#59548

Applicationsnote

RESTEK

clinical/forensic

GC Analysis of Commonly Abused Inhalants in Blood Using Rtx®-BAC1 and Rtx®-BAC2 Columns

Inhalant abuse is the intentional concentration and inhalation of volatile compounds found in commercial products. In recent years, inhalant abuse has become the method of choice for first-time drug users. In 1993, the average age for first-time inhalant abusers was 10.8 years, whereas the average age for first-time abusers of other drug substances was 12.5 years. In fact, almost 20% of eighth grade students have abused inhalants. Chronic inhalant abuse can lead to respiratory, cardiovascular, liver, and kidney disease. Acute respiratory and cardiovascular responses to inhalant abuse also can produce inhalant-induced sudden death syndrome.[1]

Inhalant abuse can be detected during screening of whole blood, serum or urine samples using headspace gas chromatography (GC) combined with flame ionization detection (FID). For this application, a GC equipped with an automated headspace sampler that simultaneously introduces a sample into two analytical columns was used. A dual-column configuration provides screening and confirmational data from the same injection. We used the Rtx®-BAC1 (30m, 0.53mm ID, 3.00µm df) and the Rtx®-BAC2 (30m, 0.53mm ID, 2.00µm df) columns—typically used in combination as a screening and confirmational column set for blood alcohol analysis. A useful extension of blood alcohol analysis using this column set is the detection of other volatile organic compounds (VOCs), such as those found in inhalants.

Optimal performance of these columns during headspace analysis depends on proper GC/headspace system set-up. Band broadening can occur if there is excess dead volume in the sample flow path prior to the sample reaching the head of the column. Low-volume inlet sleeves or injection port interfaces significantly reduce the amount of excess volume at the exit end of the transfer line and will help to maintain narrow symmetrical peak shapes. Higher carrier gas flow rates through the transfer line also are important in maintaining good peak shape. Our experiments showed that carrier gas flow rates between 15 and 25mL/minute were the most efficient for transferring the sample from the headspace sampler to the head of the column in a tight sample bandwidth.

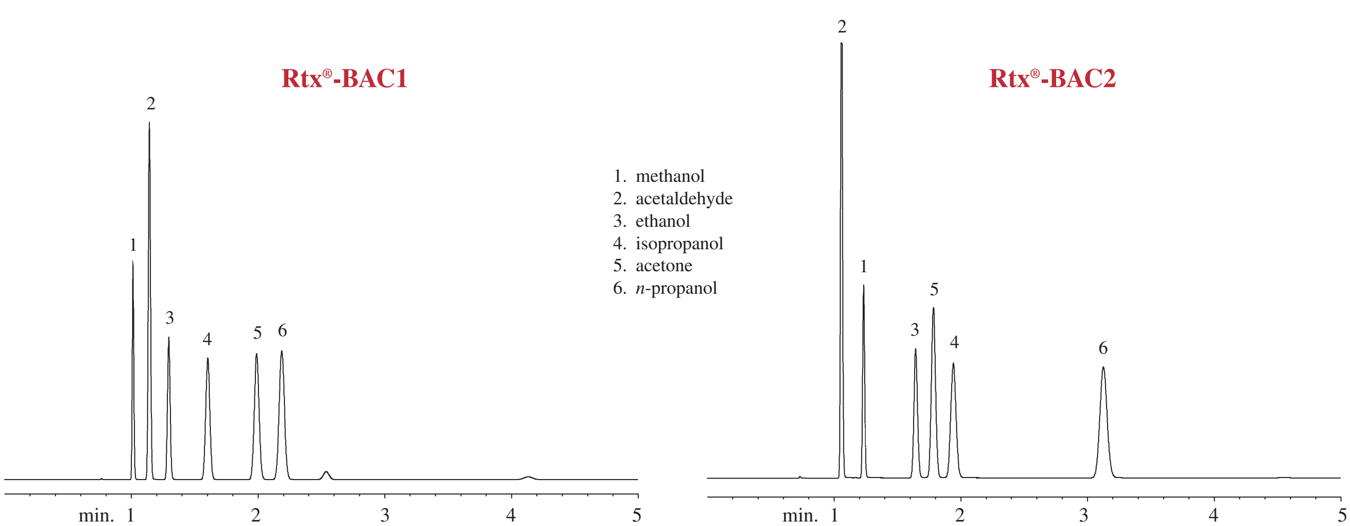
The following classes of commonly abused inhalant compounds were analyzed to determine retention times for each compound.

