APPLY THESE FUNDAMENTALS TO PERFORM RELIABLE AIR QUALITY TESTS

Together, the Agilent 5977/7890B Series GC/MSD and Markes TD systems allow you to take consistent air samples and confidently test them for a variety of contaminants.

MARKES international

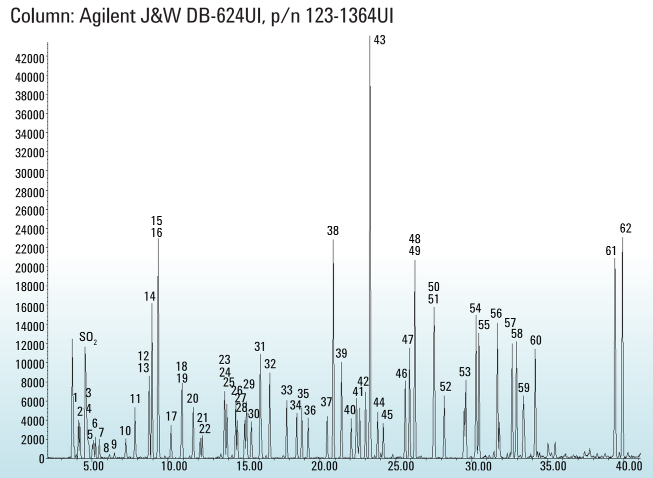
MEASURING VOLATILES IN AIR: US EPA METHOD TO-17

US Clean Air Act regulations have identified specific Hazardous Air Pollutants (HAPs), also known as air toxics. These analytes cover a wide range of polarities and volatilities, and are most effectively monitored using pumped sampling onto multisorbent tubes, followed by automated TD-GC/MS (scan) analysis.

TO-17-type methods, which are based on pumped air monitoring, facilitate the simultaneous analysis of non-polar and polar organic vapors – including volatile and semi-volatile components.

Air toxics in urban air

Column: Agilent J&W DB-624UI, p/n 123-1364UI



Analysis of urban air toxics: Splitless analysis of a 1-liter pumped sampling of air toxics standard (1 ppb) using ATA tubes. Note the extracted mass ion 45 for IPA, which demonstrates excellent peak shape. See Markes Technical note TDTS 86a for method details.

1. Propylene
2. Dichlorodifluoromethane
3. 1,2-Dichlorotetrafluoroethane
4. Methyl chloride
5. 1,2-Dichloroethane
6. 1,3-Butadiene
7. Vinyl chloride
8. Methyl bromide (bromomethane)
9. Chloroethane
10. Trichlorofluoromethane
11. Ethanol
12. 1,2-Dichloroethylene
13. 1,1,2-Trichlorotrifluoroethane (Freon 113)
14. Acetone
15. Carbon disulfide
16. Isopropyl alcohol
17. Methylene chloride
18. Tert-butyl methyl ether
19. n-Hexane
20. 1,1-Dichloroethane
21. Vinyl acetate
22. C is-1,2-Dichloroethylene
23. Methyl ethyl ketone
24. Ethyl acetate
25. Tetrahydrofuran
26. Chloroform
27. 1,1,1-Trichloroethane
28. Cyclohexane
29. Carbon tetrachloride
30. Benzene
31. n-Heptant
32. Trichloroethylene
33. 1,2-Dichloropropane
34. 1,4-Dioxane
35. Bromodichloromethane
36. Trans-1,3-dichloropropene
37. Methyl isobutyl ketone
38. Toluene
39. C is-1,3-Dichloropropene
40. Trans-1,2-Dichloroethylene
41. 1,1,2-Trichloroethane
42. Tetrachloroethylene
43. Methyl n-butyl ketone
44. Dibromochloromethane
45. 1,2-Dibromoethane
46. Chlorobenzene
47. Ethylbenzene
48. m-Xylene
49. p-Xylene
50. o-Xylene
51. Styrene
52. Tribromomethane
52. 1,1,2,2-Tetrachloroethane
54. 1,2,4-Trimethylbenzene
55. 1,3,5-Trimethylbenzene
56. 1-Ethyl-4-methyl benzene
57. 1,2-Dichlorobenzene
58. 1,3-Dichlorobenzene
59. alpha-Chloromethylbenzene
60. 1,4-Dichlorobenzene
61. 1,2,4-Trichlorobenzene
62. Hexachloro-1,3-butadiene

