

Thermal Desorption Accessories & Consumables



World-leading products for thermal desorption



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Ordering information

Ordering from Markes couldn't be simpler, either by phone, fax, email or online. Payment is accepted by credit card (Mastercard or Visa) on account. If you need help with your order, simply contact one of our highly experienced chemists or customer service agents at either of Markes' main sales locations:

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Orders may also be placed with any of our global distributors:

www.markes.com/Global-Distributors.aspx



Introduction to Markes International

Formed in 1997, Markes International is the world's foremost supplier of thermal desorption (TD) equipment, accessories and consumables for monitoring trace toxic and odorous chemicals in air, gas and materials. Serving a wide range of markets from environmental health & safety to materials testing, and from food/flavour/fragrance to defence/forensic, Markes' global customer base includes major industry, government agencies, academia and the service laboratory sector.

Markes is globally recognised for its innovation, high-quality products, technical expertise and customer service within the field of analytical thermal desorption. To complement its industry-leading range of instruments, Markes also has an unrivalled range of TD accessories and consumables. Many of these are also compatible with thermal desorption systems from other manufacturers.

Markes' factory, technical centre and headquarters is located in the UK, and in 2011, Markes expanded this and its USA operation (Markes International, Inc.), adding extra laboratory and demonstration facilities. In 2013 the company became a company of the Schauenburg International Group, and opened Markes International GmbH near Frankfurt, Germany.

Quality-assured accessories and consumables from the TD experts

When it comes to accessories and consumables for thermal desorption, we offer our customers nothing but the best:

- Application expertise that is second-to-none
- Fast delivery and excellent customer service
- Innovative technologies and product enhancements
- World-leading, patented technologies for thermal desorption
- Stringent quality control of our manufacturing procedures
- ISO 9001 accreditation
- Worldwide distributor and user base
- Online shop for simple and rapid ordering
- Custom service – if you want something special, we can do it.

And most importantly... a 100% quality guarantee.

If you're not satisfied with the products we supply, we will provide replacements or give you your money back, whichever you prefer.

Sorbent tubes

Markes International is the world's leading supplier of TD systems and associated sampling equipment. In this section, we have used our expertise to select the best sorbent tubes for a wide range of air and vapour monitoring applications.

Backed up by fast and friendly service, Markes' tubes provide optimum sampling and analytical performance. Our range includes everything from cost-effective packages of industry-standard tubes to the last word in sorbent tube innovation.

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Markes' sorbent tubes – The best in the business

4

Markes' sorbent tubes – Quality assured

As well as the inherent advantages of buying your thermal desorption accessories from the TD experts at Markes, we offer an outstanding service for sorbent tubes.

Order your sorbent tubes from us and benefit from:

- ✓ The world's widest range of sorbent tubes and related accessories
- ✓ Our capping and conditioning service, for tubes that are ready to use on delivery
- ✓ Stringent quality control of every tube
- ✓ Markes' ISO 9001-accredited manufacturing procedures
- ✓ All tubes etched with a unique serial number for easy identification, and barcoded for rapid automation
- ✓ Flexible options for tube banding, etching and labelling
- ✓ Great value for money
- ✓ Online shop for simple, secure and rapid ordering
- ✓ Custom service – if you want something special, we can do it.



***Outstanding service from an outstanding company –
Buy your sorbent tubes from the TD experts at Markes***

Sorbent tube options

Markes supplies an unrivalled choice of tubes. If you would like advice about which sorbents or sampling options to choose, please contact our specialists at consumables@markes.com, or consult Application Note TDTS 5^{p92}.

Our tubes are packed to a tolerance of $\pm 2.5\%$ or better, and each one is flow-checked prior to shipment. For quality assurance, every pack of tubes comes with a signed-and-dated quality report.

Stainless steel tubes

Stainless steel tubes are suitable for the majority of VOC air monitoring applications across a wide range of compound types and atmospheric concentrations. They can be used for both pumped and diffusive (passive) sampling. For pumped sampling applications, use of more than one sorbent bed can greatly extend the analyte range.

Inert-coated stainless steel tubes

Inert-coated stainless steel tubes have an extremely thin inert layer bonded to the metal surfaces of the tube and the front sorbent-retaining gauze. This makes these tubes suitable for sampling thermally labile and reactive compounds. As the tube dimensions are not affected by this coating, they also remain compatible with diffusive sampling.

Glass tubes

Markes' glass tubes are also widely used for sampling reactive species, and have a sorbent-retaining restriction 15 mm from one end for optimum performance both during air sampling and thermal desorption analysis. Specially treated glass tubes are also available for compatibility with amines.

Glass tubes are also popular for direct desorption of materials^{p62}, as they allow easy assessment of the state of the sample after desorption. In this case, we recommend the use of tubes with a restriction 30 mm from the end, because this helps ensure the sample material is positioned correctly within the tube.

DAAMS tubes

Depot Area Air Monitoring Systems (DAAMS) tubes can be constructed from either glass, stainless steel or inert-coated stainless steel. We supply both regular and high-flow DAAMS tubes with 6 mm ends¹, but are also happy to discuss your specific DAAMS tube requirements.

If you've got any questions or need any advice, please contact us (consumables@markes.com)



Specialist DAAMS tubes – also available barcoded

- Standard DAAMS tubes: 4½" (115 mm) long × 6 mm o.d.
High-flow DAAMS tubes: 4½" (115 mm) long × 10 mm o.d. with 6 mm o.d. ends (available in glass only).

SafeLok™ technology for sorbent tubes

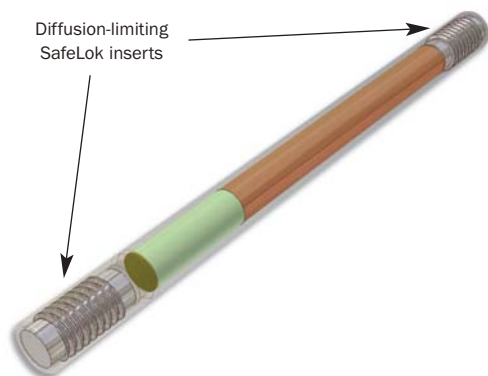
Markes' patented diffusion-locking technology provides unrivalled protection for trace and toxic samples.

SafeLok tubes incorporate a diffusion-locking insert at each end, preventing ingress or loss of volatiles when trace-level samples are being uncapped and recapped in the laboratory. This allows the integrity of clean and sampled tubes to be maintained throughout storage, transport and analysis.

By eliminating diffusive ingress, SafeLok tubes allow pumped sampling over extended periods at low flow rates (1–2 mL/min). The SafeLok inserts also make it safe to handle tubes that have been used to collect very toxic compounds.

SafeLok tubes are available in stainless steel or inert-coated stainless steel, and contain the same mass and bed length of sorbent as standard tubes. They are fully compliant with key international methods for pumped sampling, *i.e.* published data on retention and safe sampling volume data (see Application Note TDTS 20 for further details^{p92}).

SafeLok tubes are compatible with all Markes' TD instrumentation and most standard tube fittings and accessories, including Markes' ACTI-VOC sampling pump^{p32}, storage caps^{p20}, DiffLok caps^{p21}, TubeTAG^{p7}, the TC-20 conditioning unit^{p50}, and the MTS-32 sequential sampler^{p33}.



Schematic of SafeLok tube packed with two sorbents



SafeLok and standard tubes

SafeLok tubes – Guaranteeing sample integrity

TubeTAG™ – The ultimate in sorbent tube informatics

Markes' patented TubeTAG system is the world's first electronic tagging and labelling system for thermal desorption tubes. TubeTAG allows tube- and sample-specific information to be electronically associated with a particular tube for the duration of a monitoring project, or for the whole life of the tube.

TubeTAG provides a cost-effective and sophisticated solution for recording tube history and for fail-safe tracking of tubes in transit during field monitoring projects. Radio-frequency identification (RFID) technology allows information such as sample collection details to be associated with each tag. Information can be written to the tags in the field, and all stored information downloaded once back in the laboratory.

Markes' thermal desorption autosamplers include TubeTAG read/write capability as standard, but tags can alternatively be removed for compatibility with other systems (see the TAGLok tool on page 19).

Note that pre-tagged tubes require either TAG^{SCRIBE} (see page 19) or a TAG-ready Markes TD autosampler to allow full functionality.

For further information about TubeTAG, please contact one of our specialists (enquiries@markes.com), or visit our website to download the brochure.



Track the history of every tube for optimum quality assurance

Tube labelling – Standard features

Tube labelling is provided as standard on Markes tubes¹, and complements our innovative TubeTAG technology^{p19}. Tube labelling helps you keep track of samples and tube stock, and is a major step forward in routine quality control for TD laboratories.

Labels are laser-etched onto metal tubes, and applied with kiln-fired ceramic decal on glass tubes (black on a white background), ensuring that they are both clear and permanent. Our standard tube labels comprise the following three components:

Serial number

Every sorbent tube has a unique serial number on the side to allow rapid, visual identification every time.

The serial number is presented in a large clear font on both metal and glass tubes, and is visible even when the tube is capped and sealed.

Barcoding

The unique tube serial number also appears on the side of each tube in barcode form. This reduces errors when recording and tracking tubes, and eliminates time-consuming manual data entry. It is especially useful for large-scale monitoring studies and for laboratories with significant tube stock.

Markes' barcodes use Code 128 symbology, which, with its higher information density and check-sum feature, is fast becoming the international standard. For rapid and reliable barcode-scanning, we especially recommend one of the high-performance barcode readers shown on the next page.

Markes also offers a barcoding service for existing metal tubes. Please contact enquiries@markes.com for more details.

Sampling arrow

The side of every sorbent tube has an arrow indicating the direction of the air/gas sampling flow. This minimises risk of errors during field monitoring.



Markes' tube labelling – Tube tracking made simple

1. Excluding glass DAAMS tubes and glass tubes with a restriction at 30 mm.

Tube labelling – Further options

In addition to the standard tube labelling features described on the previous page, Markes offers you the ability to tailor labels on metal tubes to your own requirements¹. These options include alphanumeric labelling and tube banding – just let us know what you'd like.

Alphanumeric etching (metal tubes only)

Alphanumeric etching allows you to specify up to 10 characters (A–Z, 0–9) to be laser-etched on the side of metal tubes. Popular examples of etching include specification of:

- The maximum safe temperature for the sorbents (e.g. TMax 320C)
- The tube type (e.g. Tnx/C5TD)
- Details of the company or department (e.g. Jones Chem).

Just include clear details of your special etching requirements with your order, or contact one of our technical specialists to discuss the best option for you.



Banding (metal tubes only)

Banding is perfect for rapid visual identification of sorbent tubes – for example, a particular sorbent combination or tubes associated with a specific project or application.

Metal tubes can be permanently marked with up to five black bands. Specify your tube banding requirements on your order, or contact a Markes specialist to discuss your requirements in more detail.



1. Please note that tubes with alphanumeric etching and banding are made to order, and are not available as stock items.

Barcode readers for sorbent tubes

We supply a range of barcode readers for accurate and reliable reading of barcodes on Markes' metal and glass sorbent tubes.

We offer corded USB-powered barcode readers for at-screen use, as well as cordless models (with a docking station) for remote operation. Advanced barcode readers have a screen for automatic display of scanned information, and an integral memory to hold information about the tubes scanned prior to download onto a PC.

Contact us for more information about the range of barcode readers we offer, and to identify the best one for your application.



Examples of barcode readers available from Markes

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Our most popular sorbent tubes

All these tubes are industry-standard size (3½" × ¼"), and are supplied in packs of 10

Empty tubes

Description (all in packs of 10)	Tube code
Stainless steel	C0-AXXX-0000
Inert-coated stainless steel	C0-CXXX-0000
Glass, with restriction at 15 mm	C0-BXXX-0000
Glass, with restriction at 30 mm	C0-NXXX-0000
Glass, unrestricted	C0-FXXX-0000



Stainless steel tubes

Description (all in packs of 10)	Tube code	
	Unconditioned, without caps	Conditioned and capped
Packed with Tenax TA	C1-AXXX-5003	C1-AAXX-5003
Packed with Tenax TA/Carbograph 1TD	C2-AXXX-5032	C2-AAXX-5032
Packed with Carbograph 2TD/Carbograph 1TD	C2-AXXX-5126	C2-AAXX-5126
Packed with Carbograph 1TD/Carboxen 1003 (air toxics)	C2-AXXX-5270	C2-AAXX-5270
Packed with Tenax TA/Carbograph 1TD/Carboxen 1003 (universal)	C3-AXXX-5266	C3-AAXX-5266

Inert-coated stainless steel tubes

Description (all in packs of 10)	Tube code	
	Unconditioned, without caps	Conditioned and capped
Packed with Tenax TA	C1-CXXX-5003	C1-CAXX-5003
Packed with Tenax TA/SulfiCarb	C2-CXXX-5314	C2-CAXX-5314

Glass tubes, with restriction at 15 mm

Description (all in packs of 10)	Tube code	
	Unconditioned, without caps	Conditioned and capped
Packed with Tenax TA	C1-BXXX-5039	C1-BAXX-5039
Packed with Carbograph 1TD/Carboxen 1003 (air toxics)	C2-BXXX-5259	C2-BAXX-5259

Stainless steel tubes, fitted with SafeLok

Description (all in packs of 10)	Tube code	
	Unconditioned, without caps	Conditioned and capped
Packed with Tenax TA	C1-DXXX-5003	C1-DAXX-5003
Packed with Tenax TA/Carbograph 1TD/Carboxen 1003 (universal)	C3-DXXX-5266	C3-DAXX-5266

If you can't see what you're looking for here, have a look at the tube configurator on page 14, or contact us (enquiries@markes.com)

N.B. The tubes on this page use the following mesh sizes: Carbograph 1TD (40/60), Carbograph 2TD (40/60), Carboxen 1003 (60/80), SulfiCarb (40/70), Tenax TA (35/60).

