The Calorimetry Conference Celebrates Professor Robert H. Wood's Eightieth Birthday

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The North American Calorimetry Conference (CALCON) has served as the premier collegial forum for the dissemination of current research and state-of-the-art technological developments in calorimetry and thermodynamics. The Sixty Eighth Calorimetry Conference (CALCON 2013) honored this legacy by revisiting the site of The Second Calorimetry Conference which convened at the majestic and stately Traymore Hotel in Atlantic City, New Jersey. The skyline of this seaside resort destination has undergone dramatic changes over the past six decades and a new generation of architectural marvels glistens on the infamous boardwalk. Our Sixty Eighth annual meeting invited participants to embark on a retrospective journey back in time to the formative years of The Calorimetry Conference. In conjunction with the celebration of noteworthy achievements during this timeframe, the Organizing Committee assembled a diverse technical program focused on relevant topics in the core disciplines of biology, chemistry, physics and engineering. Retracing the footsteps of prior generations, the Board of Directors adopted a motto that encapsulates our vision of The Calorimetry Conference and its role within the scientific community: *Honoring the Past—Embracing the Present—Exploring the Future.*

While technological advances in instrumentation and methodology have impacted the field to an extent that our predecessors may never have envisioned, the core tenets of calorimetry remain unchanged as the need for accurate and precise thermodynamic data to characterize complex multi-component systems continues to represent a formidable challenge. This realization is particularly evident when viewing advancements in the physicochemical characterization of aqueous solutions under extreme conditions. Professor Robert H. Wood (University of Delaware, USA) is an acknowledged leader and pioneer of

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such critical measurements as his area of expertise is focused on solution thermodynamics at elevated temperatures and pressures. In an illustrious academic career spanning over five decades, Professor Wood and his legion of collaborators designed and fabricated instruments in which specialized flow techniques have been applied to characterize the thermodynamic properties of aqueous solutions. Each successive technological advance has extended the accessible temperature and pressure range, culminating in the characterization of aqueous solutions near the critical point of water.

The Calorimetry Conference has recognized Professor Wood's seminal contributions throughout his distinguished scientific career by conferring the inaugural James J. Christensen Memorial Award in 1988 and the prestigious Hugh M. Huffman Memorial Award in 1993. In recent years, The Calorimetry Conference has convened symposia to honor the lifetime achievements of premier scientists within their respective fields. In recognition of Professor Wood's Eightieth Birthday, the Officers and Directors of The Sixty Eighth Calorimetry Conference organized a special tribute to commemorate this significant milestone. Professors Jean-Pierre Grolier (Université Blaise Pascal, France) and Emmerich Wilhelm (Universität Wien, Austria) assembled a stellar group of research scientists including four distinguished Hugh M. Huffman Award recipients and several of Professor Wood's longtime colleagues and collaborators. Each of these participants presented an Invited Lecture in the Keynote Symposium entitled: *Aqueous Solutions, Fluid Mixtures, and Polymers: A Tribute to Robert H. Wood on the Occasion of His Eightieth Birthday*.

As an outgrowth of this honorary symposium, Drs. Joseph Rard and Earle Waghorne graciously invited the participants to publish manuscripts of their presentations in an issue of the *Journal of Solution Chemistry* specifically dedicated to Professor Robert H. Wood. The articles compiled in this issue represent a broad cross-section of solution thermodynamics and attest to the impact of Professor Wood's influence on the field. In the Editor's Introduction, Dr. Rard cites several important studies published by Professor Wood and co-workers on the enthalpies of inorganic electrolytes and their mixtures at temperatures to 373.15 K. Professor Wood assisted numerous laboratories, including that of Dr. Rard, by providing specific experimental details which is typical of his selfless nature. Dr. Rard presents an excellent overview of the synergistic partnership between the Journal of Solution Chemistry and The Calorimetry Conference. The dedication is authored by Professor Emmerich Wilhelm who describes his personal association with Professor Wood including a perspective on the significance of Robert's numerous insightful contributions to solution thermodynamics. The following narrative provides a brief synopsis of each manuscript contributed by a valued colleague and friend of Professor Wood.