Blood Alcohol Analysis

Although ethanol is not commonly abused as an inhalant, it is the primary volatile substance detected in screening for volatile organic compounds as a result of alcoholic beverage ingestion. Other compounds monitored during blood alcohol analysis include low molecular weight alcohols and their metabolites (Figure 1).

Figure 1

Baseline resolution on the Rtx®-BAC1 and Rtx®-BAC2 columns for all compounds tested for during blood alcohol screening.



30m, 0.53mm ID, 3.0µm Rtx®-BAC1 (cat.# 18001) and 30m, 0.53mm ID, 2.0µm Rtx®-BAC2 (cat.# 18000). 1.0mL headspace sample; **Oven temp.:** 40°C (hold 5 min.) to 240°C @ 5°C/min.; **Inj. & det. temp.:** 240°C; **Carrier gas:** He; **Linear velocity:** 65cm/sec.

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Anesthetics

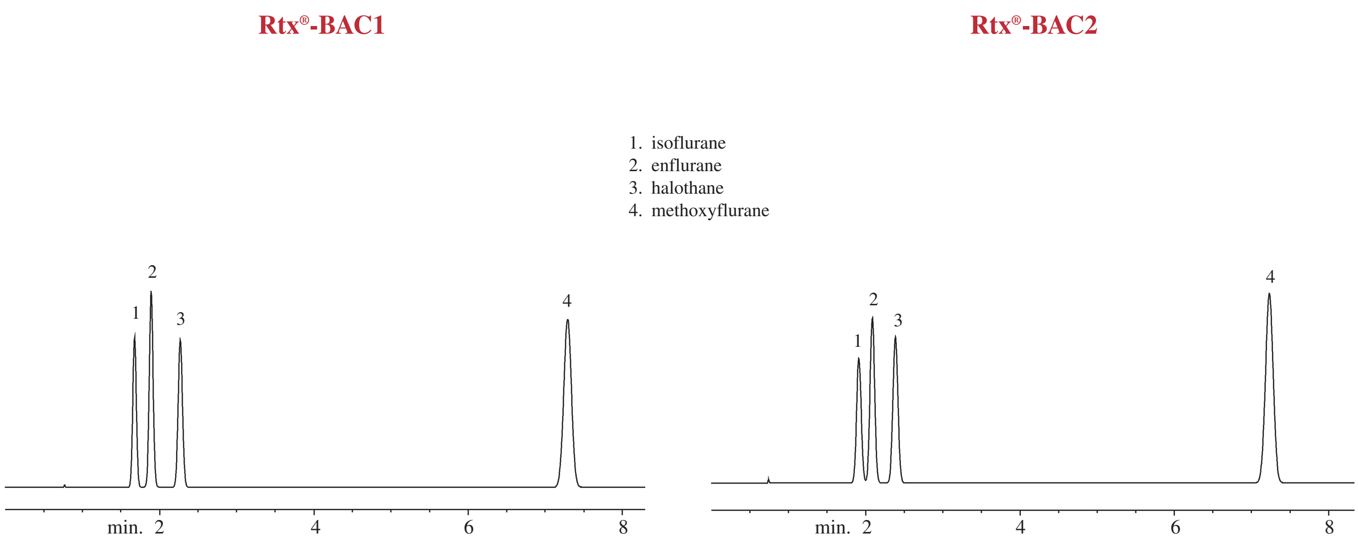
Volatile anesthetics belong to a group of low molecular weight halogenated compounds. The abuse of volatile anesthetics is uncommon but has been reported among hospital personnel and others with access to anesthetic agents (Figure 2).