Your quick guide to sorbent selection

Sorbent	Compound range	Temperature limits	Main features/comments
Carbograph 2TD Carbopack C Carbotrap C	n-C ₈ to n-C ₂₀	<ul style="list-style-type: none"> Up to 360 °C for analysis 380 °C for conditioning 	<ul style="list-style-type: none"> Hydrophobic Some activity Low background
Tenax TA	n-C _{6/7} to ~n-C ₃₀	<ul style="list-style-type: none"> 280–320 °C for analysis 330 °C for conditioning 	<ul style="list-style-type: none"> Inert and hydrophobic Very efficient release of high-boilers
Carbograph 1TD Carbopack B Carbotrap	n-C ₆ to n-C _{12/14}	<ul style="list-style-type: none"> Up to 360 °C for analysis 380 °C for conditioning 	<ul style="list-style-type: none"> Some activity (e.g. with monoterpenes) Hydrophobic Low background
Carbograph 5TD Carbopack X	Buta-1,3-diene to n-C ₇	<ul style="list-style-type: none"> Up to 360 °C for analysis 380 °C for conditioning 	<ul style="list-style-type: none"> Some activity Hydrophobic Extensive conditioning may be required to remove high-boiling contamination Low background
SulfiCarb	C ₃ to n-C ₆	<ul style="list-style-type: none"> Up to 360 °C for analysis Bring temperature up to 380 °C slowly during conditioning 	<ul style="list-style-type: none"> Replaces UniCarb – see page 28 for more details Moderate water retention Inert Pumped sampling: use weaker carbon sorbent in front to prevent irreversible contamination with high-boilers
Carboxen 1003	C ₂ to n-C ₆	<ul style="list-style-type: none"> Up to 360 °C for analysis Bring temperature up to 380 °C slowly during conditioning 	<ul style="list-style-type: none"> Moderate water retention Pumped sampling: use weaker carbon sorbent in front to prevent irreversible contamination with high-boilers
Carbosieve SIII	C ₂ to n-C ₅	<ul style="list-style-type: none"> Up to 360 °C for analysis Bring temperature up to 380 °C slowly during conditioning 	<ul style="list-style-type: none"> Significant water retention Pumped sampling: use weaker carbon sorbent in front to prevent irreversible contamination with high-boilers

Should you have any questions about sorbents, please contact our experts at enquiries@markes.com

Application-specific sorbent tubes

We've drawn on our analytical experience to suggest the optimum sorbent tubes for seven key applications.

All the tubes listed on these pages come in packs of 10, and are supplied conditioned and capped. Contact us if you'd like to check whether they'll be suitable for your application, or if you'd be interested in a modified tube type.

Soil gas/vapour intrusion

Soil gas tubes are ideal for identifying underground contamination sources and for assessing the potential risk to human health from vapour intrusion into nearby buildings. They are compatible with everything from light hydrocarbons to middle-distillate fuels.

Tube type	Stainless steel
Sorbent(s)	Quartz wool/Tenax TA/Carbograph 5TD
Tube code	C3-AAXX-5304
Target analytes	n-C ₄ to n-C _{30/32}



Air toxics

'Air toxics' range in volatility from propylene to hexachlorobuta-1,3-diene, and include polar as well as apolar organic compounds. The tubes specified below easily cover this range of analytes, and when used with Markes' TD system are perfect for complying with USA EPA Method TO-17.

Tube type	Glass
Sorbent(s)	Carbograph 1TD/Carboxen 1003 (air toxics)
Tube code	C2-BAXX-5259
Target analytes	C _{2/3} to n-C ₁₄



Tubes for monitoring unknown atmospheres

This optimised combination of three sorbents allows near-universal screening of (S)VOCs in uncharacterised indoor and outdoor environments, while the use of SafeLok technology makes these tubes very resistant to analyte losses and contamination.

Tube type	Stainless steel with SafeLok insert
Sorbent(s)	Tenax TA/Carbograph 1TD/Carboxen 1003
Tube code	C3-DAXX-5266
Target analytes	C _{2/3} to n-C _{30/32}



Odorous emissions

Sulfur compounds such as thiols have unpleasant odours even at trace concentrations, and are also thermally labile. They are indicative of meat decomposition, and are present in emissions from landfill sites, sewage farms and some industrial processes. Reliable detection of these challenging analytes requires both an inert-coated tube and a carefully optimised sorbent combination.

Tube type	Inert-coated stainless steel
Sorbent(s)	Tenax TA/SulfiCarb
Tube code	C2-CAXX-5314
Target analytes	Thiols (mercaptans)



Material emissions testing and indoor air

The material emissions tube detailed below extends the range of compounds that can be sampled and analysed quantitatively, and is particularly suitable for use with Markes' Micro-Chamber/Thermal Extractor^{P52}. It complies with recommendations in the latest edition of ISO 16000-6 (Annex D) for monitoring WVOCs, VOCs and SVOCs in material emissions and in indoor air.

Tube type	Stainless steel
Sorbent(s)	Quartz wool/Tenax TA/Carbograph 5TD
Tube code	C3-AAXX-5304
Target analytes	n-C ₄ to n-C _{30/32}



CWA monitoring

Tenax TA is the most widely used sorbent for monitoring chemical warfare agents (CWAs).

Tube type	Glass DAAMS
Sorbent(s)	Tenax TA
Tube code	C1-LXXX-7001
Target analytes	Most of the 'G' agents (GB, GD, GF, GA and homologues such as ethylsarin and crotylsarin), mustard gas (HD), VX and Russian VX, amongst others

HayeSep D is also used to monitor the derivitised G analogue of VX (obtained by passing VX over a pad impregnated with AgF).

Tube type	Glass DAAMS
Sorbent(s)	HayeSep D
Tube code	C1-LXXX-7003
Target analytes	G analogue of VX

Direct desorption of materials

The glass tubes recommended below guarantee correct positioning of material samples within the tube, and allow easy inspection of the state of the sample before and after analysis.

Tube type	Glass, with restriction at 30 mm
Sorbent(s)	—
Tube code	C0-NXXX-0000
Target analytes	—

Tried-and-tested monitoring solutions for challenging applications

Markes' tube configurator

Whatever combination of tube type and sorbent(s) you need, this tube configurator and associated code tables on page 15 will help you construct the correct part number.

Alternatively, let our thermal desorption specialists help you configure a bespoke sorbent tube for your application – see page 15.

Part numbers should be constructed using the following format, using the letters/numbers defined below:

CN-X₁X₂X₃X₄-####

Step	Code	Description
Prefix letter	C	
Number of sorbent beds (N)	0	Empty tube
	1	1 sorbent bed
	2	2 sorbent beds
	3	3 sorbent beds
Tube type (X₁)	A	Stainless steel tube, 3½" × ¼"
	B	Glass tube, 3½" × ¼", restriction at 15 mm
	C	Inert-coated stainless steel tube, 3½" × ¼"
	D	Stainless steel SafeLok tube, 3½" × ¼"
	E	Inert-coated stainless steel SafeLok tube, 3½" × ¼"
	F	Glass tube, 3½" × ¼", unrestricted
	G	Repacked tube
	H	Unpacked/repacked tube
	L	Glass DAAMS tube, 4½" × 6 mm
	M	Glass DAAMS tube, 4½" × 10 mm with 6 mm ends (high-flow)
	N	Glass tube, 3½" × ¼", restriction at 30 mm
	P	Glass tube, 3½" × 6 mm, unrestricted
	Q	Glass tube, 3½" × 6 mm, restriction at 15 mm
	R	Inert-coated glass tube, 3½" × ¼", restriction at 15 mm (for amine analysis)
Tube conditioning (X₂)	A	¼" tubes, conditioned and capped with brass storage caps
	B	6 mm tubes, conditioned and capped with brass storage caps
	C	TubeTAG-fitted ¼" metal tubes, conditioned and capped with brass storage caps
	D	TubeTAG-fitted ¼" glass tubes, conditioned and capped with brass storage caps
	E	TubeTAG-fitted 6 mm glass tubes, conditioned and capped with brass storage caps
	F	Tubes conditioned only (customer to supply caps)
	X	Tubes not conditioned or capped
TubeTAG (X₃)	A	TubeTAG attached to stainless steel tubes (¼")
	B	TubeTAG attached to glass tubes (both ¼" and 6 mm)
	X	No TubeTAG required
Tube labelling options (X₄)	A	Etching or banding (<i>metal tubes only</i>) – please contact us to discuss options
	X	No etching or banding required
Four-digit sorbent code	####	See page 15 for popular sorbent codes. For empty tubes use 0000

Hints and tips:

- ▶ Ensure you match the o.d. of your tubes (¼" or 6 mm) to the correct storage caps.
- ▶ If using the TubeTAG option, check that you've chosen the right storage caps for your tubes (stainless steel or glass).

Four-digit codes for popular sorbent combinations

To help you construct part numbers for industry-standard 3½" x ¼" sorbent tubes using the tube configurator, we've listed some popular sorbent combinations in the following tables.

Single-bed sorbent tubes

Sorbent	Metal tubes	Glass tubes
	Code	Code
Tenax TA	5003	5039
Tenax GR	5005	5041
Carbograph 1TD	5009	5045
HayeSep D	5153	5170
Carbograph 5TD	5015	5051
SulfiCarb	5312	5313
Carboxen 1003	5277	5258

Two-bed sorbent tubes

Sorbents ¹	Metal tubes	Glass tubes
	Code	Code
Quartz wool/Carbograph 2TD	5141	5134
Quartz wool/Tenax TA	5138	5189
Quartz wool/HayeSep D	5146	5196
Carbograph 2TD/Carbograph 1TD	5126	5197
Tenax TA/Carbograph 1TD (Hydrophobic)	5032	5068
Tenax TA/Carbograph 5TD	5149	5201
Tenax TA/SulfiCarb (Landfill gas/odorous emissions)	5314	5315
Carbograph 1TD/Carbograph 5TD	5180	5203
Carbograph 1TD/Carboxen 1003 (Air toxics)	5270	5259

Three-bed sorbent tubes

Sorbents ¹	Metal tubes	Glass tubes
	Code	Code
Quartz wool/Carbograph 2TD/Carbograph 1TD	5164	5212
Carbograph 2TD/Carbograph 1TD/Carboxen 1003 (Alternative to TO-17, type 3 (lower water retention))	5264	5265
Carbopack C/Carbopack B/Carbosieve SIII (TO-17, type 3)	5035	5071
Tenax TA/Carbograph 1TD/Carbograph 5TD	5154	5217
Tenax TA/Carbograph 1TD/Carboxen 1003 (Universal)	5266	5267
Carbograph 1TD/Carbograph 5TD/Carboxen 1003	5273	5274
Quartz wool/Tenax TA/Carbograph 5TD (Material emissions and soil gas)	5304	5310

1. Tubes containing two or three sorbents are packed by mass to give approximately equal bed lengths for each sorbent; quartz wool is packed to ~1 cm bed length.

Bespoke solutions for sorbent tubes

Should you not see what you're looking for on the preceding pages, then you may be interested in our custom service.

Over the years, we've developed custom solutions for numerous TD users – from special-dimension DAAMS tubes to customer-specified banding.

Each custom solution is treated as a stand-alone project on our system, meaning that one of our specialists will be dedicated to working with you.

Simply contact us if you're interested in:

- labelling or barcoding of existing tubes
- custom labelling of glass tubes
- non-standard tube dimensions
- alternative sorbent mesh sizes, bed lengths, or packing mixes
- our tube unpacking and repacking service
- our conditioning service for existing tubes
- any other query you may have.

Contact
consumables@markes.com with
details of your request



N.B. The tubes on this page use the following sorbent mesh sizes: Carbograph 1TD (40/60), Carbograph 2TD (40/60), Carbograph 5TD (40/60), Carbopack B (60/80), Carbopack C (60/80), Carbosieve SIII (60/80), Carboxen 1003 (40/60), HayeSep D (60/80), SulfiCarb (40/70), Tenax TA (35/60), Tenax GR (35/60).

