IDENTIFICATION OF GAS COMPONENTS IN LIGHTER BY GAS CHROMATOGRAPHY: An Experiment for the Undergraduate Instrumental Analysis Laboratory

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ABSTRACT

In the applications of instrumental analysis lessons, advanced instruments with the needed experiments are needed. During the lessons it is a fact that the more experiments are performed, the more learning will be. For this reason, experiments that do not last long and should be performed with more simple instruments and that increase students' attention with current events should be developed. It is thought that there is only propane gas in lighters used in daily life. However, in fact, in certain ratios, there are also other gases having similar structure besides propane gas. For these reasons, the identification of gas components in lighter has been thought. To enlighten this situation a simple experiment design has been planned.

Keywords: **Upper-Division undergraduate, Laboratory instruction, Computer-based learning, Gas chromatography, Instrumental methods.**

INTRODUCTION

In the applications of instrumental analysis lessons, advanced instruments with the needed experiments are needed. During the lessons it is a fact that the more experiments are performed, the more learning will be. For this reason, experiments that do not last long and should be performed with more simple instruments and that increase students' attention with current events should be developed. When research that has been conducted so far is examined, it is seen that so many experiments including gas chromatography method have been performed. Instead of these comprehensive implementations, the number of simpler experiments that can be performed outside the laboratory should be increased. For these reasons, the identification of gas components in lighter has been thought.

Ellison (2005) conducted an experiment using gas-liquid chromatography to measure enthalpies of vaporization of very small quantities of organic compounds. In his experiment, giving students solid or liquid samples, students were required to dissolve these elements in methylene chloride and inject into gas chromatograph. With their retention times of air and the sample measuring a series of temperatures over partial temperatures or capacity factors, enthalpies were calculated. Using mass spectrometry with selected ion monitoring and gas chromatography, Sobel and et all. (2005) found out the level of the phenol rates in the oil of winter plants. With the help of selected ion method, it enabled to carry out the analyses in a shorter time and to determine phenol µg/ml.

Using gas chromatography, Latimer (2003) examined the process of elimination reactions for university organic laboratory. In this study reactions of 1 bromopentane or 2 bromopentane from alkyl halides with sodium ethoxide or potassium tert-butoxide were observed. Knupp and et all. (2002) devised an experiment on headspace solid-phase micro extraction (HS-SPME) and gas chromatography-mass spectrometry in order to determine the flavor components in Eau de Cologne. With this experiment, it was aimed

to teach chemistry students the methods of HS-SPME and GC-MS and to get them to do analytic applications. Slawson and at all. (2001) determined the productions of biocatalysts events that Escherichia-coli bacteria produced lactones from various cyclic ketones with the help of gas chromatography and mass spectroscopy.

With the extraction of organic productions and thin layer chromatography-mass spectroscopy these productions were directly found. In this experiment, by using the biocatalyst reactions of bacteria, the students were provided with the chance of studying micro-organisms and learning the role of bacteria for synthetic chemistry. Olson and at all. (2001) utilized gas-chromatograph to determine the effects of chlorine which is used in the process of disinfection of drinking water. As is known, the chlorine is crucial for the disinfection of drinking water, but it may also be transformed into toxic matters. By examining how trihalomethanes, one of those toxic matters, is formed and how it formed a substituting reaction, students were provided with the chance of making an analysis of the mixture of compounds connected to the environment. Simpson and Rivera (2001) designed an experiment for first class organic chemistry students to compare and contrast the retention times for a molecular surface of a series of polar and non-polar aromatic hydrocarbons on gas chromatography.

