Notice of the Final Oral Examination for the Degree of Doctor of Philosophy

of

NICHOLAS DAVEY

BSc (Vancouver Island University, 2007)


Department of Chemistry

Friday, April 1, 2016
9:30 A.M.
David Turpin Building
Room A144

Supervisory Committee:
Dr. Chris Gill, Department of Chemistry, Vancouver Island University (Co-Supervisor)
Dr. Tom Fyles, Department of Chemistry, University of Victoria (Co-Supervisor)
Dr. Scott McIndoe, Department of Chemistry, UVic (Member)
Dr. Jay Cullen, School of Earth and Ocean Sciences, UVic (Outside Member)
Dr. Erik Krogh, Department of Chemistry, VIU (Additional Member)

External Examiner:
Dr. Guido Verbeck, Department of Chemistry and Biochemistry, University of North Texas

Chair of Oral Examination:
Dr. Issa Traore, Department of Electrical and Computer Engineering, UVic

Dr. David Capson, Dean, Faculty of Graduate Studies
Abstract

The typical strategy for atmospheric analysis of volatile organic compounds (VOCs), is to collect discrete samples which are then transported to a laboratory for analysis. This method has limited spatial and temporal resolution, and can be both costly and time consuming. To overcome these limitations, a mobile monitoring platform was developed for real-time quantitative chemical analysis. This work describes the development of membrane introduction mass spectrometer and identifies the necessary requirements to make a reliable and effective instrument for in-situ chemical analysis. These include, the integration of a membrane interface with a miniaturized mass spectrometer, development of a data management strategy, reducing the effects of isobaric interferences and employing an internal standard for quantitative measurements. Furthermore, the negative effects of environmental variables, such as the Earth's magnetic field, were examined and effectively eliminated. In addition, this work demonstrates quantitative mapping of atmospheric VOCs in real-time, which allows rapid identification of chemical plumes and therefore, areas of potential concern. Both lab and field-based comparisons of membrane introduction mass spectrometer data and traditional whole air sampling canister data were undertaken. The primary field site was near Ft. McMurray, AB where baseline data was collected around a steam assisted gravity drainage (SAGD) facility and surrounding public roads. Monitoring for fugitive emissions at this facility and surrounding bitumen mining and processing operations is demonstrated. Field data were also obtained, near an industrial site in Ft. Saskatchewan, AB, that demonstrate the efficacy of an adaptive sampling strategy. Finally, chemical ionization was investigated as a soft ionization strategy to improve chemical selectivity for the analysis of complex hydrocarbon mixtures. The development of an in-line liquid chemical ionization reagent delivery system is presented and proposed as an effective strategy for eliminating interferences arising from biogenic terpenes and alkyl aromatics. In all, this thesis presents the design and implementation of a mobile membrane introduction mass spectrometer for atmospheric chemical analysis. Results that improve performance and demonstrate the novelty of the data-type are provided, along with avenues for future development.