AROMATIC HYDROCARBON CONTENT OF PLASTIC PACKAGING MATERIALS

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1.0 Abstract

Common food and drug plastic packaging materials of polyethylene, polystyrene, polyvinylchloride and polyethylene terephthalate have been analyzed for aromatic hydrocarbons using thermal desorption gas chromatography/mass spectroscopy. All four types contain detectable levels of benzene, toluene, xylenes and naphthalene compounds. The source, at least in part, is believed to be gasoline vapors in the air. Polystyrene contains the highest level of aromatic hydrocarbons.

2.0 Introduction

In an earlier paper[1] the composition of volatile compounds of recycled dairy grade HDPE was reported. Over 100 compounds at the ppb-ppm range were identified. One of the classes of compounds was aromatic hydrocarbons without functional groups, i.e., other than alkyl groups like methyl. It was established that the aromatic hydrocarbons did not originate from recycling. Rather, they had been absorbed from the air. A HDPE water bottle off the shelf of a supermarket had the same aromatic hydrocarbons as the recycled HDPE. It was suggested that the origin of the aromatic hydrocarbons is from the air, coming from gasoline vapors which are widespread in ambient air. Indications are that polyethylene has a strong affinity for aromatic hydrocarbons. Thermal desorption coupled with analysis by gas chromatography/mass spectroscopy (GC/MS) requires unexpectedly high temperature to remove all the compounds. The compounds identified were benzene, toluene, xylenes and methyl naphthalene.

In the present work, the analysis for aromatic hydrocarbons was extended to other common plastic packaging materials – PVC, PET and PS.

3.0 Experimental Methods

Thermal desorption GC/MS has been described previously and information is available on the web site http://www.ims.uconn.edu/~lavigne/gcmslab.html. The GC/MS instrument is a H/P 6890 GC/MS. GC column is J&W dp-5 0.25 mm ID x 30 m, 1.0 micron film. Thermal desorption in the injection port of the GC was at 200°C/5 minutes, followed by temperature programming of the GC column at 15°C/minute. Identifications were by mass spectra of the whole mass range. Retention times were determined for each compound. Thereafter, levels of each compound were measured by single ion monitoring using an appropriate mass for each compound, as follows: benzene – 78; toluene – 91; xylenes – 106; naphthalenes – 128.

The relative content of each was measured by peak area and normalized per mg sample weight. The amounts detected were well in excess of a blank run.

4.0 Materials Analyzed

4.1 HDPE water bottle purchased one day before analysis.

4.2 PET water bottle purchased one day before analysis.

4.3 PVC blister pack of medication approximately two years old.

4.4 PS foam cup purchased one day before analysis.

4.5 PS rigid sheet food package approximately one week old.

5.0 Experimental Results

Figures 1-5 are chromatograms for the PS foam cup as an example of similar chromatograms for the others as well. Figure 1 is the full mass range chromatogram. Figure 2 is for single ion monitor chromatogram for benzene (mass 78). Figures 3-5 are for toluene, xylenes and naphthalene, resp. using mass values cited above.

The relative peak areas per mg sample are in Table 1. The levels are estimated to be in the ppb-ppm range. In the just purchased HDPE water bottle (sample 1) benzene was not detected. However, it was detected in other older HDPE bottles and in the 1995 paper.

6.0 Discussion

All four types of plastic contain aromatic hydrocarbons. The highest amount by far is in the PS foam cup. An older PS foam cup that had been in a desk drawer about two years had approximately the same levels as in the new PS foam cup. The rigid PS sheet material contains much less hydrocarbons than the foam. The high surface nature of the foam probably accounts for the high levels. The

[1] Ezrin, M and G. Lavigne, *Analysis of Organic Compounds in Recycled Dairy Grade HDPE by Thermal Desorption Gas Chromatography/Mass Spectroscopy*, SPE Recycling Division 2nd Annual Recycling Conference, 104-110 (1995).

levels in PET are approximately comparable to that in HDPE. PVC and rigid PS are approximately comparable to each other.

As was the case in the previous report on HDPE, it is reasonable to assume that most or all of the aromatic hydrocarbons are absorbed from ambient air. The fact that all contain the same hydrocarbons is significant – benzene, toluene, xylenes, naphthalene. These also are common components of typical gasoline. Presumably the levels will increase in the samples which had short exposure time, only on a supermarket shelf, and analyzed within a day of purchase. The PS foam cup was inside a PE film wrap which was not removed until the cup was analyzed. The contents in PS foam are much higher than in all the others.

Regarding PS foam, it is possible that some, or even most, of the hydrocarbons originate with the gas used to do the foaming. While the high surface nature of foam will enhance absorption of hydrocarbons from the air, the amounts relative to other materials, including rigid PS, seem too high to be accounted for entirely from gasoline in the air. Yet the same hydrocarbons are found as in the other materials, in which case absorption from the air is the likely source. Regardless of uncertainty as to source, there is no question that aromatic hydrocarbons are present in all the materials tested.

7.0 Conclusion

Aromatic hydrocarbon compounds benzene, toluene, xylenes and naphthalene have been found to be present in HDPE, PET, PVC and PS packaging materials. The content in PS foam is the highest by far, including rigid PS. The possible source of the hydrocarbons is by absorption from ambient air which contains measurable amounts of gasoline vapors. For foam PS the levels are so high as to question if some may originate with the foaming chemicals.