OZONE PRECURSORS IN AMBIENT AIR

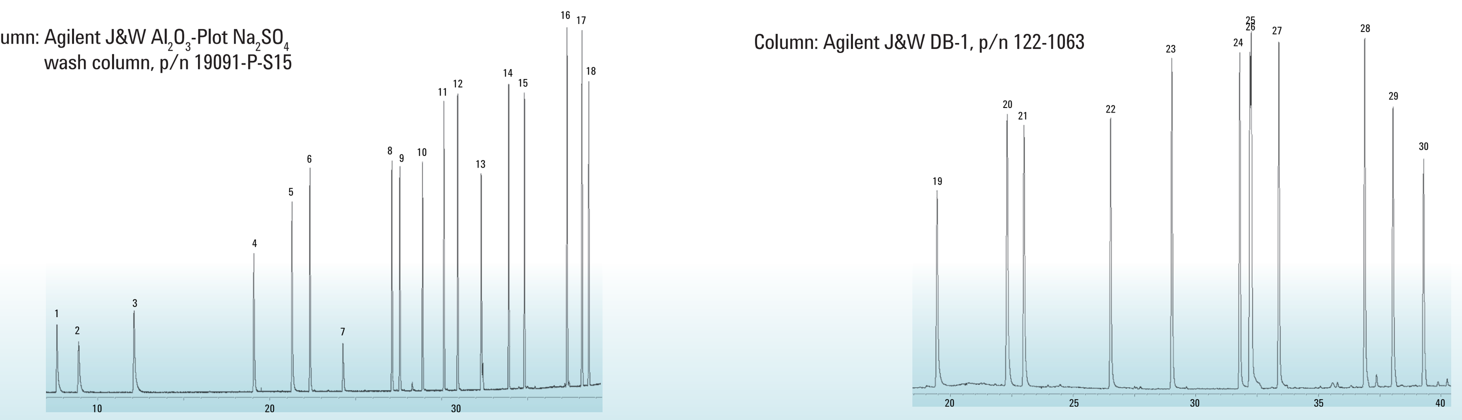
C_2 to C_{10} hydrocarbons from car exhausts have been identified as precursors to the formation of street-level ozone and urban smog. US, European, and other regulators require round-the-clock monitoring of these compounds in major urban areas, particularly during the summer months.

In addition, regulations developed in response to the Kyoto protocol on greenhouse gases require the monitoring of trace-level ultra-volatile compounds with high global warming and ozone-depleting potential. These include perfluorinated hydrocarbons (such as CF_4 and C_2F_6), the tracer gas SF_6, and N_2O. Unfortunately, these compounds begin to boil at -128 °C – and are extremely difficult to trap, concentrate, and measure at low levels; therefore, an online sampling system is required.

Analysis of C_2 to C_{10} hydrocarbons in ambient air

Column: Agilent J&W Al_2O_3-Plot Na_2SO_4 wash column, p/n 19091-P-S15

Column: Agilent J&W DB-1, p/n 122-1063



1. Ethane
2. Ethene
3. Propane
4. Propene
5. 2-Methylpropane
6. n-Butane
7. Acetylene
8. trans-But-2-ene
9. But-1-ene
10. cis-But-2-ene
11. 2-Methylbutane
12. Pentane
13. Buta-1,3-diene
14. trans-Pent-2-ene
15. Pent-1-ene
16. 2-Methylpentane
17. Isoprene
18. n-Hexane
19. Benzene
20. 2,2,4-Trimethylpentane
21. n-Heptane
22. Toluene
23. Octane
24. Ethylbenzene
25. m- & p-Xylene
26. m- & p-Xylene
27. o-Xylene
28. 1,3,5-Trimethylbenzene
29. 1,2,4-Trimethylbenzene
30. 1,2,3-Trimethylbenzene

To see more examples of Ultra volatile analysis, please see Markes Technical note 16. Dual FID dual column set up with UNITY Air Server.