Tube accessories

Markes offers a range of tube accessories to support every TD application. From tools to assist with routine tube maintenance and storage, to labour-saving tube inserts for direct desorption, Markes' tube accessories are designed to make your life easier.

Gauzes, springs and clips	18
Tools	18
TubeTAG accessories	19
Long-term storage caps	20
DiffLok caps	21
Short-term storage caps	22
Tube connection unions	22
Sorbent tube shipment boxes	22

Practical tools for enhanced tube sampling

Gauges, springs and clips

Sorbent-retaining gauges for metal tubes

Markes' sorbent-retaining gauges are manufactured to precise tolerances to ensure that they correctly fit the front groove of metal (stainless steel or inert-coated) tubes. The placement of the front gauge is critical for diffusive sampling, as it defines the diffusion gap on which uptake rate data is based (for more information, see Application Note TDS 8^{p92}). All Markes' 3½" metal tubes are supplied with this front gauge correctly and firmly fitted. Gauges can also be used to separate sorbent beds in metal multi-sorbent tubes. For inert-coated tubes, gauges in contact with the sample stream are also inert-coated.

Gauze-retaining springs

Gauze-retaining springs are used in metal tubes to ensure the rear sorbent-retaining gauze remains positioned correctly on top of the sorbent bed. Springs can be inserted and removed from the tubes using Markes' labour-saving TubeMate tool.

Torsion springs for glass tubes

Torsion springs are used in glass tubes to ensure that the rear plug of quartz wool remains positioned correctly on top of the sorbent bed. They may also be used during direct desorption of materials to secure the sample in place centrally in the heated zone of the tube.

Penclips

Penclips attach to the groove on 3½" metal tubes, so that they can be easily fastened to a lapel or pocket for personal monitoring.



Description	Part number
Sorbent-retaining gauze, pk 20	C-GZ020
Sorbent-retaining gauze, pk 200	C-GZ200
Sorbent-retaining gauze, pk 2000	C-GZ2000
Sorbent-retaining gauze, inert, pk 10	C-GZI10
Sorbent-retaining gauze, inert, pk 100	C-GZI100
Gauze-retaining spring, pk 10	C-SP010
Gauze-retaining spring, pk 100	C-SP100
Spring, torsion, for 4 mm i.d. glass tubes, pk 10	C-GTSP10
Penclip, pk 10	C-CL010
Penclip, pk 100	C-CL100

Tools

CapLok™ tool

Long-term storage caps^{p20} must be correctly tightened in order to ensure a leak-tight seal. Caps are recommended to be tightened 'finger-tight plus quarter turn'. Although this is possible with conventional spanners/wrenches, using two spanners can be awkward, and can lead to incorrect positioning of caps and other errors. For example, over-tightening of the caps may cause distortion of the PTFE ferrules and a leak in the seal. In extreme cases it is even possible to break the ends of glass tubes or deform the ends of steel tubes.



Markes' CapLok tool overcomes all these issues. It was designed by scientists at INERIS (l'Institut National de l'Environnement Industriel et des Risques, France) specifically to simplify tube capping/uncapping procedures and minimise the risk of errors. The CapLok tool is manufactured exclusively by Markes International¹.

TubeMate™ tool

TubeMate is used to insert (and remove) gauze-retaining springs in metal tubes. Once the spring is partially inserted into the end of the tube, TubeMate grips the spring and enables it to be twisted into place with very little effort. Reversing this process aids the removal of the springs when unpacking old tubes. The other end of the TubeMate tool can also be used to position the rear sorbent-retaining gauze on the sorbent surface².

Description	Part number
CapLok tool	C-CPLOCK
CapLok tool, pk 10	C-10LOK
TubeMate tool	C-TBMTE



CapLok and TubeMate tools, gauges, gauze-retaining springs and penclips

- For tubes fitted with TubeTAG^{p7}, a TAGLok tool^{p19} should be used. TAGLok fits both standard caps and tag-ready caps.
- TubeMate is not recommended for accurate positioning of the primary sorbent-retaining gauze at the sampling end of the tube.

TubeTAG accessories

Markes' patented TubeTAG system is the world's only electronic tagging and labelling system for glass and steel thermal desorption tubes. TubeTAG allows tube- and sample-specific information to be electronically associated with a particular tube for the duration of a monitoring project, or for the whole life of the tube. It is the ultimate quality-assurance system for sorbent tubes.

Accessories for TubeTAG are described below.

Packs of tags for fitting to sorbent tubes

As well as sorbent tubes pre-fitted with tags, Markes offers loose tags for attaching to existing sorbent tubes – different versions are available for stainless steel and glass tubes.

Note that tagged tubes require special long-term storage caps, which are described on page 20.

TAG^{SCRIBE}™

Information is entered onto the tags either via a Markes' TAG-ready TD autosampler or a stand-alone PC-controlled TAG^{SCRIBE}. TAG^{SCRIBE} device can be used prior to tube despatch, to enter sample information in the field, and to retrieve information from the tags after monitoring.

Pumped sampling adaptor for tagged tubes

Pumped sampling adaptors ease the connection of tagged tubes to personal monitoring pumps.



TubeTAG – The ultimate quality-assurance system for TD tubes



T: +44 (0)1443 230935

TubeTAG starter kit

A **TubeTAG starter kit** for stainless steel tubes is available in a convenient carry-case. The kit contains:

TAG ^{SCRIBE} read/write device for all TubeTAGs	C-SCRIBE
TubeTAG for stainless steel tubes, pk 10	C-TAG10
TubeTAG fixing/removal tool for ¼" stainless steel tubes	C-TAGTL
Cap, brass, ¼" & PTFE ferrule (one standard, one tag-ready), pk 10 pairs, for ¼" metal tubes	C-TCFP10
TAGLok tool for tightening/removing standard and TAG-ready ¼" storage caps	C-TAGLOK



TubeTAG kit

For further information about TubeTAG, please contact one of our specialists (enquiries@markes.com), or visit our website to download the brochure.

Description	Part number
TubeTAG for stainless steel tubes, pk 10	C-TAG10
TubeTAG for stainless steel tubes, pk 100	C-TAG100
TubeTAG for glass tubes, pk 10	C-TAGG10
TubeTAG for glass tubes, pk 100	C-TAGG100
TAG ^{SCRIBE} read/write device for all TubeTAGs	C-SCRIBE
TubeTAG fixing/removal tool for stainless steel tubes	C-TAGTL
TubeTAG fixing/removal tool for glass tubes	C-TAGKY
TAGLok tool for tightening/removing standard and TAG-ready ¼" storage caps	C-TAGLOK
Pumped sampling adaptor, ¼" tubes, pk 10	C-TPA10
Pumped sampling adaptor, ¼" tubes, pk 100	C-TPA100
Pumped sampling adaptor, 6 mm tubes, pk 10	C-TPAX10
Pumped sampling adaptor, 6 mm tubes, pk 100	C-TPAX100
TubeTAG starter kit (for stainless steel tubes)	C-TAGKT

T: 886-483-5684 (USA toll-free)

Long-term storage caps

For long-term storage (or transport) of conditioned or sampled tubes, two-piece metal storage caps fitted with one-piece PTFE ferrules (¼" or 6 mm i.d.) must be used. They are available in brass and lightweight aluminium. These caps are recommended by international standard methods such as US EPA Method TO-17, ASTM D6196 and EN ISO 16017, and have been validated for storage of sampled/blank tubes for up to 27 months¹. The caps meet a stringent cleanliness specification and tight manufacturing tolerances.



For tubes fitted with TubeTAG⁷, an extended 'tag-ready' long-term storage cap must be used on the tagged end of the tube.

Note that use of Markes' CapLok¹⁸ or TAGLok¹⁹ tools extend the life of combined PTFE ferrules, but that ferrules should nevertheless be replaced after approximately 20 operations.

[Standard ¼" brass and aluminium long-term storage caps for industry-standard tubes \(stainless steel or glass\)²](#)

Description	Part number
Cap, storage, brass, ¼" & PTFE ferrule, pk 10	C-CF010
Cap, storage, brass, ¼" & PTFE ferrule, pk 20	C-CF020
Cap, storage, brass, ¼" & PTFE ferrule, pk 100	C-CF100
Cap, storage, brass, ¼" & PTFE ferrule, pk 200	C-CF200
Cap, storage, aluminium, ¼" & PTFE ferrule, pk 20	C-CFA20
Cap, storage, aluminium, ¼" & PTFE ferrule, pk 200	C-CFA200
Ferrule, ¼", combined PTFE, pk 20	C-FP020
Ferrule, ¼", combined PTFE, pk 200	C-FP200

[6 mm brass long-term storage caps for 6 mm stainless steel tubes or glass tubes with 6 mm o.d. ends²](#)

Description	Part number
Cap, storage, brass, 6 mm & PTFE ferrule, pk 10	C-CF010-XZ
Cap, storage, brass, 6 mm & PTFE ferrule, pk 20	C-CF020-XZ
Cap, storage, brass, 6 mm & PTFE ferrule, pk 100	C-CF100-XZ
Cap, storage, brass, 6 mm & PTFE ferrule, pk 200	C-CF200-XZ
Ferrule, 6 mm, combined PTFE, pk 20	C-FP020-XZ
Ferrule, 6 mm, combined PTFE, pk 200	C-FP200-XZ

1. F. Lindquist and H. Bakkeren, Stability of chlorinated hydrocarbons on Tenax. CEC commissioned report from TNO, No. R90/268, 1990.
2. These items are also suitable for the untagged end of ¼" or 6 mm stainless steel or glass tubes as appropriate.

[Tag-ready ¼" brass long-term storage caps for industry-standard stainless steel tubes](#)

Description	Part number
Cap, brass, ¼" & PTFE ferrule, tag-ready, pk 10, for ¼" metal tubes	C-TCF10
Cap, brass, ¼" & PTFE ferrule, tag-ready, pk 100, for ¼" metal tubes	C-TCF100

[Tag-ready ¼" or 6 mm brass long-term storage caps for glass tubes](#)

Description	Part number
Cap, brass, ¼" & blind PTFE ferrule, tag-ready, pk 10, for ¼" glass tubes	C-T4GCF10
Cap, brass, ¼" & blind PTFE ferrule, tag-ready, pk 100, for ¼" glass tubes	C-T4GCF100
Cap, brass, 6 mm & blind PTFE ferrule, tag-ready, pk 10, for 6 mm glass tubes	C-T6GCF10
Cap, brass, 6 mm & blind PTFE ferrule, tag-ready, pk 100, for 6 mm glass tubes	C-T6GCF100

[Pairs of long-term storage caps for ¼" tagged tubes](#)

Description	Part number
Cap, brass, ¼" & PTFE ferrule (one standard, one tag-ready), pk 10 pairs, for ¼" metal tubes	C-TCFP10
Cap, brass, ¼" & PTFE ferrule (one standard, one tag-ready), pk 100 pairs, for ¼" metal tubes	C-TCFP100



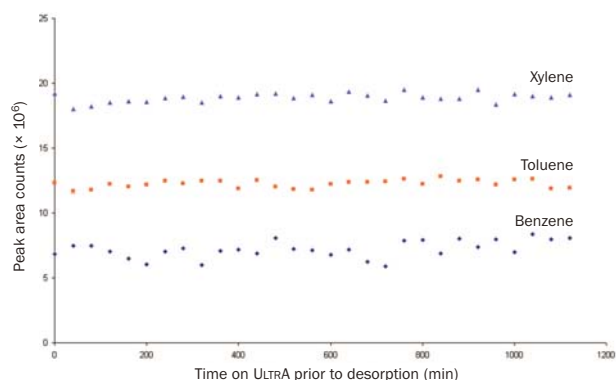
CapLok tool, capped tube, and ¼" brass long-term storage caps

**Storage caps –
For method-compliant tube
storage**

DiffLok™ caps

Tubes on all Markes' TD autosamplers (TD-100 and ULTRA) are sealed with unique DiffLok caps, which simply push onto both ends of every tube. DiffLok caps use Markes' patented¹ diffusion-limiting technology (also found in SafeLok tubes^{P6}), to preserve sample integrity by preventing both analyte loss and artefact ingress. They ensure that even volatile analytes are successfully retained, guaranteeing reproducible results for standards at the beginning and end of a 100-tube sequence.

DiffLok caps remain on the tubes throughout an analytical sequence. This preserves sample and tube integrity before and after desorption, but at the same time also simplifies the automatic TD process, thus optimising uptime and productivity. DiffLok caps have been field-proven to seal sampled and blank tubes much more effectively than alternative PTFE push-on caps incorporating PTFE-coated O-rings².