Alkyl Nitrites

Alkyl nitrites are abused for their vasodilation properties. Abuse has centered on the ability of alkyl nitrites to produce short-lived highs and possible aphrodisiac sensations. Analysis of alkyl nitrites in biological samples is complicated by the fact that alkyl nitrites are rapidly hydrolyzed to their corresponding alcohol. Analytical methods should take this into account by monitoring for both the parent compound and the corresponding alcohol (Figure 3).

Figure 2

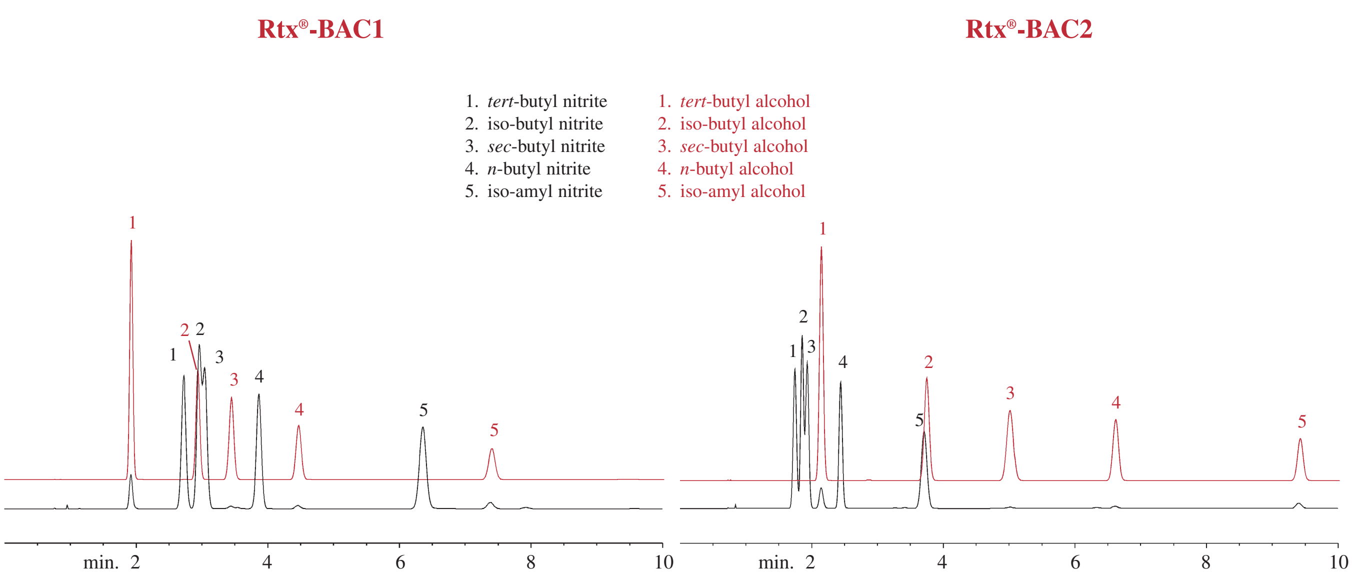
Fast analysis times for volatile anesthetics on the Rtx®-BAC1 and Rtx®-BAC2 columns.



30m, 0.53mm ID, 3.0µm Rtx®-BAC1 (cat.# 18001) and 30m, 0.53mm ID, 2.0µm Rtx®-BAC2 (cat.# 18000). 1.0mL headspace sample; **Oven temp.:** 40°C (hold 5 min.) to 240°C @ 5°C/min.; **Inj. & det. temp.:** 240°C; **Carrier gas:** He; **Linear velocity:** 65cm/sec.

Figure 3

Complete screening and confirmation for alkyl nitrites and metabolites on the Rtx®-BAC1 and Rtx®-BAC2 columns.