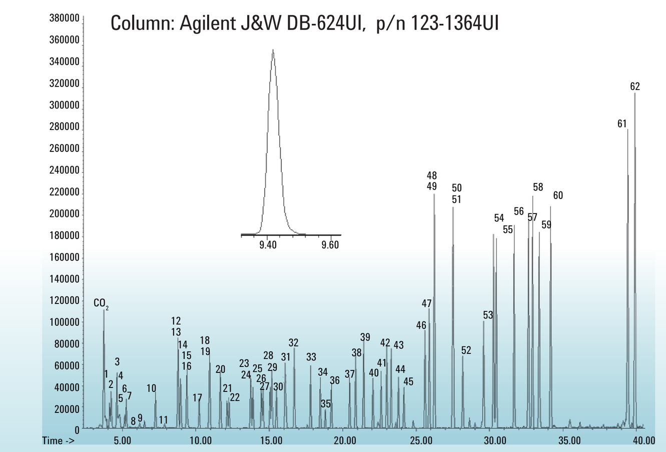
URBAN AIR TOXICS: TO-14 AND TO-15

EPA Methods TO-14 and TO-15 cover the testing of ambient air for toxic organic compounds. Generally, TO-14 is limited to the analysis of non-polar compounds, while TO-15 is larger in scope and better defined for analyzing VOCs in air and other gaseous matrices.

Canisters are ideally suited for sampling ultra-volatile organics, such as freons and C_2 hydrocarbons, which are difficult to trap on sorbent tubes at ambient temperature. They also make grab sampling more convenient.

TO-15 air toxics in urban air

Column: Agilent J&W DB-624UI, p/n 123-1364UI



Instumentation: Markes CIA Advantage with Agilent 7980B GC and 5977A MSD. Splitless analysis of 1 L x 1 ppb air toxics standard using EPA method TO-15 with canister sampling. Note the excellent peak shape in the close-up of extracted mass ion 45 for IPA. See Markes Technical note 81a for method details.

1. Propylene
2. Dichlorodifluoromethane
3. 1,2-Dichlorotetrafluoroethane
4. Methyl chloride
5. 1,2-Dichloroethane
6. 1,3-Butadiene
7. Vinyl chloride
8. Methyl bromide (bromomethane)
9. Chloroethane
10. Trichlorofluoromethane
11. Ethanol
12. 1,2-Dichloroethylene
13. 1,1,2-Trichlorotrifluoroethane (Freon 113)
14. Acetone
15. Carbon disulfide
16. Isopropyl alcohol
17. Methylene chloride
18. Tert-butyl methyl ether
19. n-Hexane
20. 1,1-Dichloroethane
21. Vinyl acetate
22. Cis-1,2-Dichloroethylene
23. Methyl ethyl ketone
24. Ethyl acetate
25. Tetrahydrofuran
26. Chloroform
27. 1,1,1-Trichloroethane
28. Cyclohexane
29. Carbon tetrachloride
30. Benzene
31. n-Heptane
32. Trichloroethylene
33. 1,2-Dichloropropane
34. 1,4-Dioxane
35. Bromodichloromethane
36. Trans-1,3-dichloropropene
37. Methyl isobutyl ketone
38. Toluene
39. Cis-1,3-Dichloropropene
40. Trans-1,2-Dichloroethylene
41. 1,1,2-Trichloroethane
42. Tetrachloroethylene
43. Methyl n-butyl ketone
44. Dibromochloromethane
45. 1,2-Dibromoethane
46. Chlorobenzene
47. Ethylbenzene
48. m-Xylene
49. p-Xylene
50. o-Xylene
51. Styrene
52. Tribromomethane
53. 1,1,2,2-Tetrachloroethane
54. 1,2,4-Trimethylbenzene
55. 1,3,5-Trimethylbenzene
56. 1-Ethyl-4-methyl benzene
57. 1,2-Dichlorobenzene
58. 1,3-Dichlorobenzene
59. α-Chloromethylbenzene
60. 1,4-Dichlorobenzene
61. 1,2,4-Trichlorobenzene
62. Hexachloro-1,3-butadiene