No analyte loss from Tenax tubes capped with DiffLok caps and analysed on Markes' ULTRA autosampler over a 24-hour period

DiffLok caps are available for 1/4" and 6 mm o.d. tubes, and in stainless steel or inert-coated stainless steel. Inert-coated caps are only ever required for the sampling/desorption end of the tube when analysing reactive compounds. Replacement O-rings are also available for routine maintenance of the caps.

For DiffLok caps and O-rings compatible with 8 mm diameter DAAMS tubes, contact Markes (consumables@markes.com).

Description	Part number
Cap, DiffLok, stainless steel, 1/4", pk 10	C-DL010
Cap, DiffLok, stainless steel, 1/4", pk 100	C-DL100
Cap, DiffLok, inert, 1/4", pk 10	C-DLS10
Cap, DiffLok, inert, 1/4", pk 100	C-DL1S0
Cap, DiffLok (one stainless steel, one inert), 1/4", pk 10 pairs	C-DLP10
Cap, DiffLok (one stainless steel, one inert), 1/4", pk 100 pairs	C-DL1P0
O-Ring, low-emission, pk 10 (replacements for 1/4" DiffLok caps)	U-COV10
O-Ring, low-emission, pk 100 (replacements for 1/4" DiffLok caps)	U-COV100
Cap, DiffLok, stainless steel, 6 mm, pk 10	C-DL010-XZ
Cap, DiffLok, stainless steel, 6 mm, pk 100	C-DL100-XZ
Cap, DiffLok, inert, 6 mm, pk 10	C-DLS10-XZ
Cap, DiffLok, inert, 6 mm, pk 100	C-DL1S0-XZ
Cap, DiffLok (one stainless steel, one inert), 6 mm, pk 10 pairs	C-DLP10-XZ
Cap, DiffLok (one stainless steel, one inert), 6 mm, pk 100 pairs	C-DL1P0-XZ
O-Ring, low-emission, pk 10 (replacements for 6 mm DiffLok caps)	U-COV45
O-Ring, low-emission, pk 100 (replacements for 6 mm DiffLok caps)	U-COV450



DiffLok caps maintain sample integrity throughout the analytical sequence

1. UK Patent No. GB 2337513; US Patent No. US 6,564,656 B1.
2. Push-on PTFE caps have been shown to allow significant analyte loss – see: P.P. Ballesta, Losses from ATD-400, *The Diffusive Monitor*, 1997, issue 9.

Short-term storage caps

Aluminium push-on caps with O-ring seals are convenient for short-term storage of cleaned or sampled $\frac{1}{4}$ " tubes, for example, when they are being analysed almost immediately after sampling. Note that push-on caps should not be used for long-term storage or transport of tubes.

Description	Part number
Cap, push-on, aluminium, $\frac{1}{4}$ ", pk 20	C-AC020
Cap, push-on, aluminium, $\frac{1}{4}$ ", pk 200	C-AC200

Tube connection unions

Multi-bed sorbent tubes are commonly used for sampling atmospheres containing VOCs over a wide volatility range. However, single-bed sorbent tubes connected in series are a useful alternative, for example when monitoring breakthrough from the front (primary) tube.

Standard $\frac{1}{4}$ " o.d. tubes can be connected in series using $\frac{1}{4}$ "– $\frac{1}{4}$ " stainless steel unions fitted with the same one-piece PTFE ferrules used in $\frac{1}{4}$ " storage caps. After sampling, the tubes are disconnected, capped and stored individually prior to analysis.

Linking sorbent tubes in series allows the use of sorbent combinations that cannot be packed into a single tube. It also completely eliminates the risk of higher-boiling analytes migrating to the stronger sorbents during sample storage.

Description	Part number
Unions, $\frac{1}{4}$ "– $\frac{1}{4}$ ", stainless steel & $\frac{1}{4}$ " PTFE ferrules, pk 10	C-UNS10
Unions, $\frac{1}{4}$ "– $\frac{1}{4}$ ", stainless steel & $\frac{1}{4}$ " PTFE ferrules, pk 100	C-UNS100

Sorbent tube shipment boxes

Markes provides two types of lightweight and robust storage boxes for convenient shipment of sorbent tubes:

- Standard ribbed cardboard box for a pack of 10 pre-packed (uncapped and unconditioned) industry-standard tubes
- Large ribbed cardboard box for a pack of 5 pre-conditioned, capped and/or tagged industry-standard tubes.

Storage boxes for DAAMS tubes are also available – please contact Markes for details (consumables@markes.com).



Large ribbed storage box

Description	Part number
Box, 10-slot, unconditioned tubes, pk 10	C-10BX10
Box, 10-slot, unconditioned tubes, pk 100	C-10BX100
Box, 5-slot, conditioned/tagged tubes, pk 10	C-5BX10
Box, 5-slot, conditioned/tagged tubes, pk 100	C-5BX100

Sorbents

To complement our extensive range of pre-packed tubes, Markes offers a wide range of bulk sorbents for customers who wish to pack their own tubes, or who have other sorbent requirements.

Careful selection of sorbent type and mesh size is critical for the successful outcome of any thermal desorption application. Contact our team of specialists for expert help and advice, with fast and friendly service.

Porous polymers	24
Graphitised carbon blacks	27
Carbonised molecular sieves	28
Zeolite molecular sieves	29
Other non-carbon sorbents	30
Activated charcoal	30

Sorbents from Markes – Opening up a range of tube packing options

Porous polymers

Most porous polymer sorbents are inert, making them suitable for the analysis of labile and reactive compounds such as thiols and CS gas. In addition, their broadly hydrophobic nature allows them to be used for sampling in humid conditions.

However, some porous polymer sorbents (PoraPak and HayeSep) can exhibit high artefact levels, and may display significant batch-to-batch variation.

Note that the Chromosorb Century series porous polymers are no longer available – please contact us for a recommended alternative for your application.

Notes

- ▶ Where several mesh sizes are available, recommended mesh sizes are marked by a '*'. Note that fine mesh sizes can lead to high tube impedance/back-pressure.
- ▶ Attention must be paid to the temperature limitations of sorbents, particularly when packing multi-bed sorbent tubes.

For a quick guide to sorbent selection for different TD applications, see our Quick Reference Guide on page 11



Tenax® TA (35/60*, 60/80)**Tenax® GR (35/60*, 60/80)**

Tenax TA is arguably the world's favourite TD sorbent, offering quantitative trapping and efficient release for VOCs and SVOCs ranging in volatility from n-hexane to n-C₂₆ and above. It is the most thermally stable of the porous polymers, but still benefits from being used at the lowest practical temperature for the application, to minimise artefacts and extend tube life.

Tenax GR contains 23% graphitised carbon as an integral part of the material (the graphitised carbon is co-precipitated with the Tenax polymer). For some compounds, Tenax GR offers slightly higher breakthrough volumes than Tenax TA, and its use is widely reported in the scientific literature.

For both Tenax TA and Tenax GR, the 35/60 mesh size is strongly recommended for optimum performance in sorbent tubes.

Sorbent strength	Weak
Specific surface area	~35 m ² /g
Approx. analyte volatility range	n-C ₇ to n-C ₃₀ b.p. 100 °C to 450 °C
Example analytes	Aromatics (except benzene); apolar compounds b.p. >100 °C; polar compounds b.p. >150 °C; semi-volatile compounds, including many CW agents
Recommended conditioning temp.	Up to 330 °C
Recommended desorption temp.	Up to 320 °C

Hints and tips for Tenax

- ▶ Hydrophobic – great for humid atmospheres
- ▶ Low inherent artefacts – good for trace-level monitoring
- ▶ Inert – suitable for labile components
- ▶ Do not exceed sorbent maximum temperature – sorbent will break down and may contaminate system flow path
- ▶ Repack sorbent tubes after 100 thermal cycles
- ▶ Allows efficient desorption, giving quantitative recovery of high-boiling compounds and sharp GC peaks.

Description	Part number
Sorbent, Tenax TA (35/60), 10 g	C-TNXTA
Sorbent, Tenax TA (60/80), 10 g	C-TNXTA60
Sorbent, Tenax GR (35/60), 10 g	C-TNXGR
Sorbent, Tenax GR (60/80), 10 g	C-TNXGR60

PoraPak™ Q (50/80)**PoraPak™ N (50/80)**

There are several PoraPak porous polymers available that vary both in strength (specific surface area) and polarity. The two most commonly used in thermal desorption applications are PoraPak Q and PoraPak N.

PoraPak Q is the weaker of these two sorbents – it is only slightly polar, and is a general-purpose PoraPak sorbent. PoraPak N is the most polar (and least thermally stable) PoraPak sorbent, and is typically used for monitoring volatile nitriles.

Sorbent strength	Medium
Specific surface area	~500 m ² /g (Q) ~300 m ² /g (N)
Approx. analyte volatility range	b.p. 50 °C to 200 °C
Example analytes	Oxygenated compounds (Q) Volatile nitriles (N)
Recommended conditioning temp.	Up to 220 °C (Q) Up to 170 °C (N)
Recommended desorption temp.	Up to 190 °C (Q) Up to 165 °C (N)

Hints and tips for PoraPak

- ▶ PoraPak Q is hydrophobic, but PoraPak N is less so. Care is therefore required when using PoraPak N in humid environments
- ▶ High artefacts (~10–50 ng/component) limits the use of these sorbents for trace-level monitoring, e.g. ambient atmospheres.
- ▶ Keep the desorption temperature to a minimum to reduce artefact levels
- ▶ Conditioned PoraPak may self-generate aromatic hydrocarbons over time. It is recommended that tubes packed with this sorbent are used as soon as possible after conditioning
- ▶ Inert – suitable for labile components
- ▶ Repack sorbent tubes after 50 thermal cycles
- ▶ Not generally suitable for:
 - Multi-bed sorbent tubes
 - Cold traps (special applications only)
 - Long-term (>8 h) diffusive sampling.

Description	Part number
Sorbent, PoraPak N (50/80), 20 g	C-2PPKN
Sorbent, PoraPak Q (50/80), 20 g	C-2PPKQ

Other PoraPak sorbents (P, T, S, R, etc.) are available from consumables@markes.com on request.

HayeSep® D (60/80)

HayeSep polymers were developed to exhibit less bleed and shrinkage than other medium-strength porous polymer sorbents. HayeSep D is the strongest sorbent in this series. However, its use tends to be restricted to very specialised applications, e.g. monitoring volatile chemical warfare agents.

Sorbent strength	Medium
Specific surface area	~800 m ² /g
Approx. analyte volatility range	n-C ₅ to n-C ₁₂ b.p. 50 °C to 200 °C
Example analytes	Specifically used for GB/GE derivatives of VX (chemical warfare agents)
Recommended conditioning temp.	Up to 280 °C
Recommended desorption temp.	Up to 260 °C (see Hints and tips)

Hints and tips for HayeSep D

- ▶ Hydrophobic
- ▶ High artefacts (~10–50 ng/component) limits the use of this sorbent for trace-level monitoring, e.g. ambient atmospheres
- ▶ Keep the desorption temperature to a minimum to reduce artefact levels
- ▶ Inert – suitable for labile components
- ▶ Repack sorbent tubes after 50 thermal cycles or more frequently if used near the maximum temperature limit
- ▶ Not generally suitable for:
 - Multi-bed sorbent tubes
 - Cold traps (special applications only).

Description	Part number
Sorbent, HayeSep D (60/80), 20 g	C-2HSPD

Other HayeSep sorbents are available are available from consumables@markes.com on request.



Graphitised carbon blacks

These are non-specific carbon sorbents, widely used for trace-level applications due to their minimal artefact levels. They vary from very weak to medium/strong, and are used for a wide range of VOCs and SVOCs. They are fairly hydrophobic and therefore suitable for sampling under humid conditions. They can, however, contain trace levels of metals, which means they are not always 100% inert. This makes them less suitable for some labile or highly reactive species, e.g. thiols and monoterpenes.

Note that these sorbents are prone to formation of fines, and that over-compression during tube packing can lead to high back-pressure. Remember all Markes' sorbent tubes are flow-checked before shipment to ensure reliable sampling and performance.

Although generally considered to be non-porous, the strongest graphitised carbon sorbents (e.g. Carbograph 5TD) do exhibit microporosity, which improves the ability of these sorbents to trap ultra-volatile compounds. These sorbents therefore provide a 'bridge' between the graphitised carbon blacks and the stronger carbonised molecular sieves^{p28}.

All the graphitised carbon blacks have certain general characteristics, as indicated below.

Recommended conditioning temp.	Up to 380 °C
Recommended desorption temp.	Up to 360 °C

Hints and tips for graphitised carbon blacks

- ▶ Hydrophobic – unaffected by high humidity
- ▶ Minimal artefacts – good for monitoring at all concentration levels
- ▶ Friable and compressible – CARE: Compressing these sorbents can lead to high back-pressures and blocked tubes
- ▶ 40/60 mesh is recommended for ideal flow characteristics in sorbent tubes and cold traps
- ▶ Repack tubes after 200 thermal cycles.

