Volatile Organic Compounds From Plastics

Mindy Rodriguez, Dr. Seaton,* Dr. Mead, and Bonnie Monteleone
Chemistry Department
University of North Carolina Wilmington
mnr9774@uncw.edu

Abstract & Introduction

World plastic consumption has increased dramatically over the past 60 years yet little research has been done on the chemical compounds escaping plastics. Volatile organic compounds (VOCs) are leaching out from plastics at both elevating temperatures and at room temperature. This research compares VOCs leaching from different plastics and at elevating temperatures.

Figure 1: Plastics that underwent GCMS.

Methods

The plastic samples were obtained from black monochromatic plastic, general household plastic wrappers, plastic utensils, plastic lids from bottles, plastic used for shipping, and known preproduction plastics purchased from Sigma Aldrich which are found in plastics. Some plastics were placed in a grinder along with dry ice to ensure VOCs would not escape when grinded. After they were grinded, they were placed in sealed containers. Headspace vials were filled to ¼ full with the plastic samples. The vial was capped and sealed. The Headspace GC/MS Bruker SHS-40 was used to analyze. Plastics in vials were heated at 80°C for ten minutes in the headspace unit. 1 µL of the gas was then injected into the GC/MS. The GC temperature programs started at 30°C for five minutes and increased at a rate of 20°C per minute to 200°C. Mass spectra of peaks from each chromatogram were compared to the NIST MS-library and to MS from peaks from standard plastics and identified where possible.

Figure 2: Headspace GC/MS Bruker SHS-40 that was used for analyzing the VOCs.

Discussion

When analyzing the VOCs from the plastics, there were similar peaks that arose. The most common chemical compounds that were found were styrene, propyl benzene, and ethyl benzene. Styrene and ethyl benzene are used for fuel additives, paint and coating additives, rubbers, and plastics. Propyl benzene can be used in fuel additives as well. These VOCs have short-term and long-term effects on humans and animals. Short-term human exposure to styrene, propyl benzene, and ethylbenzene can experience mucous membrane irritation and eye irritation. Propyl benzene is mildly toxic if ingested or inhaled.[1] All of these compounds have not been found to be carcinogenic to humans, but propyl benzene has been found to be carcinogenic to animals.[1] A study done on female workers in plastic industry reported increased spontaneous abortions and a decrease in births.[2] It is not known if the plastics had an effect on reproductive or development of fetus. The plastic fork and knife combination contained all three VOCs and leached the most VOCs out of all the plastics analyzed. The general plastic, plastic lids, and the fork and knife plastic utensil had similar peaks of styrene and ethylbenzene leaching out in similar times.

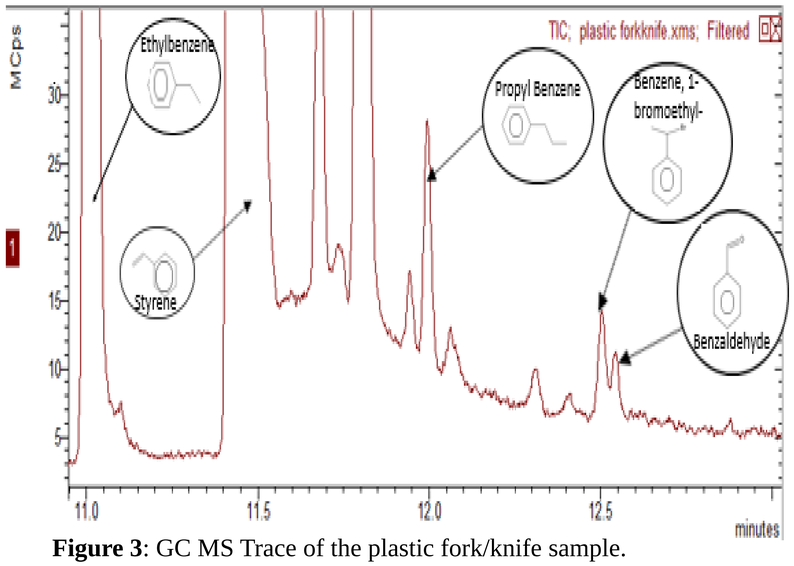

Figure 3: GC MS Trace of the plastic fork/knife sample.

Conclusions

Out of all the plastics analyzed, the plastic lids and the plastic bags leach the least. The mixture of forks and knifes leach the most out of all the plastics. The most common volatile organic compounds that leached were styrene, propyl benzene, ethyl benzene. These compounds may not be carcinogenic to humans, but can have negative health affects on human respiratory and central nervous systems. Benzaldehyde was found in the plastic fork/knife sample. Benzaldehyde has physical properties that makes it hazardous to the environment. Benzaldehyde can contaminate groundwater since it sinks in water.[3] Further analysis of plastics should be done to grasp a better understanding of the human and environmental impact from plastic consumption.

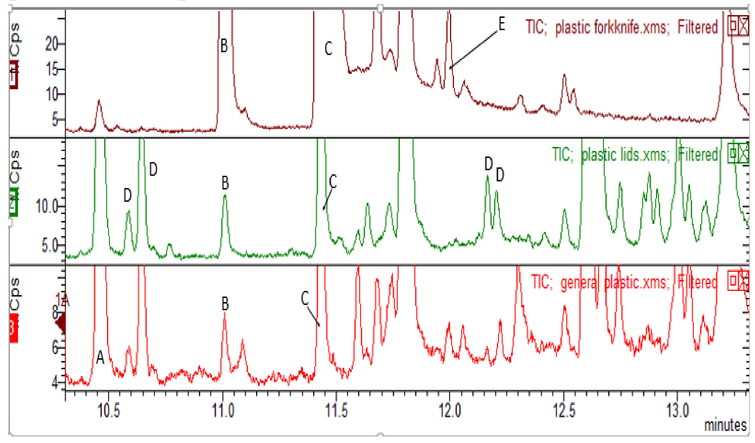

Figure 4: GC MS Trace from some of the plastic samples. The letters denote different chemical structures found (A= alkane, B= ethylbenzene, C= styrene, D= branched alkane, E=propyl benzene).

References and Acknowledgements

1. National Center for Biotechnology Information. PubChem Compound Database; CID=7500, 7501, and 7668. United States National Library of Medicine, Bethesda, MD, 2016.
2. U.S. Environmental Protection Agency. Integrated Risk Information System (IRIS) on Styrene. National Center for Environmental Assessment, Office of Research and Development, Washington, DC. 1999.
3. U.S. Coast Guard. Chemical Hazard Response Information System (CHRIS) - Hazardous Chemical Data. Commandant Instruction 16465.12C. Washington, D.C. 1999.

UNCW Student Fee-Based Green Initiative Fund