	Relative peak area per mg sample			
Material*	benzene	toluene	xylenes	naphthalene
1 HDPE	—**	3.3	2.2	1.7
2 PET	0.47	0.323	9.7	3.95
3 PVC	23.4	29.2	78.0	16.2
4 PS foam	1393	464	3420	30
5 PS rigid	36	398	34.6	1.8

* See Materials Analyzed section for identification
** Benzene was detected in other HDPE with longer exposure time.

Table 1. Relative Levels of Aromatic Hydrocarbons in Plastic Packaging Materials

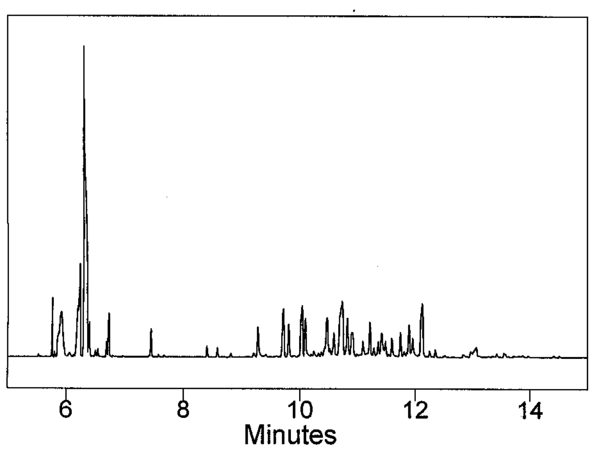

Figure 1. Chromatogram of PS foam cup with full mass range.

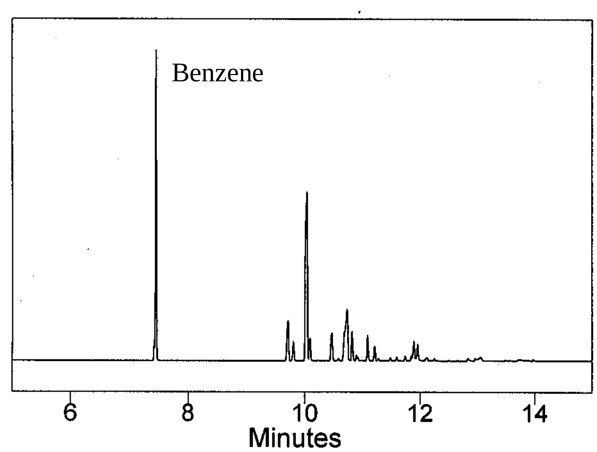

Figure 2. Single ion monitoring of figure 1 for mass 78 for benzene.

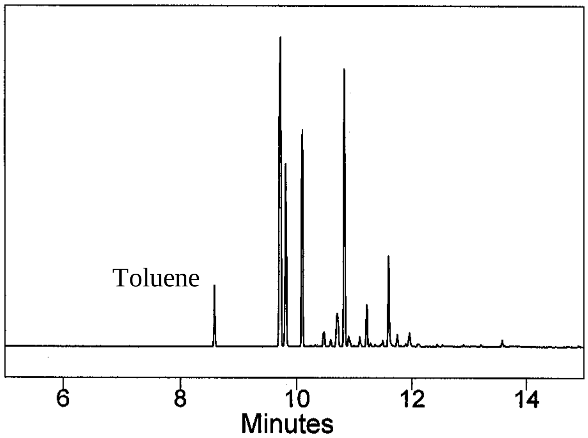

Figure 3. Single ion monitoring of figure 1 for mass 91 for toluene.

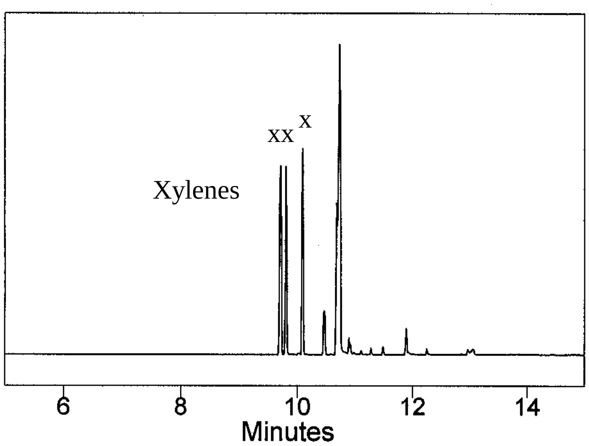

Figure 4. Single ion monitoring of figure 1 for mass 106 for xylenes.

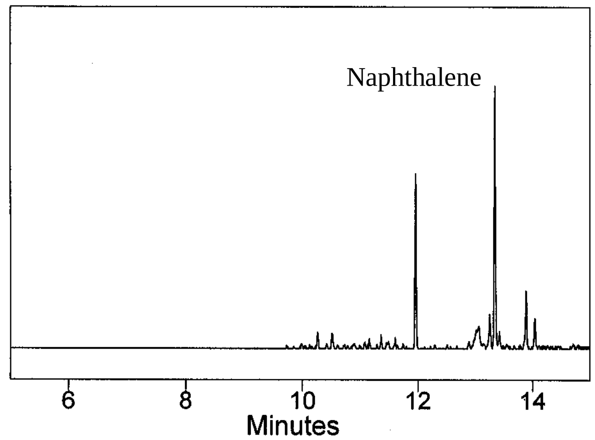

Figure 5. Single ion monitoring of figure 1 for mass 128 for naphthalene.

Key Words: plastic packaging materials, aromatic hydro-carbons