Carbograph™ 2TD (20/40, 40/60*, 60/80)

Sorbent strength	Very weak
Specific surface area	~10 m ² /g
Approx. analyte volatility range	n-C ₈ to n-C ₂₀
Example analytes	Alkylbenzenes, hydrocarbons to n-C ₂₀ , semi-volatiles

Hints and tips for Carbograph 2TD

- ▶ Not as efficient as Tenax at releasing high-boiling compounds.

Carbograph™ 1TD (20/40, 40/60*, 60/80)

Sorbent strength	Weak/medium
Specific surface area	~100 m ² /g
Approx. analyte volatility range	n-C _{5/6} to n-C ₁₄
Example analytes	Ketones, alcohols, aldehydes; apolar components; perfluorocarbon tracer gases; benzene, toluene, xylene (1–4-week diffusive exposure in ambient air)

Hints and tips for Carbograph 1TD

- ▶ Widely used 'general-purpose' sorbent. Often used in two- or three-bed sorbent tubes.

Carbograph™ 4TD (20/40)

Sorbent strength	Medium
Specific surface area	~130 m ² /g
Approx. analyte volatility range	n-C _{4/5} to n-C ₁₂
Example analytes	Light hydrocarbons

Carbograph™ 5TD (20/40, 40/60*)

Sorbent strength	Medium/strong
Specific surface area	~100 m ² /g
Approx. analyte volatility range	n-C _{3/4} to n-C _{6/7} b.p. 50 °C to 150 °C
Example analytes	Light hydrocarbons; buta-1,3-diene (1-week diffusive exposure)

Description	Part number
Sorbent, Carbograph 2TD (20/40), 10 g	C-CG220
Sorbent, Carbograph 2TD (40/60), 10 g	C-CG240
Sorbent, Carbograph 2TD (60/80), 10 g	C-CG260
Sorbent, Carbograph 1TD (20/40), 10 g	C-CG120
Sorbent, Carbograph 1TD (40/60), 10 g	C-CG140
Sorbent, Carbograph 1TD (60/80), 10 g	C-CG160
Sorbent, Carbograph 4TD (20/40), 10 g	C-CG420
Sorbent, Carbograph 5TD (20/40), 10 g	C-CG520
Sorbent, Carbograph 5TD (40/60), 10 g	C-CG540

Other graphitised carbon blacks are available from consumables@markes.com on request.

Carbonised molecular sieves

Carbonised molecular sieves are the strongest sorbents and are used to trap the most volatile compounds. Because they function according to adsorption and molecular sieve principles, their specific surface area is not a key indicator of their strength. The size and shape of both the analyte molecule and the particle pores also determine the analytes that each sorbent is most suited to.

All carbonised molecular sieves have certain basic characteristics, and these are indicated below.

Recommended conditioning temp.	Up to 380 °C <i>N.B.</i> The temperature should be increased gradually from 100 °C, especially during initial conditioning, to remove oxygen and avoid rapid expansion of volatiles which can crack the sieves
Recommended desorption temp.	Up to 360 °C

Hints and tips for carbonised molecular sieves

- ▶ These sorbents are not very hydrophobic and may therefore require dry-purging prior to desorption to remove excess water (see page 50)
- ▶ Assume safe sampling volumes are reduced by a factor of 10 when sampling in air at >80% relative humidity
- ▶ Due to their strength, carbonised molecular sieves are easily contaminated by higher-boiling compounds, and should be protected by a front bed of weaker sorbent, except when used for diffusive sampling (see page 35)
- ▶ Minimal (<0.1 ng) artefacts allow monitoring at trace levels
- ▶ Inert – suitable for labile compounds
- ▶ Repack tubes after 200 thermal cycles
- ▶ For optimum performance, increase the temperature gradually during conditioning (see table).

Carboxen™ 569 (20/45)

Sorbent strength	Strong
Specific surface area	~485 m ² /g; also functions on molecular sieve principles
Approx. analyte volatility range	n-C ₃ to n-C ₈ b.p. -30 °C to 150 °C
Example analytes	Volatile hydrocarbons

Hints and tips for Carboxen 569

- ▶ More hydrophobic than most carbonised molecular sieves.

SulfiCarb™ (40/70) (replaces UniCarb™)

Sorbent strength	Very strong
Specific surface area	~1200 m ² /g; also functions on molecular sieve principles
Approx. analyte volatility range	n-C ₃ to n-C ₈ b.p. -30 °C to 150 °C
Example analytes	Very volatile compounds, e.g. vinyl chloride monomer, CS ₂ , methanol, ethanol, acetone etc. Used for very volatile but sterically large molecules, e.g. SF ₆

Hints and tips for SulfiCarb

- ▶ UniCarb is no longer available. However, we are able to supply a similarly inert sorbent, SulfiCarb, which has the same physical properties and very similar performance for reactive sulfur species and light VOCs.

Carbosieve™ SIII (60/80)

Sorbent strength	Very strong
Specific surface area	~800 m ² /g, but primarily functions on molecular sieve principles
Approx. analyte volatility range	Ethane to n-C ₅ (also ethylene from small volumes) b.p. -60 °C to 80 °C
Example analytes	Ultra-volatile hydrocarbons

Hints and tips for Carbosieve SIII

- ▶ Significantly water-retentive – avoid using in humid conditions if at all possible, and dry-purge extensively.

Carboxen™ 1003 (40/60)

Sorbent strength	Very strong for small molecules
Specific surface area	1000 m ² /g; also functions on molecular sieve principles
Approx. analyte volatility range	Ethane to n-C _{5/6}
Example analytes	Ultra-light compounds

Hints and tips for Carboxen 1003

- ▶ Carboxen 1003 offers the best performance of all the carbon molecular sieves (e.g. Carbosieve SIII, Carboxen 1000), from the perspective of retention of ultra-light compounds whilst allowing breakthrough of water. Markes recommends using Carboxen 1003 for many air monitoring methods that may previously have specified Carboxen 1000 or Carbosieve SIII.

Carboxen™ 1000 (60/80)

Sorbent strength	Very strong for small molecules
Specific surface area	>1200 m ² /g; also functions on molecular sieve principles
Approx. analyte volatility range	Permanent gases and light hydrocarbons b.p. -60 °C to 80 °C
Example analytes	Ultra-volatile hydrocarbons

Hints and tips for Carboxen 1000

- ▶ Retains some water – avoid using in humid conditions if possible, and dry-purge extensively.

Description	Part number
Sorbent, Carboxen 569 (60/80), 10 g	C-C569
Sorbent, SulfiCarb (40/70), 10 g	C-SLCRB
Sorbent, Carbosieve SIII (60/80), 10 g	C-CSIII
Sorbent, Carboxen 1003 (40/60), 10 g	C-C1000
Sorbent, Carboxen 1000 (60/80), 10 g	C-C1003

Other carbonised molecular sieves are available from consumables@markes.com on request.



Graphitised carbon black and porous polymer sorbents available from Markes International

Get the best out of your sorbents and sorbent tubes with expert advice from Markes (see also Application Note TDTS 27^{p92})

Zeolite molecular sieves

These are very selective hydrophilic sorbents that work on molecular sieve principles. They are used for specific TD applications, e.g. monitoring nitrous oxide (MS 5 Å).

Molecular sieve 5 Å

Sorbent strength	Very strong
Pore size	5 Å
Typical application	Nitrous oxide monitoring in occupational hygiene applications
Recommended conditioning temp.	300 °C to 350 °C <i>N.B.</i> Increase gradually from 100 °C during initial conditioning, to remove oxygen and avoid rapid expansion of volatiles which can crack the sieve
Recommended desorption temp.	165 °C (for N ₂ O applications)

Hints and tips for molecular sieve 5 Å

- ▶ High (~10 ng) artefacts
- ▶ Significantly hydrophilic – do not use in humid conditions
- ▶ Repack tubes after 200 thermal cycles
- ▶ Molecular sieve tubes used for N₂O monitoring are desorbed in the sampling direction to allow selective release of N₂O.

Molecular sieve 13X

Sorbent strength	Very strong
Pore size	9 Å
Typical application	Buta-1,3-diene monitoring in occupational hygiene applications
Recommended conditioning temp.	300 °C to 350 °C <i>N.B.</i> Increase gradually from 100 °C during initial conditioning, to remove oxygen and avoid rapid expansion of volatiles which can crack the sieve
Recommended desorption temp.	265 °C (for buta-1,3-diene applications)

Hints and tips for molecular sieve 13X

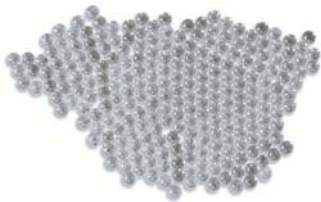
- ▶ High (~10 ng) artefacts
- ▶ Significantly hydrophilic – do not use in humid conditions
- ▶ Repack tubes after 200 thermal cycles
- ▶ Note that some of the latest standard methods recommend Carbograph 5TD as a more robust alternative sorbent for buta-1,3-diene.

Description	Part number
Sorbent, molecular sieve 5 Å, 20 g	C-MSV5A
Sorbent, molecular sieve 13X, 20 g	C-MS13X

Other non-carbon sorbents

Quartz beads

Quartz beads are completely inert and are used primarily in TD instrument cold traps⁷⁷ when monitoring high-boiling, chemically active compounds such as chemical warfare agents. Quartz beads can be used in sorbent tubes in place of quartz wool (see below), if required.



Quartz wool

Quartz wool is often used in sorbent tubes as the first 'sorbent' in a multi-bed sorbent tube when the range of compounds of interest includes very high-boiling and/or reactive compounds, such as PAHs, phthalates and explosives. It is important that the fibres are the correct diameter – coarse-grade quartz wool has a high proportion of broken fibres, which can reduce its inertness and introduce particles into the TD flowpath. If total inertness is required, e.g. when analysing extremely labile compounds, then silanised glass wool is recommended.

Silanised glass wool

Silanised glass wool is used in sorbent tubes and focusing traps when analysing extremely labile compounds. However, it has a maximum recommended operating temperature of 250 °C. Above 275 °C, residual silanising reagent can break down, coating the TD flowpath with active degradation products and compromising system performance, especially with regard to recovery of high-boilers.

Unsilanised glass wool

Unsilanised glass wool can be used in sorbent tubes where inertness is not an issue. Tubes packed with unsilanised glass wool must be rigorously conditioned.

Description	Part number
Quartz beads, 1.5 mm, pk 100	C-QTZBD
Quartz wool, 10 g	C-QUTZW
Glass wool, silanised, 10 g	C-SILGW
Glass wool, unsilanised, 10 g	C-UNSGW

Activated charcoal

Activated charcoal is prone to causing poor analyte recovery and sample degradation during thermal desorption. It is **only recommended for use in split-flow filter tubes**, and should not be used in TD sampling tubes.

Description	Part number
Sorbent, activated charcoal, 5 g	C-CHARC

If you can't see the sorbent you need, contact us and we'll find it for you, or recommend a good alternative

Pumped sampling

While no single sampling method suits all air monitoring applications, pumped (active) sampling onto sorbent tubes perhaps provides the most versatile option for simultaneous monitoring of multiple target compounds and/or monitoring unknown atmospheres.

Markes' sorbent tubes are ideal for pumped monitoring. They can be packed with up to three discrete sorbent beds, and are compatible with all but the most volatile species (e.g. acetylene and ultra-volatile freons).

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Pumped-tube sampling – The most versatile air monitoring option

Pumped sampling

Pumped sampling onto sorbent tubes is one of the most versatile TD sampling methodologies. Precise volumes from 20 mL to several hundred litres may be drawn through the tubes, ensuring compatibility with a huge concentration range (sub-ppt to high ppm).

A pump is connected to the rear (non-sampling) end of the sorbent tube so that air is drawn onto the front (sampling/grooved) end. Pumped sampling is typically performed at flow rates of around 20–100 mL/min. However, higher flow rates (up to 500 mL/min) may be used for short sampling periods (~15 minutes), as long as the safe sampling volumes of the components of interest are not exceeded. Safe sampling volumes for a wide range of analytes are given in key standard methods (e.g. EN ISO 16017 Part 1) and other documents (see Application Note TDTS 20^{p92}).

Many personal air sampling pumps are available on the market, but not all are optimised for sampling onto thermal desorption tubes. Lower-cost 'constant-pressure' pumps may struggle to deal with the relatively high back-pressure/impedance of some two- or three-bed TD tubes, whereas Markes' **ACTI-VOC** delivers a constant flow rate irrespective of normal tube impedance.

Other accurate low-volume sampling options include Markes' **Easy-VOC grab-sampler**^{p33}.