With this experiment, the students were allowed to learn to compare and contrast the correlation analysis, molecular modeling, and gas chromatography technique. Bressette (2001) developed a simple semi-imperative gas chromatography method using NMR tubes. It was achieved that compounds are easily isolated and good results were succeeded using 5 mm NMR tubes. Atterholt and at all. (2000) developed a syllabus for the university chemistry about environmental applications to be dealt more. Nahir (1999) analyzed gas chromatography and mass spectrometer, and the diesel fuel. With this experiment to be applied in the lessons of environmental chemistry and instrumental analysis, polycyclic hydrocarbons, mass spectra of single-ion-mode chromatograms and total-ion- chromatograms results were achieved. Sykes and Caple (1999) developed three experiments which use gas chromatography in regional characterization of some natural foods like pistachio pine nuts, the prairie turnip and maize. With this method, definition and isolation of some fatty acids were achieved. Smith and at all. (1998) developed a low cost gas chromatography detector which students can use in experiments. Approximately 450 first class students determined hydrocarbons and chloride in the gas chromatography experiments.

Wedvik and at all. (1998) designed an experiment including gas chromatography, computer models and viscometry methods to clarify the intermolecular forces in chemistry courses better. With the gas chromatography, in a sample including n-alkanes mixtures, a simulation in the intermolecular forces was made. With the computational models, how the intermolecular forces occur was better identified. By that way, London forces, dipole-dipole interaction, and hydrogen bonds were explained. With the organic liquids viscosity, physical features of intermolecular force were scaled. Williams and Pierce (1998) carried out two gas chromatography experiment in which orange oil and d-Limonene's dissolve in water was examined. D-limonene was defined using anisol, and orange oil was defined using n-orbited Valencia oil. By the help of these experiments, students learnt how to define the concentration and the limit of the detections. Rhoads and at all. (1997) developed a gas chromatography medium for ozonolysis event in the organic chemistry laboratory. In this experiment, methyl oleate, stilbene, a-methylstilbene, 4-methylstyrene and a-methylstyrene were used. Brazdil (1996) defined oxygenate extracted from gasoline and analyzed by gas chromatography. By means of calculations the percentages of methanol, ethanol, or methyl tert-buthyl ether were obtained.

Kegley and at all. (1996) developed a laboratory experiment for environmental chemistry to define polycholorinated biphenyl in river and gulf sediments which included gas chromatography. By increasing the interests of students for chemistry with this application of chemistry including real life events, an evaluation the PCB contaminated

matters was made. Kostecka and at all (1996) developed lab experiments, which are appropriate for non-science major students, including gas chromatography and mass spectrometry. By giving these experiments names such as "Discovering Molecular Secrets," The Extraordinary Chemistry of Ordinary Things," "From Ozone to Oil Spills: Chemistry the Environment and You," and "Solving Crime through Analytical Chemistry," they were separately tested.

Marriot and Carpenter (1996) established a system including gas chromatography capillary injection for instrumental analysis students. With this system a demonstration was successfully made to students. Frühling and Faßbinder (1981) also performed an experiment of gas chromatography with an inexpensive detector to be used in student-experiments. In their studies, they used semi-conductive gas sensor as detector.

EXPERIMENT

It is thought that there is only propane gas in lighters used in daily life. However, in fact, in certain ratios, there are also other gases having similar structure besides propane gas. To enlighten this situation a simple experiment design has been planned.

Figure: 1 The Experiment Design

Experiment design mainly consists of 4 elements.

1. **Injection Block: It is a T shaped block in which the lighter gas is given to the column mechanism with the help of a syringe.**