30m, 0.53mm ID, 3.0µm Rtx®-BAC1 (cat.# 18001) and 30m, 0.53mm ID, 2.0µm Rtx®-BAC2 (cat.# 18000). 1.0mL headspace sample; **Oven temp.:** 40°C (hold 5 min.) to 240°C @ 5°C/min.; **Inj. & det. temp.:** 240°C; **Carrier gas:** He; **Linear velocity:** 65cm/sec.

Industrial Solvents

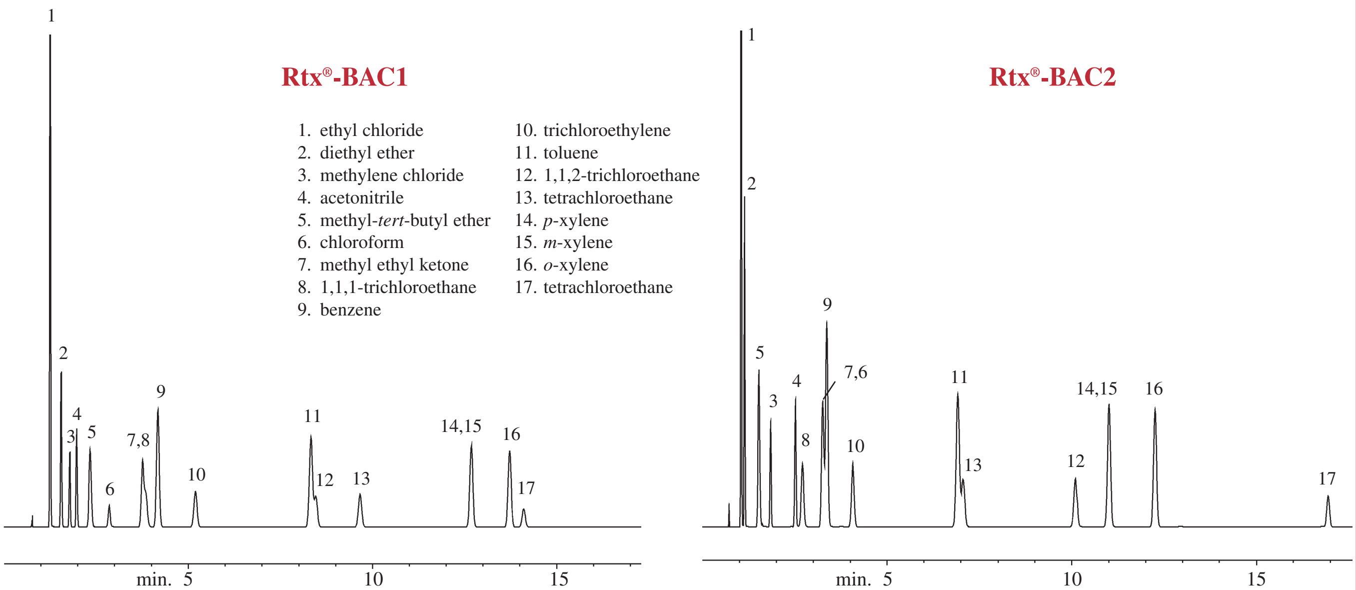
Industrial solvents are the most likely VOCs to be abused. Industrial solvents are available in purified form or as solvents in many household products. Toluene is the most commonly abused industrial solvent and is used in many products such as paints or glues (Figure 4).

Petroleum Hydrocarbons

Distilled petroleum fractions are used as carrier solvents for many commercial products. Distilled fractions, like mineral spirits, are used in products like pesticides, herbicides, paints, lacquers, thinners, and household cleaning products. Inhalation, ingestion or adsorption through the skin can produce detectable concentrations of a variety of individual hydrocarbons (Figure 5).