ACTI-VOC low-flow pump

ACTI-VOC™ low-flow pump

Markes' ACTI-VOC low-flow pump is tailor-made for TD tubes. The pump is constant-flow, meaning that once it has been calibrated (using the flowmeter on page 82) it will maintain this flow to within ±5%, even when using TD tubes of significantly different impedance. The pump operates between 1 and 350 mL/min (or between 20 and 200 mL/min in constant flow mode), and is powerful enough to achieve these flow rates even when there is significant back-pressure (up to 25" of water or 0.9 psi), making it suitable for use with high-impedance sorbents and SafeLok tubes^{p6}.

ACTI-VOC is robust, and ideal for personal monitoring applications. It includes a belt clip for ease of use, but is also compact and lightweight enough to fit into a shirt or jacket pocket. It is simple to operate, with a clock that displays the elapsed sampling time. ACTI-VOC has intrinsic safety certification, and the NiMH battery allows fast charges and consistent performance for at least 8 hours.

The **ACTI-VOC kit** includes:

- Tubing and adaptors providing push-fit connections to TD tubes, guaranteeing constant-flow operation
- CapLok tool to simplify tube capping
- Tool for flow adjustment
- Mains charger
- Adaptor for bag sampling
- Convenient carry-case.



If you need advice about sampling with flows above 350 mL/min, please contact Markes (enquiries@markes.com).

Description	Part number
ACTI-VOC low-flow pump kit	C-LFP-01
Spare ACTI-VOC filter assembly	SERZ-1076
Spare ACTI-VOC bag sampling accessory	SERZ-1070
Spare ACTI-VOC charger	SERLFP-5002
Spare ACTI-VOC tube adaptor assembly	SERZ-1097
Spare ACTI-VOC back-pressure adaptor	SERLFP-5003

Easy-VOC™ grab-sampler

Easy-VOC allows the rapid 'grab-sampling' of up to 1000 mL air/gas samples directly onto sorbent tubes, without the need for calibrated pumps or complicated mass flow control equipment.

Typical 50–200 mL Easy-VOC sampling volumes are ideal for monitoring workplace and industrial atmospheres, and are also suitable for many urban and indoor air monitoring applications (depending on the sensitivity of your TD–GC(MS) system).

Easy-VOC allows multiple accurate aliquots of 50–100 mL air or gas to be steadily introduced to standard or SafeLok tubes over a period of several seconds. The small air/gas volumes sampled by Easy-VOC reduce the risk of analyte breakthrough, allowing quantitative retention of more volatile compounds. Accurate sampling of smaller air/gas volumes also minimises water management issues.

The **Easy-VOC starter kit** contains:

Easy-VOC pump (plus CapLok tool and carry-case)	C-EZVOCPO
Stainless steel, SafeLok sorbent tubes, packed with Tenax TA/Carbograph 1TD/Carboxen 1003, conditioned and capped, pk 10 <i>For pumped sampling of VOCs from C_{3/4} to C₃₀</i>	C3-DAXX-5266

The versatile three-bed sorbent tubes supplied in each Easy-VOC starter kit harness Markes' patented SafeLok^{®6} technology. This helps preserve the integrity of clean and sampled tubes without compromising method compliance.

Also available is a cost-effective **Easy-VOC accessory pack**. This contains three spare rubber inlets, two spare gaskets, and lubricant.

Description	Part number
Easy-VOC pump (plus CapLok tool and carry-case)	C-EZVOCPO
Easy-VOC starter kit	C-EZVOCKT
Easy-VOC accessory pack	C-EZVOCAK



Easy-VOC – Simple, fast and accurate air sampling

MTS-32™ multiple tube sampler

The MTS-32 is a compact, portable sampler, designed for unattended sequential sampling of air onto sorbent tubes. Ambient air is pulled sequentially through a series of up to 32 (3½") sorbent tubes by an ACTI-VOC pump^{®32}. Each tube is sampled at the same flow rate regardless of any impedance variation, so that the same volume of air is collected in each case.

During automated sampling, it is essential that unused tubes are effectively sealed, to prevent sample losses from the tubes and ingress of contaminants by diffusion. The MTS-32 achieves this by harnessing diffusion-locking technology in the form of SafeLok tubes^{®6} and/or DiffLok caps^{®21}.



MTS-32 multiple tube sampler

The MTS-32 allows users to select sampling times. It is housed in a showerproof case constructed of low-outgassing materials, and can be powered by mains electricity or a battery. An integral fan continually refreshes the air inside the case, ensuring that the air sampled accurately reflects the immediate environment. Custom interfaces can be designed for specific applications (contact enquiries@markes.com).

Description	Part number
MTS-32 multiple tube sampler <i>Also requires constant-flow pump (e.g. ACTI-VOC low-flow pump^{®32}), 12 V battery and charger, or mains power supply</i>	MTS-32
Power supply accessory for MTS-32	MTS-5011
12 V Battery assembly for MTS-32	MTS-5009
Mains charger for 12 V battery of MTS-32	MTS-5010
Cable assembly for connecting MTS-32 to external 12 V battery <i>Required if 12 V battery is not supplied by Markes</i>	MTS-5013

Diffusive (passive) sampling

Diffusive (passive) sampling using sorbent tubes provides a convenient and quantitative method for a range of air monitoring applications:

- Personal exposure assessment in the workplace
- Time-weighted-average monitoring of ambient outdoor or indoor air over extended periods (e.g. 2 weeks)
- Sub-slab soil gas and vapour-intrusion studies
- Monitoring fugitive and area emissions from industrial sites, e.g. at the factory fenceline.

Markes' TD tubes (stainless steel and inert-coated stainless steel) are specifically designed for method-compliant diffusive sampling as well as pumped monitoring. They are also supported by Markes' expertise in sorbents and TD-GC(MS) analysis.

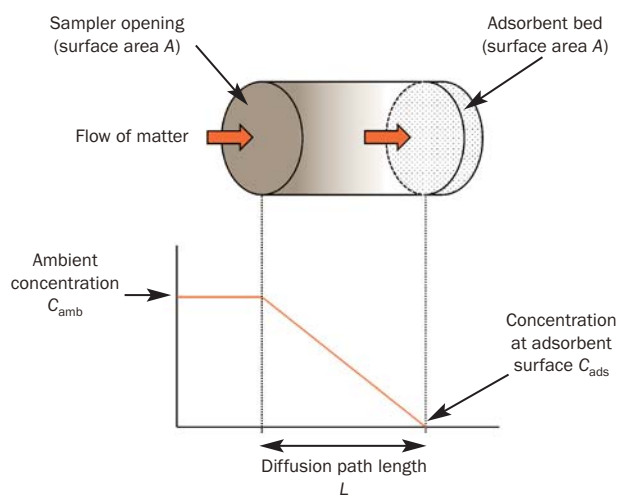
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Diffusive sampling – low-cost and quantitative

Diffusive (passive) sampling

Quantitative diffusive (passive) sampling onto sorbent tubes combined with TD-GC analysis first came to the fore for workplace air monitoring in the early 1980s^{1,2} as a means of overcoming the limitations of using traditional charcoal/solvent extraction methods – namely poor sensitivity, variable recovery and solvent toxicity.

Markes' diffusive passive samplers are based on standard 3.5" (89 mm) × 6.4 mm o.d. stainless steel tubes with a precise air (diffusion) gap (5 mm i.d. × 15 mm long) at the sampling end as required by standard methods. One side of the diffusion gap is defined by the sampling surface of the sorbent in the tube and the other by the gauze in the diffusion cap. VOCs move across this air gap, driven by the concentration gradient, and the mass of each analyte retained is proportional to its time-weighted average concentration in the air throughout the exposure period.



Axial diffusive sampling

With no need for a pump or other bulky apparatus, passive samplers are extremely unobtrusive, convenient and low-cost. This makes them ideal for personal exposure studies and large-scale air monitoring campaigns (pollution mapping).



Deploying diffusive samplers for fence-line monitoring.

Picture courtesy of BP Chemicals, Hull, UK

Diffusive sampling rates are relatively slow – the equivalent of pumped sampling rates from 0.5–1.0 mL/min – but this means they can be used in almost any environment (high or low air flow rates). They are ideal for both short-term personal exposure monitoring (0.5–12 hours) in the workplace and extended (1–4-week) monitoring of ambient, indoor or industrial air.

Compatible compounds range from the very volatile (e.g. nitrous oxide, buta-1,3-diene) to the semi-volatile (e.g. naphthalene), and from non-polar (e.g. n-nonane) to polar (e.g. ethanol). The precise sampling rate (uptake rate) for each compound must be determined according to specific protocols³. However, 30 years of widespread use has resulted in a database of over 100 published uptake rates, which are available in various reference standards (e.g. EN ISO 16017 part 2) and other documents (see Application Note TDTs 1^{p92}). Diffusive/passive tubes have minimum detection limits of about 10 ppb for short-term (8 hour) exposure and ~0.1 ppb for long-term (2–4 week) sampling.

1. R.H. Brown, J. Charlton and K.J. Saunders, The development of an improved diffusive sampler, *American Industrial Hygiene Association Journal*, 1981, 42: 865–869.
2. E. Woolfenden, Sorbent-based sampling methods for volatile and semi-volatile organic compounds in air: Part 1: Sorbent-based air monitoring options, *Journal of Chromatography A*, 2010, 1217: 2674–2684.

3. EN 838 Workplace atmospheres – Diffusive samplers for the determination of gases and vapours – Requirements and test methods.

Relevant standard methods include:

- **EN ISO 16017:** Air quality – Sampling and analysis of volatile organic compounds in ambient air, indoor air and workplace air by sorbent tube/thermal desorption/capillary gas chromatography. Part 2: Diffusive sampling
- **ASTM D6196:** Standard practice for selection of sorbents, sampling and thermal desorption analysis procedures for volatile organic compounds in air
- **EN 14662:** Ambient air quality – Standard method for the measurement of benzene concentrations. Part 4: Diffusive sampling followed by thermal desorption and gas chromatography
- **US EPA Draft Method 325:** Volatile organic chemicals in air – Monitoring fugitive industrial emissions and area sources using passive samplers and TD-GC/(MS) analysis. Part A: Deployment and Part B: Analysis
- **UK HSE: MDHS 80:** Volatile organic compounds in air. Laboratory method using diffusive solid sorbent tubes, thermal desorption and gas chromatography (August 1995).



**Diffusive (passive) sampling –
The ideal low-cost and
unobtrusive sampling option for
personal exposure assessment**

Diffusion sampling technology from Markes

Markes is at the forefront of diffusive (passive) sampling using sorbent tubes, and was the first to pioneer inert-coated stainless steel tube options for passive sampling of reactive compounds. Tubes fitted with Markes' TubeTAG^{®7} are also fully compatible with diffusive sampling. Exposure start and end times can be recorded electronically using TubeTAG.

Markes' diffusion caps are usually made of clean, anodised aluminium. However, we can also supply stainless steel versions for use in more corrosive atmospheres if required. For traceability purposes, diffusion caps can also be supplied etched with a unique serial number.

The diffusion cap replaces the storage cap at the sampling (grooved) end of the TD sample tube for the duration of the exposure/monitoring period. The storage cap at the other end of the tube is left in place.



Stainless steel sorbent tube with diffusion caps

Description	Part number
Caps, diffusion, axial, aluminium, pk 10	C-DF010
Caps, diffusion, axial, aluminium, pk 100	C-DF100
Caps, diffusion, axial, aluminium, etched with serial number, pk 10	C-DF010E
Caps, diffusion, axial, aluminium, etched with serial number, pk 100	C-DF100E
Caps, diffusion, axial, stainless steel, pk 20	C-DFS20

For information on Markes' Diffusive monitoring starter kit, please see page 65.

Canister sampling

Canisters are useful for sampling very volatile, non-polar compounds such as C₂ hydrocarbons and the most volatile freons, which can be difficult to retain on sorbent tubes at ambient temperature. Canisters and sorbent tubes are thus complementary, allowing analysts equipped with both to address a larger range of applications than either method on its own. For discussion of the relative merits of canisters and sorbent tubes, see Markes' Application Note TDTS 79^{p92}.

Markes manufactures the best available technology for automated canister analysis. The *CIA Advantage* system operates cryogen-free, offers up to 27 channels, and is fully compliant with US EPA Method TO-14/TO-15. See page 73 of this catalogue or the *CIA Advantage* brochure for more details.

To complement the *CIA Advantage*, we also provide a wide range of canisters and canister sampling accessories.

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Canisters for air monitoring – Simple sampling for very volatile organics in air

Canisters

To complement the versatility of Markes' CIA *Advantage* system for automated canister analysis, Markes offers three types of canisters:

- **TO-Can® air monitoring canisters** are optimised for US EPA Methods TO-14/TO-15 and ASTM D5466. The canisters are electropolished and contain high-quality metal-to-metal seals and a stainless steel diaphragm valve.
- **SilcoCan® air monitoring canisters** with Siltek®-treated valves offer unsurpassed inertness, even for brominated or sulfur-containing species.

