Applications of Gas Chromatography with Headspace Autosampler

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Introduction
Gas chromatography (GC) is a separation technique for volatile compounds that involves the vaporization of a sample through an injector. Then, the sample is carried by a gas moving through a stationary phase (column) packed with a gel or a solid until reaching a detector. The CME Department recently acquired a GC system with exchangeable detectors: Thermal conductivity detector (TCD) and flame ionization detector (FID). To enhance interdisciplinary collaboration across Units and Departments within the University of Dayton, this work seeks to develop GC and Headspace-GC (HS-GC) analytical methods for use both in the classroom and in research.

Objectives
- To understand the variables manipulated in GC and HS-GC and apply this knowledge to developing characterization methods
- To generate a characterization method to determine the concentration of ethanol in aqueous mixtures obtained from a distillation process

Methods
An extensive literature review has been conducted through Journal articles, books, and webinars before starting with the Summer Undergraduate Research Experience (SURE) program with the SoE this summer.

Equipment
- Thermo Scientific GC w/TCD and FID detector
- Autosampler (Triplus RSH)
- Capillary Column [TG-BOND Q+]
- HS and GC vials

Background: GC vs. HS-GC
Headspace sampling: The more volatile compounds are extracted from the sample. For example:

Results and Discussion
- Two separate calibration curves (C,D) were generated in the laboratory using liquid samples of 10, 40, 50, 65, 90, and 100 % (v/v) ethanol/water using GC.
- Sample preparation was improved between analysis as shown on each calibration

Using HS-GC Quantitatively
- Sample volume: \( V_s = V_e \times (F_{col} + F_{s}) \)
- Injection time: \( T_i = (V_{syr}/F_{col} + F_{s}) \times (P_i/P_a) \)
- This combination allows sample concentrations determination

Future Applications
- Analyze ethanol and water samples obtained from the Unit Operations Laboratory.
- Characterize the efficiency of GC analysis of EtOH/H₂O/oil samples vs. using HS-GC for ternary mixtures
- Characterize SCFA (short chain fatty acid) content in Listeria metabolites present in mice feces with the SURE program in the SoE during this summer

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Selected References