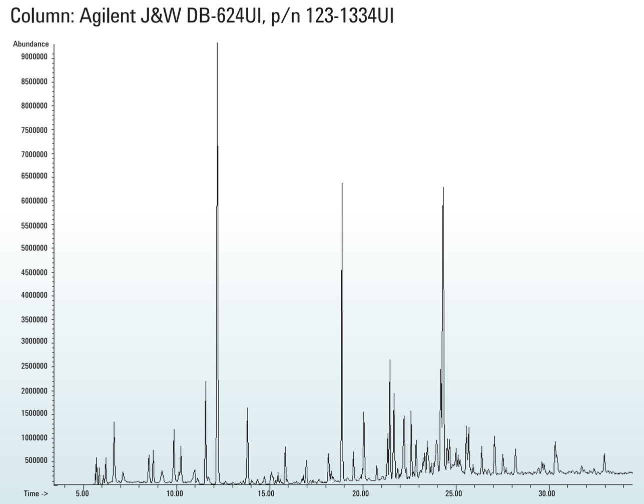
INDOOR AIR QUALITY: US EPA METHOD TO-17, EN ISO 16017-1, ASTM D 6196

Most people in the developed world spend an estimated 90% of their time indoors. Regulators and scientists around the world are increasingly concerned about the impact of poor indoor air quality (IAQ) on human health and comfort. Sources of indoor pollutants may range from interior decorations, furnishings and carpets, to construction materials, and even the soil upon which the structure was built.

Recent environmental developments (e.g. the EC directive on Energy Performance of Buildings) are putting further pressure on IAQ by reducing building ventilation rates. In this example, pumped tube samplers were used with subsequent TD-GC/MS analysis for profiling of ppt-ppb level VOCs.

Profiling indoor air quality (IAQ)

Column: Agilent J&W DB-624UI, p/n 123-1334UI



TD system: Series 2 (ULTRA-)UNITY or TD-100
Desorption: 5 min at 280 °C (depends on sorbent)
Trap: To match tube (25 to 300 °C)
Split: During trap desorption only ~15:1
Analysis: GC/MS (scan)

TD-GC/MS analysis of clean indoor air pumped onto a multi-sorbent tube. To find out more about sampling in indoor environments, see Markes Technical TDTS 28.

Agilent 5977/7890B Series GC/MSD and Markes Unity Series 2 TD

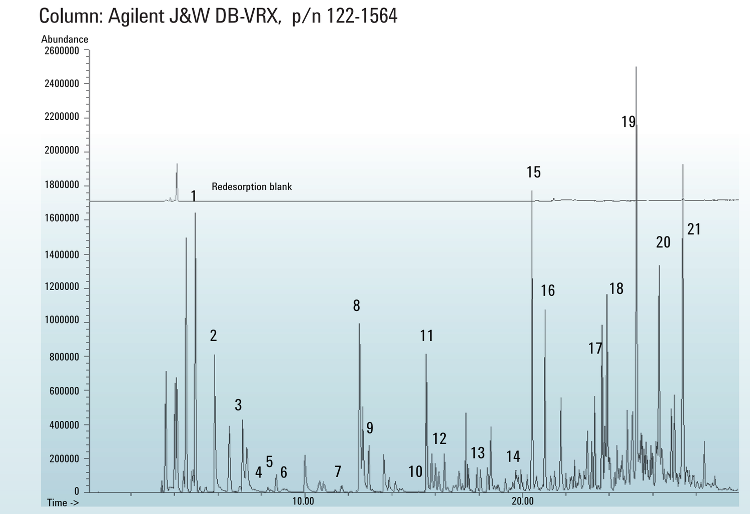
ODOROUS AND TOXIC LANDFILL GAS

The Intergovernmental Panel on Climate Change (IPCC) estimates that 2% of the world's greenhouse gas emissions are caused by landfills.

Consequently, new regulations in Europe and Asia require the monitoring of trace toxic and odorous compounds in landfill gas. These analyses can be performed online, or by active or passive sampling onto sorbent tubes.

