

## SFC/SFE 2019: Pushing the Limits -

### The Green Chemistry Group – <https://www.greenchemistrygroup.org>

Summarised by: J. David Pinkston, PhD, Archer Daniels Midland Company, 4666 East Faries Parkway, Decatur, Illinois 62526, USA

**Proteins? Extremely polar metabolites? Planetary science? Cannabinoids? Water as a stationary phase? These are hardly topics one might have expected to be discussed in a conference on 'supercritical fluid chromatography and extraction' just a few years ago. Yet these and other surprising topics were indeed on full display at SFC/SFE 2019, the 13th International Symposium on Supercritical Fluid Chromatography and Related Technologies, held in Philadelphia, Pennsylvania, from 29 September through 1 October 2019.**

The conference began before a standing-room-only crowd with the presentation of a Lifetime Achievement Award to Larry T. Taylor, Professor Emeritus at Virginia Tech University. Prof. Taylor helped grow SFE and SFC into the vibrant fields they are today, contributing over 400 publications in these and other fields, and helping to organise over 22 international conferences on SFC and SFE. Larry gave thanks to special individuals who shaped his career, and J. David Pinkston (Archer Daniels Midland Company, USA) provided perspective on Professor Taylor's contributions to the field.

Despite the unusual range of topics mentioned above, the analysis and purification of pharmaceuticals and their impurities are still mainstays of SFC. Eric Regalado (Merck, USA) described the advantages of SFC, combined with ultraviolet absorbance and mass spectrometric detection, for impurity fate mapping in the synthesis of pharmaceuticals. He also illustrated one advantage of SFC - the isolation of molecules that are altered by the presence of water in the mobile phase. Abhijit Tarafder (Amgen, USA) discussed the prediction of maximum injection volumes, a traditional Achilles' heel of SFC, in preparative chiral separations. Pierre Billemont (UCB Biopharma, Belgium) discussed the economic and speed advantages of SFC over HPLC for milligram to kilogram-scale preparative separations. Enhanced fluidity LC provides many of the advantages of SFC for the analysis of proteins. Raffael Bennett (Merck, USA) reported on the conformational analysis of protein therapeutic agents using hydrogen-deuterium exchange and EFLC. Martin Enmark (Karlstad University, Sweden) provided an insightful view of the molarity of the mobile-phase modifier in SFC. Due to the pressure drop along the column, this molarity of the modifier around the peak of interest changes as the peak moves down the column. Martin used this insight to provide a practical approach for retention matching and successful scale-up from analytical to preparative separations.

Using physico-chemical measurements to predict the suitability of a molecule for further development as a potential pharmaceutical product has become an important part of the pharmaceutical discovery process. Gilles Goetz (Pfizer, USA) and Romulo Romero (AstraZeneca, USA) each described various aspects of the impact of SFC on estimating EPSA (exposed polar surface area) of molecules in the pharmaceutical discovery process. SFC-based



Professor Larry T. Taylor (right) receiving the Lifetime Achievement Award from Green Chemistry Group President Ray McLain.

EPSA measurements are quick, and are more reliable than previous empirical methods.

Tony Yan (Pfizer, USA) provided an interesting discussion of the use of SFC to study in-vivo chiral inversion. Takeshi Bamba (Kyushu University, Japan) and colleagues have pushed the limits of SFC for years, and he reported on the development of SFC methods for amino acids, peptides, and water-soluble polar metabolites, optimising columns and additives for impressive results.

Susan Olesik (The Ohio State University, USA) demonstrated dramatic improvement in signal-to-noise ratio in the detection of large proteins using enhanced fluidity LC and electrospray ionisation. 'Supercharging' and improved nebulisation provided S/N ratio increases ranging from 1 to 3 orders of magnitude. This promises to be an active area of research in the characterisation and detection of proteins.

The importance of preparative-scale SFC in pharmaceutical drug development was illustrated by the fact that two sponsors of the conference (Shimadzu Corporation and Waters Corporation) each described SFC instruments introduced this year for preparative and semi-preparative purification. A third sponsor (Agilent) described new approaches for more straightforward chiral method development, an area of importance in the pharmaceutical industry.

Fundamental studies and column development were featured in a number of presentations. Terry Berger (SFC Solutions, USA) discussed extra-column void volume and the limits of kinetic performance in SFC. His work provides guidance for future instrumental improvement. Bill Farrell (Pfizer, USA) discussed novel column shapes and column entrance and exit technologies designed to improve separation efficiency. Application of these designs (called 'active flow technology') in SFC is still under development. Matthew Przybyciel (ES Industries, USA) demonstrated novel stationary phases developed specifically for SFC, while Quentin Gros (University of Orleans, France) used linear solvation energy relationship analysis to classify 14 'Shim-Pack' stationary phases in the multidimensional 'spidergram' analysis of retention mechanisms developed by the groups of West and Lesellier at the University of Orleans.

In a novel twist on column development, Kevin Thurbide (University of Calgary, Canada) and colleagues are exploring the use of adsorbed water as a stationary phase in uncoated columns. Kevin described the effects of pH, temperature, mobile-phase pressure, the presence of chiral selectors, salts, and other solutes in the water phase. This will be fascinating area of research in 'green' separations.

A variety of novel applications was also discussed in the conference. Cannabinoids are a rapidly growing area of interest, especially in the use of SFE for large-scale extraction and purification. Jerry King (CFS, USA) provided a masterful keynote lecture on the use of SFE and SFC for the production and analysis of cannabinoids, while Lucie Novakova (Charles University, Czech Republic) discussed analytical-scale method development for SFE and SFC of cannabinoids. Blair Berger (University of Texas at Arlington, USA) and Gioacchino Luca

Losacco (University of Geneva, Switzerland) described the use of SFC/MS for the detection of drugs of abuse in hair, and prohibited substances in urine respectively. SFC has traditionally demonstrated advantages in the analysis of highly lipophilic mixtures. Rob Campbell (Dow Chemical, USA) discussed its use in the analysis of synthetic sebum oil, while A. Paige Wicker (University of Texas at Arlington, USA) described on-line SFE-SFC/MS for the analysis of PAHs in soils. The online extraction and determination eliminate many steps relative to the traditional extraction and analysis methods. Similarly, Dan Hengst (Eurofins, USA) described a variety of rapid online SFE-SFC/MS methods for automated extraction and analysis of vitamins and mycotoxins in the foods and nutritional-supplements areas.

In a mind-expanding discussion of instrument design facing the restrictions of inter-planetary travel, Victor Abrahamsson (Jet Propulsion Laboratory/California Institute of Technology, USA) closed the conference with a discussion of SFE/SFC for in-situ (i.e., on-planet) planetary exploration. Online extraction and analysis with a CO<sub>2</sub>-based mobile phase provides many advantages.

The conference also featured a packed poster session. A. Paige Wicker (University of Texas at Arlington, USA) and Rick Wikfors (Agilent Technologies, Germany) accepted the two Outstanding Poster Awards for their respective team of co-authors. Wicker and colleagues focused on using multivariate analysis to optimise online SFE-SFC/MS methods, while Wikfors and coauthors reported on the use of enhanced fluidity LC for the separation and identification of highly polar compounds.

SFC/SFE 2019 was organised by the Green Chemistry Group an organization promoting environmentally friendly and sustainable separation technologies. The GCG gratefully thanks the vendor/exhibitors of the conference for their financial support. For information about the conference sponsors, abstracts, and presentations please see <https://www.greenchemistrygroup.org/>. Mark your calendar - the next conference in this series will be held in Prague, Czech Republic, from 19th through 22nd October 2020.