be used as flame-retardants others are used as propellants. Presently, their implementation into specialized areas such as lubricants, heat transfer fluids, separations technology, catalytic reactions, and energy storage are being investigated by several research groups.

Special attention is often paid to a full characterization of these fluids in terms of their chemical, physical, electrochemical, and thermal properties, along with their impurities level. It is well known that many properties of non-aqueous systems, like ionic liquids, are strongly affected by traces of impurities and particularly moisture. Nevertheless, many authors do not provide a systematic characterization of the water, metal, and/or halide content of their pure ionic liquids. This lack of information induces problems when data are then critically evaluated. A better understanding of the physical properties of pure ionic liquids and their mixtures with other molecules is therefore crucial prior to developing any model, industrial application or process involving these novel materials. This better understanding can only be guided by combining several efforts ranging from applied to theoretical sciences to allow the development of a structure–properties relationship of these fascinating materials called “ionic liquids”.

All these fundamental points are addressed in this special issue of the Journal of Solution Chemistry. The quality and the number of the manuscripts that we received meant that we had to produce not one, but two combined volumes for this special issue. We hope that this compilation improves not only our fundamental understanding of ionic liquids from the molecular level to their macroscopic properties, but also opens windows for potential novel applications.

Finally, the success of a special issue is not only based on the quality of the authors and their manuscripts but it is an association of joint efforts of the journal's Editorial Team, authors, and of course, reviewers. Again, many thanks for all your efforts!

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