Odors and toxics in landfill gas

Column: Agilent J&W DB-VRX, p/n 122-1564



1. Vinyl chloride (Toxic)
2. Chloroethane
3. 1-pentene
4. Furan
5. Dimethyl sulphide
6. Carbon disulphide
7. 1,1-dichloroethane
8. Butan-2-ol
9. 1,1- & 1,2-dichloroethene
10. 1,1,1-trichloroethane
11. Butan-1-ol
12. Benzene
13. Trichloroethene
14. Dimethyl disulphide
15. Toluene
16. Butanoic acide ethyl ester
17. Xylene
18. Nonane
19. a-pinene
20. Decane
21. Limonene

Trace-level identification of target analytes and major components in 100 mL of landfill gas. The patented inert valve within the Markes Unity Series 2 TD facilitates subsequent offline analysis of the sampled tubes by allowing you to select low flow path temperatures (120 °C in this example). See Markes Technical TDTS 47.

Tubes

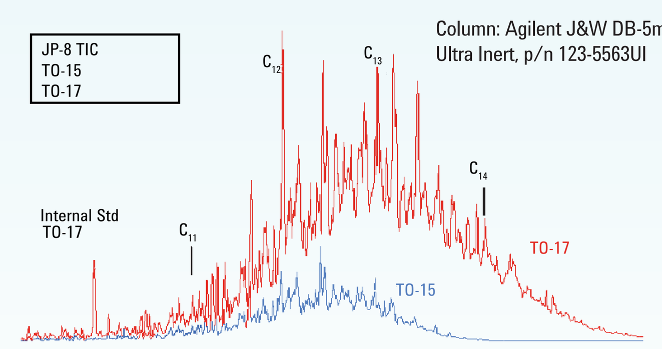
ADVANTAGES	DRAWBACKS
High versatility	Not suitable for the most volatile freons or C_2 hydrocarbons.
Compliance with standard methods, and complete retention of all but the most volatile organic compounds	
Using multiple sorbents, along with backflush desorption, facilitates simultaneous desorption/recovery of analytes of different volatilities	

Tube sampling vs. canister sampling

Given the complexity and variability of organic vapors in air, it is impossible for one sampling approach to suit every monitoring scenario. The two most common sampling strategies include:

- Pumped or diffusive (passive) sampling onto sorbent tubes
- Pumped into a coated stainless steel canister or plastic air tight bag

(Pictured right) Profiles of JP-8 kerosene-contaminated soil gas obtained using canister sampling and TO-15 analysis (blue) and sorbent tube sampling with TO-17 analysis (red). Soil gas measurements assess the risk of vapor intrusion into nearby buildings. See Markes Technical notes TDTS 79 and 80 for method details.



Passivated canisters

ADVANTAGES	DRAWBACKS
Ideal for highly volatile chemicals (such as C_2 hydrocarbons) and non-polar compounds (such as Freons)	Prone to poor recovery of less volatile, or more polar, species
Easy air sampling by releasing a single valve	Require stringent cleaning – including repeated evacuation and purging – between uses
Canisters can be re-used indefinitely	Canisters can be expensive, as well as difficult to transport and store
	TWA sampling is not easy with a canister and requires an elaborate set-up defined by EPA method TO-15

Ensuring an inert GC flow path is critical – and now, easy to achieve

By minimizing flow path activity through proprietary chemistries, **Agilent Inert Flow Path solutions** ensure accurate quantification and high sensitivity for trace-level analysis.

- **Ultra Inert liners** – with or without deactivated glass wool – are certified to provide low surface activity and highly reproducible sample vaporization, facilitating delivery of active analytes.
- **Inert Inlet weldments** are treated to prevent adsorption and degradation.
- **Ultra Inert gold-plated inlet seals** are manufactured using metal injection molding, gold plating, and application of our Ultra Inert chemistry to produce a leak-free seal that reduces active analyte adsorption.
- **Inert MS source** ensures sensitivity when analytes reach the mass spectrometer.
- **Capillary Flow Technology purged union** lets you backflush high boilers in heavy-matrix samples, increasing column lifetime and system productivity.
- **UltiMetal Plus Flexible Metal ferrules** are the *only* ferrules that won't introduce active sites into the flow path.
- **Agilent J&W Ultra Inert GC columns** are rigorously tested to ensure exceptionally low bleed and consistently high inertness for optimal active analyte delivery to the GC or MS detector.
- **Gas Clean purifier** removes oxygen, moisture, hydrocarbons, and other contaminants.

Don't miss a thing in your GC analysis.
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To learn more about the best practices for environmental and workplace air monitoring, visit agilent.com/chem/air

The Measure of Confidence

Agilent Technologies