In the first article of this special issue, Professor George H. Zimmerman (Bloomsburg University, USA) in collaboration with Dr. Hughes Arcis (University of Guelph, Canada) describe a detailed methodological approach aimed at improving extrapolation methods of AC impedance spectra acquired at high solute concentrations. The authors performed these studies on an AC conductance instrument and cell fabricated in Professor Wood's laboratory and donated to the Hydrothermal Chemistry Laboratory at the University of Guelph. In this study, Zimmerman and Arcis successfully incorporate improvements in experimental design by minimizing the inductance effect, thereby reducing uncertainties associated with measuring and extrapolating the impedance spectra of aqueous solutions at high concentrations. The authors express their gratitude to Professor Wood for the benefit of his extensive operating experience and numerous productive discussions.

Dr. Mirosław S. Gruszkiewicz and his colleagues describe the acquisition of conductivity data employing a new apparatus designed and fabricated at the Oak Ridge National Laboratory. A significant part of these achievements are attributed to the experience that

Dr. Gruszkiewicz gained during his postdoctoral studies at the University of Delaware [1]. As stated in the article, the conductivity cell constructed under the direction of Professor Robert Wood [2] represented a pioneering implementation of fluid flow design applied to the characterization of extremely dilute solutions. This instrument facilitated determination of ionic mobilities and equilibrium constants in high-temperature aqueous solutions with unprecedented accuracy. Interpretation of the results has significant implications for geothermal energy production and CO₂ sequestration in natural systems including geologic formations. Elucidation of the mechanisms leading to metal corrosion may extend the lifetime of materials, thereby reducing costs associated with enhanced geothermal energy production.

Dr. Monica Corea (Instituto Politécnico Nacional, Mexico) in collaboration with colleagues describes an experimental method to study the solution energetics of sodium hydroxide and carboxylated polymeric particle interactions. This contribution is of particular relevance given the current emphasis on nanotechnology applications and the dearth of rigorous thermodynamic methods to characterize and standardize nanomaterials. Dr. Corea's article addresses this void by proposing a multiparametric approach to delineate structure–property relationships. The authors employ a diversity of experimental techniques including densimetry, sound velocity, isothermal titration calorimetry, dynamic light scattering, and zeta-potential measurements. The combined thermodynamic approach affords increased precision and reproducibility, ultimately facilitating advancements in the design, synthesis, and characterization of novel nanomaterials.

Dr. Jose Manuel del Río (Instituto Mexicano del Petróleo, Mexico) in collaboration with Professor Jean-Pierre Grolier describes a novel method applying the Gibbs–Duhem equation to evaluate isothermal titration calorimetry isotherms. The authors propose a criterion to identify whether the forward and reverse processes of a particular system are equivalent given their dependence on the partial properties of component interactions. The methodology has been verified via analysis of published experimental data and facilitates selection of an appropriate binding model to ensure accurate interpretation of ITC isotherms. The authors provide interested users with application spreadsheets that assist in experimental design and evaluation of the thermodynamic parameters for any desired molecular interaction.

Professor Emmerich Wilhelm's article on solubilities and fugacities presents an overview of classical thermodynamics applied to the characterization of nonelectrolyte solutions and supercritical substances. As the author eloquently states, this particular area of research has benefitted enormously from the ground-breaking studies of Professor Robert Wood who designed a flow vibrating-tube densimeter for measuring apparent molar volumes of gases at high dilution in water at elevated pressures (20–35 MPa) and temperatures (300–716 K) within the supercritical region. Considering the experimental difficulties associated with measuring the partial molar heat capacity changes on solutions of gases dissolved in water at dilute concentrations, only seven sets of data exist and all originate from Professor Wood's laboratory. In conjunction with collaborators, Professor Wood determined the apparent molar isobaric heat capacities at small solute mole fractions of gaseous solutes in water, including aqueous argon, xenon, methane, and ethane. In closing, Professor Wilhelm reminisces on several unforgettable experiences including his visit with Professors Grolier and Wood at the Université Blaise Pascal in France, where the three distinguished Huffman Award recipients had an opportunity to enjoy a vibrant discussion on “hot topics” in solution thermodynamics.