Both the above are available in 1 L and 6 L sizes and are pre-fitted with a ¼" three-port valve and a vacuum pressure gauge (reading from -30 inHg to 60 psi).

- **Miniature air sampling canisters** are also available, either electropolished or Siltek-treated, and fitted with a Quick-Connect stem fitting.

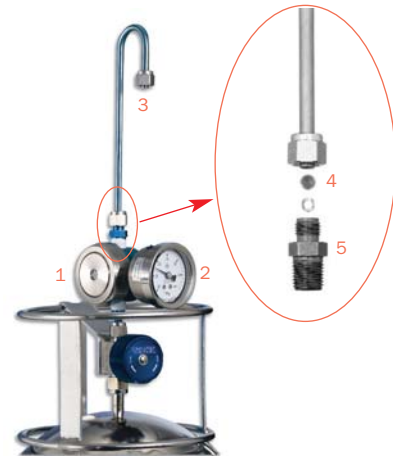
All canisters are shipped clean and pressurised with contaminant-free nitrogen.



Everything you need for canister air sampling and analysis

Canister air sampling

Evacuated canisters are predominantly used for grab-sampling but can also be applied for extended monitoring periods. For time-weighted-average (TWA) air sampling using canisters, we recommend the use of an air sampling kit. This incorporates all the necessary hardware, and is easy to assemble for field use. The air sampling kits supplied by Markes enable 1 hour of sampling into a 1 L canister, or 8 hours of sampling into a 6 L canister.



TWA canister air sampling kit

1. Flow controller: maintains constant mass flow as the pressure within the canister changes from -30 inHg to 7 inHg (we recommend sampling is stopped before 7 inHg). Siltek options available.
2. Stainless steel vacuum gauge: monitors canister vacuum change during sampling.
3. ¼" sample inlet: Siltek option available.
4. Replaceable 2 µm frit filter, washer: prevents particles from blocking the critical orifice. Siltek option available.
5. Critical orifice: selected according to canister volume and sampling time required. Interchangeable with other sizes. Siltek option available.

Description	Part number
TO-Can with gauge and ¼" valve, 1 L	C-TOCAN1
TO-Can with gauge and ¼" valve, 6 L	C-TOCAN6
SilcoCan with gauge and Siltek ¼" valve, 1 L	C-SLCAN1
SilcoCan with gauge and Siltek ¼" valve, 6 L	C-SLCAN6
TWA air sampling kit, stainless steel <i>Gives 1 h sampling from a 1 L canister or 8 h sampling from a 6 L canister</i>	C-ASK1168SS
TWA air sampling kit, Siltek-treated <i>Gives 1 h sampling from a 1 L canister or 8 h sampling from a 6 L canister</i>	C-ASK1168SL
Miniature air sampling canister (400 mL), electropolished with Quick-Connect stem fitting	C-MNCANSS
Miniature air sampling canister (400 mL), Siltek-treated with Quick-Connect stem fitting	C-MNCANSL
TWA air sampling kit, electropolished, 0.5–2 mL/min (for miniature canisters only)	C-ASKMNSS
TWA air sampling kit, Siltek-treated, 0.5–2 mL/min (for miniature canisters only)	C-ASKMNSL
Replacement 2 µm frit filter for critical orifice (includes washers), stainless steel, pk 3	C-ASK2USS
Replacement 2 µm frit filter for critical orifice (includes washers), Siltek-treated, pk 3	C-ASK2UST

Canister racks

Markes' canister racks are available as accessories for supporting canisters attached to CIA *Advantage* systems. Each canister rack holds up to 15 canisters (14 samples and one internal standard). The bench-mounted model (Bench Rack) holds canisters up to 1 L, and the floor-mounted model (Maxi Rack) holds canisters up to 6 L.



Markes' Bench Rack and Maxi Rack

Description	Part number
Bench Rack (400 mL to 1 L canisters)	U-RACK01
Maxi Rack (1 L to 6 L canisters)	U-RACK02

Standard dilution into canisters

Markes' diluter makes possible the accurate dilution of a standard gas, allowing the creation of multiple calibration levels from a single original standard, with the option of humidification.

Description	Part number
Diluter	U-DILUT
Humidification option for diluter or CIA <i>Advantage</i>	U-HUMID

Canister cleaning

Cleaning canisters is a critical part of any canister-based air monitoring methodology. The TO-14/TO-15-compliant TO-Clean canister cleaning system available from Markes can be adapted to clean canisters of different sizes – from twelve 6 L canisters to 48 miniature canisters – and at temperatures up to 110 °C.



TO-Clean canister cleaning system

The system is fully automated, allowing the user to start a cleaning cycle and walk away. Using the touch-screen controller, up to ten custom cleaning methods can be defined and loaded as needed. The system also comes with an automated leak-check method, ensuring consistently high performance.

Hints and tips

- Note that, unlike canisters, sorbent tubes are automatically cleaned by the TD analytical process. However, for automatic conditioning of freshly packed tubes, or tubes that have been unused for an extended time, we recommend the TC-20 multi-tube conditioner and dry-purge unit – please see page 50 for details.

Description	Part number
TO-Clean canister cleaning system with isothermal oven (120 V a.c.)	U-TOCLN120
TO-Clean canister cleaning system with isothermal oven (220–240 V a.c.)	U-TOCLN220
Miniature canister brackets for TO-Clean, pk 12	C-TOCLNMN
1 L brackets for TO-Clean, pk 12	C-TOCLN1L
3 L brackets for TO-Clean, pk 12	C-TOCLN3L

Calibration and standards

Calibration is one of the most important considerations for any quantitative analysis, and Markes provides a wide range of standards and accessories to make TD calibration as easy as possible for busy labs. We supply everything from stand-alone tube loading rigs and internal standard addition accessories to audit and check-standards pre-loaded onto sorbent tubes.

Markes' Application Notes TDTS 7 and TDTS 75^{p92} present detailed technical advice on preparing sorbent tube standards and calibrating your thermal desorption system. Markes' team of TD specialists is also always on hand to help you succeed.

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Internal standards	47
Gas standards for external calibration of environmental methods	47

Standards and accessories for reliable and quantitative thermal desorption

Calibration Solution Loading Rig (CSLR™)

Key TD standard methods (e.g. ISO 16017 and US EPA Method TO-17) recommend that liquid- and gas-phase standards are loaded onto the sampling end of clean sorbent tubes in a stream of carrier gas using unheated apparatus.



Calibration Solution Loading Rig

Markes' Calibration Solution Loading Rig (CSLR) has been specifically designed for loading sorbent tubes with gas- or liquid-phase standards. It has a flow-path constructed of stainless steel and consists of an unheated injector port with a controlled carrier gas supply. The sampling end of a packed sorbent tube is connected to the CSLR by a ¼" brass nut and PTFE ferrule.

The carrier gas flow is adjusted using a needle valve, and is normally set between 50 and 100 mL/min, according to standard methods. This sweeps the injection port and carries the standard into the sorbent tube. The calibration standard (gas or liquid phase) is introduced through the injector septum using an appropriate precision syringe. The compounds of interest are swept onto the sampling end of the attached tube in the stream of carrier gas, and reach the sorbent bed in the vapour phase.

Advice on routine calibration of TD methods is given in Markes' Application Notes TDTS 7 and TDTS 75^{p92}.

Hints and tips

- ▶ Wherever possible, to simplify the analytical procedure, a sufficient volume of carrier gas is allowed to pass through the sorbent bed to remove the bulk of solvent (for liquid standards), while quantitatively retaining compounds of interest.

Description	Part number
Calibration Solution Loading Rig	C-CSLR
Septum, 9.5 mm (for CSLR), pk 10	C-SPTA

Liquid-phase external calibration

It is not always possible or convenient to introduce liquid standards in a stream of carrier gas as described above. In these cases, liquid standards can be injected directly onto the back of specially packed sorbent tubes (glass is recommended) containing a 1 cm bed of Tenax TA held in place by a 1 cm bed of quartz wool. See Application Note TDTS 7^{p92} for more details.



Syringe (top) and liquid-phase calibration tube containing a 1 cm bed of Tenax TA (bottom)

Description	Part number
Tube, glass, Tenax TA, 1 cm calibration, pk 10	C1-BXXX-5072
Tube, glass, Tenax TA, 1 cm calibration, conditioned and capped, pk 10	C1-BAXX-5072

Check-standards

Check-standards contain a range of routine and challenging analytes, and are useful when setting up instrumentation or troubleshooting. Markes supplies two types of check-standard, both prepared on conditioned Tenax TA sorbent tubes.

Instrumentation check-standards contain benzene, toluene, o-xylene, isobornyl methacrylate (IBMA) and dioctyl phthalate at a nominal concentration of 90 ng/μL for each component. A single check-standard is supplied with all Markes' systems. Replacement check-standards are available in packs of 10.

Material emissions check-standards enhance validation and quality control for service and manufacturing labs using TD–GC(MS) to test chemical emissions from products and materials. The Tenax TA sorbent tubes are pre-loaded in the gas phase with a range of polar and non-polar VOCs ranging in volatility from C₆ (n-hexane) to C₁₆ (n-hexadecane), at a nominal loading of 100 ± 10 ng per compound. The standard complies with the ISO 17025 method for loading tubes (also in accordance with ISO 9001).

The material emissions check-standard contains:

n-Hexane
4-Methylpentan-2-one
Toluene
n-Butyl acetate
Cyclohexanone
Phenol
1,2,3-Trimethylbenzene
4-Phenylcyclohexene
n-Hexadecane

Note that all these compounds are included in the 'Indoor air and material emissions' proficiency testing scheme described below.

Description	Part number
Check-standard (BTX, isobutyl methacrylate (IBMA) and dioctyl phthalate), 90 ng/μL (nominal), Tenax TA, pk 10	C-CHK10
Check-standard (material emissions), 100 ng per tube (nominal), Tenax TA, pk 10	C-CHK10-ME

Do you participate in a Proficiency Testing scheme for TD?

As part of our service to customers, Markes likes to make thermal desorption users aware of complementary third-party services that could be of interest and benefit. Proficiency testing (PT) schemes are a case in point.

PT schemes for thermal desorption work by providing participating laboratories with spiked tubes for analysis. The tubes are analysed by these laboratories, preferably as part of their routine operation, and the results reported to the scheme organisers. The laboratories involved are then provided with a report showing how closely their results agree with the accepted values.

Regular participation in a proficiency-testing scheme:

- Provides a laboratory with an important independent insight into their performance
- Benchmarks laboratory performance against other scheme participants
- Allows laboratories to demonstrate commitment to measurement quality to regulatory agencies, accreditation bodies and laboratory customers.

The Workplace Analysis Scheme for Proficiency

One of the most popular PT schemes for thermal desorption is the **Workplace Analysis Scheme for Proficiency (WASP)**. This tests the performance of laboratories measuring exposure to hazardous chemical substances in the ambient, indoor and workplace air environments using TD methods. The scheme was established in 1988, and currently has more than 200 laboratory participants worldwide. The WASP scheme is operated by the UK Health & Safety Laboratory, which oversees management, registration and membership, together with preparation and distribution of the spiked tubes, processing the participant data and providing reports.



WASP can offer the following useful PT analyte/sample combinations:

Ambient air

Testing environment: ISO 16017-1 & 2 and US EPA TO-17 Analytes: BTEX Loading: 15–300 ng †

Indoor air and material emissions

Testing environment: ISO 16000-6 Analytes: A range of 13 indoor-relevant (S)VOCs Loading: 50–300 ng

Workplace air

Testing environment: ISO 16017-1 & 2 Analytes: BTEX Loading: 0.5–200 μg †
Testing environment: ISO 16000-3 Analyte: Formaldehyde Loading: 3–60 μg ‡

† Analytes provided together on a TD sorbent tube packed with Tenax TA. Test samples dynamically loaded from a standard atmosphere based upon procedures set out in ISO 6145-4.

‡ Glass fibre filter spiked with DNPH derivative. Note this requires HPLC, and is not compatible with TD–GC(MS) methods.

If you are interested in WASP, please contact the UK Health & Safety Laboratory on +44 (0)1298 218553 or proficiency.testing@hsl.gov.uk

Certified reference standard (CRS) tubes

All analytical methodology is subject to performance criteria and quality assurance tests. Reference standards should be used at regular intervals for analytical quality assurance and to confirm routine calibration procedures.

CRS tubes offered by Markes International are prepared by an expert national standards laboratory following approved methodology (ISO 6145 parts 4 or 8, accredited to ISO 17025). They are certified traceable to primary standards. CRS tubes are prepared by introducing known concentrations of compounds into individually labelled sorbent tubes. Analyte masses are accurate to $\pm 3\%$ at levels above 100 ng, and at $\pm 5\%$ for masses from 10–100 ng.

