



## Project Summary

# Evaluation of Polyurethane Foam Cartridges for Measurement of Polynuclear Aromatic Hydrocarbons in Air

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The objective of the project was to evaluate polyurethane foam (PUF) cartridges as collection media for quantification of vapor phase polynuclear aromatic hydrocarbons (PAHs) in air.

Two cleanup methods for PUF cartridges—compression rinsing, and combined compression rinsing and Soxhlet extraction—have been evaluated. Both methods successfully remove interfering material and background PAHs from the PUF. The compression rinsing method is recommended because it is easier, faster, and cheaper.

Two procedures for extraction of PAHs from the PUF matrix, Soxhlet extraction and compression rinsing, were compared. Modified EPA medium volume samplers having quartz fiber filters to collect particles and PUF cartridges to trap vapors were used. Prior to sampling, known quantities of perdeuterated PAHs were spiked into each cleaned PUF cartridge. Eight samplers were operated outdoors in parallel for 24 hours. After sampling, four PUF samples were Soxhlet-extracted with 10 percent ether/hexane and the other four PUF samples were extracted by alternate compression and decompression 50 times in the same solvent. These sample extracts were analyzed by on-column injection, electron impact gas chromatography/mass spectrometry (EI GC/MS) to determine PAHs. The results showed that compression rinsing is comparable to conventional Soxhlet extraction, and that both methods successfully remove

PAHs from the PUF cartridges. The compression rinsing method was then used in the stability study.

The stability study was carried out to determine the stability of PAHs adsorbed on PUF cartridges as a function of storage time between collection and extraction. Two sets of PUF samples were collected for this study. The first set of samples was stored in the presence of light, and the second set of samples was kept in the dark. The storage temperature for both sets of samples was approximately 20°C. The samples were stored for 1, 10, 20, or 30 days and then extracted with 10 percent ether/hexane. Sample extracts were analyzed by EI GC/MS. The levels of perdeuterated benzo(a)pyrene decreased significantly during storage. The rate of decrease was much faster when the PUF cartridges were stored in the light. Other PAH levels were not adversely influenced by the storage time.

*This Project Summary was developed by EPA's Environmental Monitoring Systems Laboratory, Research Triangle Park, NC, to announce key findings of the research project that is fully documented in a separate report of the same title (see Project Report ordering information at back).*

## Introduction

Polynuclear aromatic compounds have been extensively studied and have received increased attention in studies of air pollution in recent years because some

of the compounds are highly carcinogenic or mutagenic. To understand the extent of human exposure to polynuclear aromatic compounds, reliable sampling and analytical methodology must be established for monitoring the concentrations of these compounds in air. In general, the analytical methodology is well developed, but the sampling procedures can often reduce the validity of analytical results. Several studies have shown that the three- to four-ring polynuclear aromatic hydrocarbons (PAH) in air may be mainly in the vapor phase and are not retained by filters because of volatilization. A wide variety of adsorbents such as Tenax-GC, XAD-2 resin and polyurethane foam (PUF) has been used to sample organic vapors. The PUF cartridge is easy to handle in the field and has good airflow characteristics; it has been successfully used for collection of pesticide and polychlorinated biphenyl (PCB) vapors.

Recently, Battelle conducted a study to collect ambient and indoor air PAH using a sampler with a quartz fiber filter and a PUF back-up trap. It was observed that the PUF cartridges changed from a pale white to a light yellow color over a one-week storage period. It is not known whether this color change is associated with any change in the PUF cartridge's ability to retain PAHs. In a large-scale air monitoring program, placement of the samplers in the field and the return of filters and traps after air collection to analytical laboratories may take several weeks. Therefore, it is necessary to conduct a study to assess the stability of PAHs adsorbed on the PUF cartridges during storage.

The objective of this project was to evaluate PUF cartridges for collection and subsequent analysis of vapor phase PAH in air.

## Procedure

Two studies were performed in this project:

- Extraction study to evaluate two extraction procedures, Soxhlet extraction and compression rinsing, for removal of PAH from the PUF matrix.
- Stability study to determine the stability of PUF traps by examining the measured PAH concentration as a function of storage time between collection and extraction.

The sample extracts were analyzed by electron impact gas chromatography/mass spectrometry (EI GC/MS) to deter-

mine both native PAHs and spiked perdeuterated PAHs.

## Results

Both methods of cleaning the PUF cartridges left only small quantities of naphthalene in the cartridges. The extraction study gave generally good recoveries (>85 percent) for spiked D<sub>8</sub>-PAHs with the exception of D<sub>8</sub>-naphthalene using either the Soxhlet extraction or the compression method. The loss of D<sub>8</sub>-naphthalene was anticipated since this compound is highly volatile. The sampling temperature during this experiment was 0°C to 10°C. Even greater losses of this volatile compound can be expected at higher sampling temperatures.

Levels of native PAHs found in the PUF cartridges were very similar using these two methods. The levels of PAHs found in the PUF cartridges, expressed as ng per cubic meter of air sampled, ranged from 0.10 ng/m<sup>3</sup> to 29.39 ng/m<sup>3</sup> and 0.17 ng/m<sup>3</sup> to 28.41 ng/m<sup>3</sup> using the Soxhlet-extraction and the compression methods, respectively. These data demonstrate that the compression technique is comparable to Soxhlet-extraction in removing PAHs from the PUF cartridges. Since significant time and cost savings can be achieved by using the compression method, this method was used in the stability study.