Figure 4

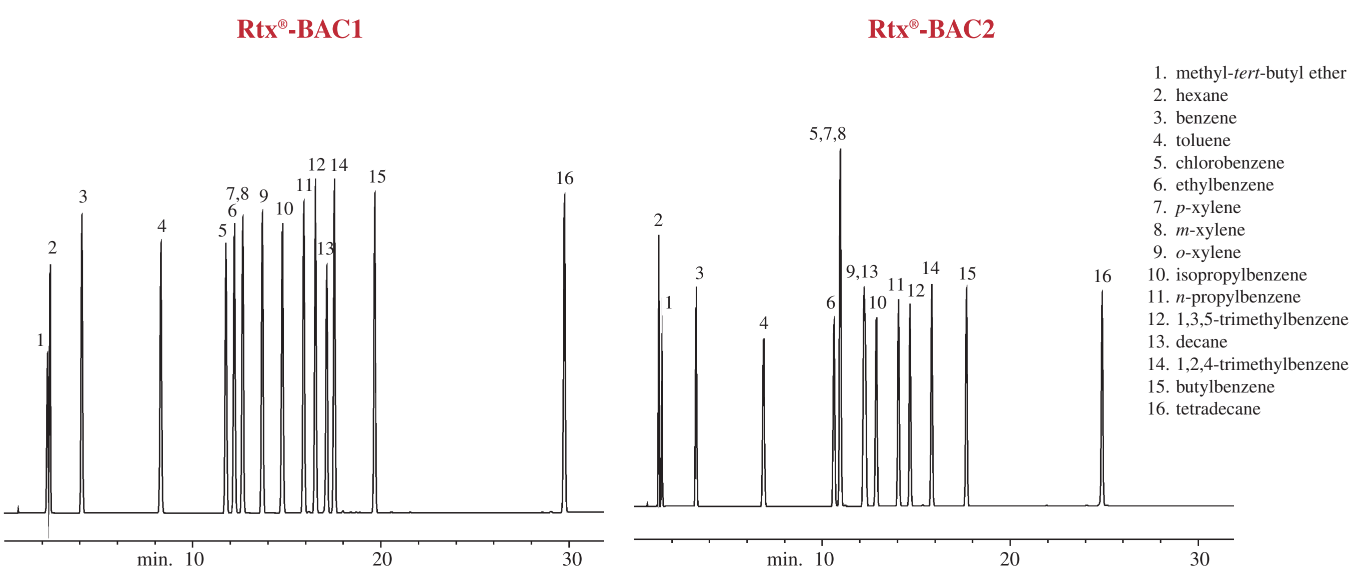
Elution order changes for common industrial solvents on the Rtx®-BAC1 and Rtx®-BAC2 columns.



30m, 0.53mm ID, 3.0µm Rtx®-BAC1 (cat.# 18001) and 30m, 0.53mm ID, 2.0µm Rtx®-BAC2 (cat.# 18000). 1.0mL headspace sample;
Oven temp.: 40°C (hold 5 min.) to 240°C @ 5°C/min.; **Inj. & det. temp.:** 240°C; **Carrier gas:** He; **Linear velocity:** 65cm/sec.

Figure 5

The Rtx®-BAC1 and Rtx®-BAC2 columns have good thermal stability for analyzing higher boiling hydrocarbons.



30m, 0.53mm ID, 3.0µm Rtx®-BAC1 (cat.# 18001) and 30m, 0.53mm ID, 2.0µm Rtx®-BAC2 (cat.# 18000). 1.0mL headspace sample;
Oven temp.: 40°C (hold 5 min.) to 240°C @ 5°C/min.; **Inj. & det. temp.:** 240°C; **Carrier gas:** He; **Linear velocity:** 65cm/sec.

Results

All of the compounds involved in the study exhibited good peak shape and response when analyzed by GC on either stationary phase. Both columns were programmed to 240°C without an appreciable increase in stationary phase bleed, and they analyzed some of the higher boiling point compounds found in the heavier petroleum distillates. Each stationary phase exhibited a unique selectivity for individual compounds. Coeluting compounds on one stationary phase were resolved on the complimentary stationary phase.