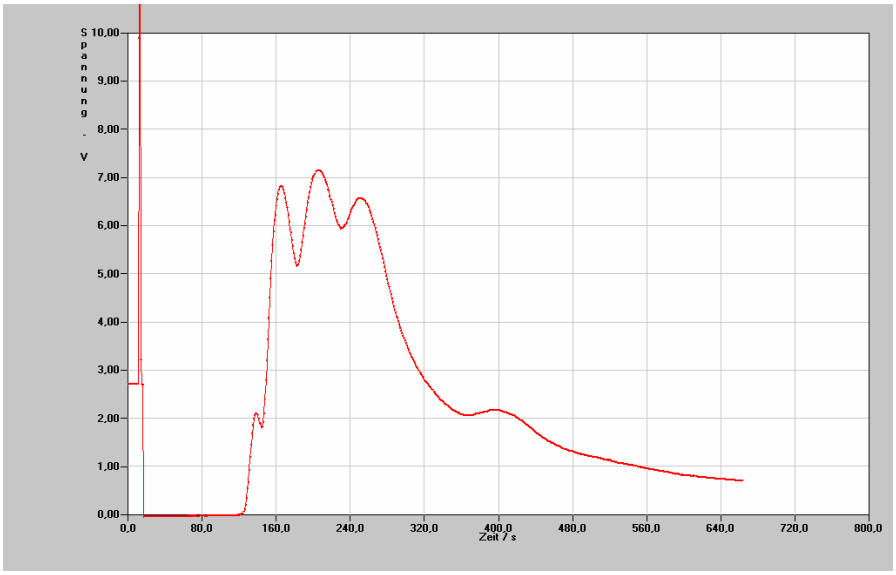
Figure: 2 Injection of gas

2. **Separating Columns: It is made up of a fine rubber hose which is fixed to the block to which the gas is given. Chalk dust is used a stationary phase. While one tip of the T-block is fixed to the separating column, the other tip is fixed to the pump. In this situation, gas is able to pass through the separating column.**

3. **Detector: A detector which can measure different migration speed of different gases is used.**

4. **Carrier Gas: Air, given with the pomp of aquarium, is used as the carrier gas. By this method, it is safer and easier compared to the other gases.**

In this experiment, firstly the gas mixture is extracted from the lighter gas. Secondly this gas is injected in the separating column. Thirdly, with the help of carrier gas, different gases move at different speed. Then this speed is measured by the computerized detector and voltmeter. Lastly, chromotogram is obtained as seen in Graphic 1 below.

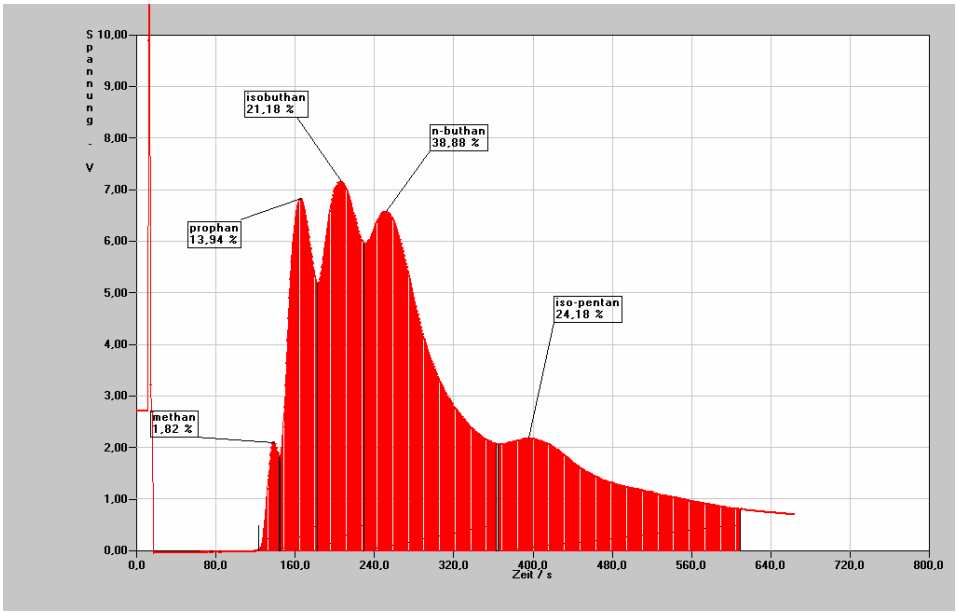


Graphic: 1 Chromotogram

Hazards

As the gas within the lighter is flammable, you should be careful during the gas injection. Meanwhile that the gas flares up may damage both the hands of the staff and the other instruments like computers.

RESULTS AND DISCUSSION



Graphic: 2 Chromotogram results

When Graphic: 2 is examined, it is clearly seen that these gases are methane, propane, i-butane, n-butane and i-pentane successively. The findings indicate that the Chromotogram is clearly observable. So, gas types in the lighter gas are determined. With this experiment, in instrumental analysis lessons, a better-understanding of this lesson has been reached by increasing the student interest.

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