Professor Peter Tremaine in collaboration with Drs. Plumridge and Arcis contribute an article on the limiting conductivities of univalent cations and the chloride ion under

hydrothermal conditions. The authors acknowledge Professor Wood's pioneering contributions in designing and developing high precision flow cells to facilitate such measurements. These technological advancements yield significant improvements in the speed and accuracy of conductivity measurements on dilute solutions over the temperature range of 323–673 K and pressures to 40 MPa. In a companion article, Professor Tremaine and colleagues present a thermodynamic model for the sodium iron (III) hydroxy phosphate (SIHP) water system under hydrothermal conditions. Such studies are highly relevant when considering the fact that SIHP is an important iron (III) corrosion product in high-pressure steam generators operating under phosphate pH control. The objective of this research is to complete the database for sodium phosphate reactions with magnetite by obtaining solubility data for SIHP and maricite under controlled redox conditions.

Professor Jean-Pierre Grolier contributes a personal perspective that reminisces on his lifelong journey in experimental thermodynamics with particular emphasis on the characterization of solutions and polymers under extreme conditions. The author presents an overview of chemical thermodynamics from its origins to modern times and the importance of judicious experimental measurements on the heats of mixing and interactions. Professor Grolier reports on recent developments in instrumentation that expand our capabilities to operate over extended ranges of temperature and pressure. The power of these experimental approaches is exemplified by the data acquired on pure liquids and polymer systems. The majority of these achievements may be traced to the pivotal role of Professor Wood whose contributions to modern thermodynamics stand the test of time. The instruments designed by Professor Wood have proven of critical importance in characterizing the high-temperature and high-pressure thermodynamics of fluids. Frequent visits to Professor Wood's laboratory set the foundation for numerous fruitful interactions that resulted in the publication of collaborative studies [3–6] and culminated in Professor Wood receiving an honorary degree from the Université Blaise Pascal as described in the manuscript.

In the final article of this special issue, Professor Peter L. Privalov presents a retrospective overview of the significant progress achieved in a specific area of solution thermodynamics, namely the characterization of nucleic acids and proteins, which are of fundamental importance in biology. The author describes a timeline of discovery that parallels technological developments and advancements in calorimetric instrumentation. Over the past five decades, Professor Privalov and his colleagues have contributed to broaden our understanding of the thermodynamic forces that stabilize complex macromolecular structures. During the course of these studies, Professor Privalov employed model compounds to evaluate the contributions of hydration and non-covalent interactions on the heat capacity effect of protein unfolding [7]. Towards this end, the author determined heat capacity differences between water and dilute alcohol solutions within the temperature range of 278–398 K [8]. These findings contributed to the realization that predictive capabilities are required to characterize the thermodynamic properties of aqueous organic species at infinite dilution and high temperatures. Professor Wood and his colleagues subsequently addressed this void by developing an approach to calculate functional group additivity for alcohols [9] and acids [10]. The impact and relevance of both investigators' collective contributions to the field of solution thermodynamics is clearly evident. In summary, this article describes Professor Privalov's lifelong research interests that are focused on designing ultrasensitive calorimetric instruments capable of studying biological macromolecules and characterizing the physical basis of nucleic acid and protein structure, the hydrophobic interaction [11], and thermodynamic forces driving protein–DNA interactions [12].

The papers comprising this special issue reflect the broad impact of Professor Robert H. Wood's pioneering contributions and represent a *tour de force* in solution thermodynamics. The authors include four distinguished Huffman Memorial Award recipients whose seminal achievements in their respective disciplines effectively augment and complement Professor Wood's legacy. The Officers and Directors of The Sixty Eighth Calorimetry Conference gratefully acknowledge Professors Jean-Pierre Grolier and Emmerich Wilhelm for organizing a memorable Keynote Symposium to commemorate Professor Wood on the occasion of his Eightieth Birthday. We are deeply indebted to Drs. Joseph Rard and Earle Wagborne for their gracious and unwavering support in compiling these manuscripts into a special issue that serves as a lasting tribute to Professor Robert H. Wood. We echo and endorse Dr. Rard's sentiments on the longstanding collaborative partnership between The Calorimetry Conference and the Journal of Solution Chemistry, a synergistic relation that is of mutual benefit to both organizations and entirely consistent with our core mission of providing an interactive forum for the dissemination of current research and technological developments in calorimetry and chemical thermodynamics.

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