Conclusions

Inhalant abuse can be detected accurately by analyzing biological samples using headspace sampling combined with gas chromatography. When used in a dual-column setup, the Rtx®-BAC1 and Rtx®-BAC2 columns are very effective for identifying and confirming the presence of VOCs for detection of inhalant abuse.

References

1. National Institute on Drug Abuse, Research Report Series, Inhalant Abuse, June 6, 1996.

Table I: Inhalant Retention Times (Columns and Conditions Listed in Figure 1)

Compound	Rtx®-BAC1 Elution Order	Rtx®-BAC1 Ret. Time (min.)	Rtx®-BAC2 Elution Order	Rtx®-BAC2 Ret. Time (min.)
methanol	1	1.017	5	1.237
acetaldehyde	2	1.146	1	1.063
ethyl chloride	3	1.275	2	1.071
ethanol	4	1.299	8	1.648
diethyl ether	5	1.574	4	1.167
isopropanol	6	1.607	15	1.945
isoflurane	7	1.661	13	1.922
methylene chloride	8	1.805	11	1.849
Freon® 113	9	1.864	3	1.145
enflurane	10	1.891	16	2.081
tert-butyl alcohol	11	1.926	17	2.154
acetone	12	1.992	10	1.787
acetonitrile	13	1.997	20	2.553
n-propanol	14	2.191	25	3.130
halothane	15	2.267	18	2.383
methyl *tert*-butyl ether	16	2.366	7	1.554
hexane	17	2.495	6	1.386
tert-butyl nitrite	18	2.736	9	1.750
chloroform	19	2.870	27	3.290
sec-butyl alcohol	20	2.962	30	3.793
isobutyl nitrite	21	2.973	12	1.853
sec-butyl nitrite	22	3.059	14	1.939
isobutyl alcohol	23	3.460	32	5.100
tetrahydrofuran	24	3.736	24	2.845
methyl ethyl ketone	25	3.768	26	3.271
ethyl acetate	26	3.800	23	2.785
carbon tetrachloride	27	3.842	21	2.565
1,1,1-trichloroethane	28	3.869	22	2.729
n-butyl nitrite	29	3.879	19	2.469
benzene	30	4.186	28	3.392
n-butyl alcohol	31	4.565	33	6.747
trichloroethylene	32	5.205	31	4.084
isoamyl nitrite	33	6.377	29	3.728
methoxyflurane	34	7.279	36	7.219
isoamyl alcohol	35	7.428	38	9.447
toluene	36	8.358	34	6.944
1,1,2-trichloroethane	37	8.498	39	10.138
methyl isobutyl ketone	38	9.510	37	7.964
tetrachloroethylene	39	9.681	35	7.081
chlorobenzene	40	11.810	41	11.012
ethylbenzene	41	12.279	40	10.704
p-xylene	42	12.726	42	11.038
m-xylene	43	12.727	43	11.046
o-xylene	44	13.733	44	12.280
tetrachloroethane	45	14.106	50	16.968
isopropylbenzene	46	14.845	46	12.962
n-propylbenzene	47	15.966	47	14.124
1,3,5-trimethylbenzene	48	16.565	48	14.711
decane	49	17.166	45	12.369
1,2,4-trimethylbenzene	50	17.586	49	15.904
butylbenzene	51	19.739	51	17.732
tetradecane	52	29.806	52	24.950

Product Listing

Rtx®-BAC1 GC Columns

length	ID	df (µm)	cat.#
30m	0.53mm	3.0	18001
30m	0.32mm	1.8	18003

Rtx®-BAC2 GC Columns

length	ID	df (µm)	cat.#
30m	0.53mm	2.0	18000
30m	0.32mm	1.2	18002

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Other Trademarks: Freon—E.I. du Pont de Nemours & Co., Inc.