Only volatile and semi-volatile PAHs were found in the PUF cartridges. Higher molecular weight PAHs ( $m/e \geq 252$ ), such as benzo(a)pyrene and coronene, and 1-nitropyrene were not detected in the PUF cartridges, indicating that these compounds are predominantly retained on the filter.

The stability study was conducted to determine whether a significant loss of PAHs captured by PUF cartridges occurs during the storage period. Two sets of PUF samples were obtained for this study. The first set of PUF samples were stored at room temperature (~20°C) in the light, and the second set of samples was stored at room temperature in the dark.

Recoveries of the perdeuterated PAHs for the first set of PUF samples (stored in the light) ranged from 0.6 percent for D<sub>8</sub>-naphthalene to 102.3 percent for D<sub>12</sub>-chrysene. Low recoveries were obtained for D<sub>8</sub>-naphthalene, which decreased from 2.6 percent to 0.4 percent after 20 days storage. The low recovery and the decreasing recovery trend for D<sub>8</sub>-naphthalene during storage are mainly due to the volatilization of this compound. The storage time does not appear to have adverse

effects on the recoveries of D<sub>10</sub>-phenanthrene, D<sub>10</sub>-pyrene, and D<sub>12</sub>-chrysene. The variations of recovery for these compounds were less than 15 percent and may be due to small variations in sampling and analysis procedures. It should be noted that the recoveries of D<sub>12</sub>-benzo(a)pyrene decreased significantly with increased storage time; the recoveries decreased from 92.1 percent to 11.7 percent after storage for 20 days. It is possible that oxidation or other degradation reactions of D<sub>12</sub>-BaP may occur during storage.

In the second set of PUF samples (stored in the dark), the relative recovery data are similar to those obtained with the first set of samples. But the recovery of D<sub>12</sub>-BaP decreased less in the second set of samples than in the first set. The recoveries decreased from 95.4 percent to 44.3 percent after 20 days storage. Even after 30 days, 29.5 percent of the D<sub>12</sub>-BaP was recovered. It appears that the PUF-adsorbed D<sub>12</sub>-BaP is more stable in the absence of light.

Similar recovery trends were observed for the native PAHs. The storage time does not significantly affect the levels of phenanthrene, pyrene, and chrysene found in the PUF samples. Slightly decreasing concentrations were detected for naphthalene. Similar decreasing levels were observed for anthracene, an isomer of phenanthrene. The reactive PAH, cyclopenta(c,d)pyrene, higher-molecular weight PAHs ( $m/e \geq 252$ ), and 1-nitropyrene were not detected in the PUF samples.

## Conclusions and Recommendations

Two PUF cleanup methods, compression rinsing and combined compression rinsing and Soxhlet extraction have been evaluated for their ability to remove interfering material and background PAHs from PUF cartridges. The results show that the compression-only technique is comparable to the combined compression and Soxhlet extraction method. Thus the compression method is recommended for use in the future for time and cost savings.

The results of the extraction study indicate that levels of both native and perdeuterated PAHs found in the PUF cartridges are similar using either the Soxhlet extraction method or compression rinsing. It has been demonstrated that both methods can successfully remove PAHs from the PUF cartridges. Since significant time and cost savings

can be achieved by using compression rinsing, this method was used in the stability study.

Generally, good recoveries for the spiked perdeuterated PAHs were obtained for PUF samples extracted immediately after collection, with the exception of D<sub>8</sub>-naphthalene. This finding demonstrated that PUF cartridges cannot quantitatively retain volatile two-ring PAHs under the sampling conditions employed. Greater loss of volatile components would be expected at higher sampling temperatures. It should be noted that cyclopenta-(c,d)pyrene and higher molecular weight PAHs ( $m/e \geq 252$ ) were not detected in the PUF samples. 1-Nitropyrene was also not found in the PUF samples.

The stabilities of PAHs adsorbed on PUF cartridges during storage with and without light were investigated. The results indicated that levels of BaP decreased significantly during storage. The rate of decrease was much faster when PUF cartridges were stored in the presence of light. The levels of the remaining PAHs were not significantly influenced by the storage time.

Both XAD-2 resin and PUF are commonly used to collect PAH vapors in ambient air sampling. A comparative study is recommended to evaluate the flow characteristics and the collection efficiency for PAH vapors by using the two adsorbents (XAD-2 and PUF) as backup traps in ambient air sampling. Recently, several research groups indicated that extracts of clean PUF plugs show mutagenic activity and interfere with bioassay results. Therefore, bioassay analysis is recommended for samples collected from these two adsorbents. The bioassay results can provide information as to whether PUF plugs or XAD-2 resin would interfere with bioassay. To characterize and to compare these two adsorbents thoroughly, studies are also recommended to determine the stability of PAHs captured on XAD-2 resin as a function of time.

In this study, quartz fiber filters were used to collect air particulate matter. However, there are other types of filters which can be considered for collection of particles. Very few studies have been conducted to evaluate filter material for collection of particle-bound PAHs. It is recommended that an evaluation study be conducted to compare different types of filters such as quartz fiber, glass fiber, and Teflon-coated for collection of PAHs in ambient air sampling. Several important filter characteristics such as flow

characteristics and collection efficiency can be addressed for different types of filters.

Studies to determine sample stabilities for different types of filters and to determine the effects of storage time on PAH samples collected on different types of filters are also recommended.

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*The complete report, entitled "Evaluation of Polyurethane Foam Cartridges for Measurement of Polynuclear Aromatic Hydrocarbons in Air," (Order No. PB 85-245 645/AS; Cost: \$9.95, subject to change) will be available only from:*

*National Technical Information Service*

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