Typically, CRS tubes are loaded with a small number of analytes that are representative of the method being undertaken. They provide a convenient tool for in-house quality assurance of the complete TD–GC(MS) analytical process and associated calibration protocols. Routine use of CRS tubes complies with guidance given in international standard methods and provides continual assurance of system and procedure reliability, thus contributing to staff confidence. In these respects, in-house use of CRS tubes complements participation in external proficiency testing schemes such as WASP^{P45}.

All CRS tubes are supplied in packs of 10 standards with an additional shipping blank. Standards are wrapped in aluminium foil and sealed into air-tight boxes prior to shipment. A chromatogram of the shipping blank is supplied, together with a certificate of standard traceability. BTX and TO-17 standards are supplied with an example chromatogram and full user instructions.

BTX standards

BTX CRS tubes loaded with benzene, toluene and o-xylene are available either at 100 ng per component (suitable for the majority of environmental applications) or at 1 μg per component (suitable for many industrial air and material emissions applications). These standards are prepared using conditioned Tenax TA tubes and have a certified shelf-life of 6–12 months.

TO-17 standard

A TO-17 CRS is available loaded with nine components of varying volatilities and polarities that are typical of the compounds found during air toxics monitoring. (*N.B.* This standard is prepared to order and typically has a longer lead time than the BTX standards.)

The compounds included¹ are benzene, toluene, o-xylene, 1,2,4-trimethylbenzene, dichloromethane, 1,1,1-trichloroethane, methyl tert-butyl ether, methyl ethyl ketone and ethyl acetate. The required concentration of the standard can be specified. These standards are prepared on conditioned Tenax TA tubes and have a certified shelf-life of 6 months.

Custom standards

If you require a special combination of components pre-loaded onto conditioned sorbent tubes, Markes also offers a custom CRS tube service. Up to eight components can be specified, with the sorbent typically being Tenax TA (although others are available). However, data must be available to demonstrate the stability of the compound/sorbent combination requested. If you require custom-specified CRS tubes, please discuss your requirements with a Markes specialist prior to ordering (enquiries@markes.com).

Description	Part number
CRS (BTX), 100 ng, pk 10	C-BTX100-10
CRS (BTX), 1 μg , pk 10	C-BTX1UG-10
CRS (TO-17), specify concentration, pk 10	C-TO17XX-10
CRS (custom), pk 10	C-CUST-10
CRS (custom), pk 20	C-CUST-20
CRS (custom), pk 40	C-CUST-40

**TD quality assurance from
Markes – Your peace of mind**

1. Prior to March 2008, TO-17 CRS standards included butan-1-ol. New data shows that this component is not stable over the shelf-life of the CRS, and therefore it is no longer included in the standard.

Internal standards

Many TD air monitoring methods (tube- or canister-based) benefit from the addition of a gas-phase internal standard (IS). Markes provides the option of IS addition capability on all automated TD configurations, whether tube- or canister-based – see the relevant sections on ULTRA autosamplers^{p71}, TD-100 systems^{p70} and CIA Advantage systems^{p73} for more details.

Hints and tips

- ▶ Selection of the optimum IS gas depends on the application. Typical internal standard compounds include deuterated hydrocarbons (e.g. toluene- d_8) and halogenated compounds (such as bromofluorobenzene).
- ▶ The internal standard gas should be supplied in a pressurised cylinder fitted with a high-purity regulator capable of supplying standard to the TD system at pressures up to 50 psig.
- ▶ The concentration of internal standard required depends on the expected concentration of the analytes. As a general rule-of-thumb:
 - If the expected mass of analyte on the tube is about a nanogram, then a 1 ppmv internal standard is suggested
 - If the expected mass of analyte on the tube is about a picogram, then a 1 ppbv internal standard is suggested.

Markes offers¹ a 1 ppm IS gas containing four halogenated/deuterated compounds (in bulk nitrogen), suitable for use with US EPA Methods TO-14/TO-15/TO-17 and other TD-GC/MS applications:

Compounds (in N₂)	Bromochloromethane 1-Bromo-4-fluorobenzene Chlorobenzene- d_5 1,4-Difluorobenzene
Cylinder²	Aluminium construction (8.3 cm × 29.5 cm) PI-marked for compliance with EU regulations and US DOT specifications 3AL2216 2.2 lb/1 kg
Pressure/regulation	110 L of gas at 1800 psig CGA-180 outlet fitting

Description	Part number
Standard, gas cylinder, TO-14A IS/tuning mix, 1 ppm	C-GS14A-1PPM
Regulator, high-purity VOC, 0–100 psi outlet	C-GSREG-100
Tubing, stainless steel, 1/8", to connect IS to ISDP	SERZ-0022

1. These items may be unavailable in some territories – please contact Markes International for further information.
2. Pressurised cylinders of gas standards are subject to 'hazardous materials' shipping supplements by most freight carriers.

Gas standards for external calibration of environmental methods

Markes also offers a selection of gas standards¹ suitable for a variety of canister-based air monitoring methods. All cylinders are of aluminium construction (8.3 cm × 29.5 cm)² and PI-marked for compliance with EU transport regulations and US DOT specification 3AL2216.

Sulfur component mix – 1 ppm

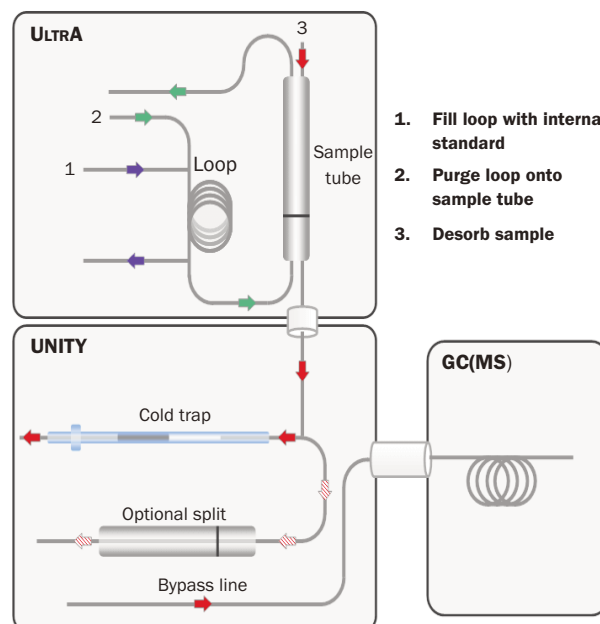
Supplied in nitrogen at 1800 psig, this standard has a 6-month stability and an accuracy of $\pm 10\%$. 1 mL of this standard contains approximately 2 ng of the following components:

Carbonyl sulfide	Ethane thiol	Methane thiol
Dimethyl sulfide	Hydrogen sulfide	

Volatiles (Japan) component mix – 1 ppm

Supplied in nitrogen at 1800 psig, this mixture of volatile organics contains some compounds that are traditionally difficult to prepare as calibration standards. 1 mL of this standard contains approximately 2–7 ng of the following components:

Acrylonitrile	Chloroform	Tetrachloroethene
Benzene	1,2-Dichloroethane	Trichloroethene
Buta-1,3-diene	Dichloromethane	Vinyl chloride



Schematic of internal standard/dry-purge (ISDP) accessory for ULTRA

TO-15 'Air toxics'/TO-17 65-component mix – 1 ppm

Supplied in nitrogen at 1800 psig. Injecting 1 mL of this mix onto a sorbent tube or cold trap introduces 2–4 ng of each component.

Acetone	Ethanol*
Acrolein	Ethyl acetate
Benzene	Ethylbenzene
Benzyl chloride*	4-Ethyltoluene
Bromodichloromethane	Heptane
Bromoform	Hexachlorobuta-1,3-diene
Bromomethane	Hexane
Buta-1,3-diene	Hexan-2-one (methyl butyl ketone)
Butan-2-one (methyl ethyl ketone)	Methyl methacrylate
Carbon disulfide*	4-Methylpentan-2-one
Carbon tetrachloride	(methyl isobutyl ketone)
Chlorobenzene	Methyl <i>tert</i> -butyl ether
Chloroethane	Naphthalene
Chloroform	Propan-2-ol
Chloromethane	Propene
Cyclohexane	Styrene
Dibromochloromethane	1,1,2,2-Tetrachloroethane
1,2-Dibromoethane	Tetrachloroethene
1,2-Dichlorobenzene	Tetrahydrofuran
1,3-Dichlorobenzene	Toluene
1,4-Dichlorobenzene	1,2,4-Trichlorobenzene
Dichlorodifluoromethane (Freon® 12)	1,1,1-Trichloroethane
1,1-Dichloroethane	1,1,2-Trichloroethane
1,2-Dichloroethane	Trichloroethene
1,1-Dichloroethene	Trichlorofluoromethane (Freon® 11)
<i>cis</i> -1,2-Dichloroethene	1,1,2-Trichloro-1,2,2-trifluoroethane
<i>trans</i> -1,2-Dichloroethene	(Freon® 113)
Dichloromethane	1,2,4-Trimethylbenzene
1,2-Dichloropropane	1,3,5-Trimethylbenzene
<i>cis</i> -1,3-Dichloropropene	Vinyl acetate
<i>trans</i> -1,3-Dichloropropene	Vinyl chloride
1,2-Dichlorotetrafluoroethane	<i>m</i> -Xylene
(Freon® 114)	<i>o</i> -Xylene
1,4-Dioxane	<i>p</i> -Xylene

* Note that the stability of these compounds cannot be guaranteed.

Ozone precursor/PAMS 57-component mix – EPA concentrations 20–60 ppbC¹

Supplied in nitrogen at 1800 psig. Injecting 1 mL of this mix onto a TD cold trap introduces approximately 0.1 ng of each component (in the list below, individual concentrations in ppbC¹ are given in parentheses).

Acetylene (40)	Isopropylbenzene (40)
Benzene (30)	Methylcyclohexane (30)
<i>n</i> -Butane (40)	Methylcyclopentane (25)
But-1-ene (30)	2-Methylheptane (25)
<i>cis</i> -But-2-ene (35)	3-Methylheptane (25)
<i>trans</i> -But-2-ene (25)	2-Methylhexane (25)
Cyclohexane (40)	3-Methylhexane (25)
Cyclopentane (20)	2-Methylpentane (20)
<i>n</i> -Decane (30)	3-Methylpentane (40)
<i>m</i> -Diethylbenzene (40)	<i>n</i> -Nonane (25)
<i>p</i> -Diethylbenzene (25)	<i>n</i> -Octane (30)
2,2-Dimethylbutane (40)	<i>n</i> -Pentane (25)
2,3-Dimethylbutane (50)	Pent-1-ene (25)
2,3-Dimethylpentane (50)	<i>cis</i> -Pent-2-ene (35)
2,4-Dimethylpentane (40)	<i>trans</i> -Pent-2-ene (25)
<i>n</i> -Dodecane (40)	Propane (40)
Ethane (25)	<i>n</i> -Propylbenzene (30)
Ethylbenzene (25)	Propene (25)
Ethene (20)	Styrene (40)
<i>m</i> -Ethyltoluene (25)	Toluene (40)
<i>o</i> -Ethyltoluene (30)	1,2,3-Trimethylbenzene (25)
<i>p</i> -Ethyltoluene (40)	1,2,4-Trimethylbenzene (40)
<i>n</i> -Heptane (25)	1,3,5-Trimethylbenzene (25)
<i>n</i> -Hexane (30)	2,2,4-Trimethylpentane (30)
Hex-1-ene (60)	2,3,4-Trimethylpentane (25)
Isobutane (25)	<i>n</i> -Undecane (30)
Isopentane (40)	<i>o</i> -Xylene (25)
Isoprene (40)	<i>m/p</i> -Xylene (combined) (40)

Hints and tips

- ▶ This standard contains some very volatile analytes and is not suitable for loading onto standard sorbent tubes at ambient temperature.

Description	Part number
Standard, gas cylinder, sulfur mix, 1 ppm	C-GSSUL-1PPM
Standard, gas cylinder, volatiles (Japan mix), 1 ppm	C-GSVOL-1PPM
Standard, gas cylinder, TO-15, 65-component mix, 1 ppm	C-GS15-1PPM
Standard, gas cylinder, O ₃ /PAMS, 57-component mix, EPA concentration, 20–60 ppb	C-GSPAMS-EPA
Regulator, high-purity VOC, 0–100 psi outlet	C-GSREG-100

1. ppbC = parts per billion expressed as carbon.

Sampling accessories

Markes provides the widest available range of specialist accessories for thermal desorption. Together, these innovative sampling tools offer compatibility with gas-, liquid- and solid-phase samples, and enhance a broad range of applications.

TC-20 tube conditioner and dry-purge unit	50
Micro-Chamber/Thermal Extractor (μ -CTE)	52
Thermal analysis/evolved gas collection	56
SPE-tD sorptive extraction cartridges	56
Headspace-Thermal Desorption (HS-TD)	57
Bio-VOC breath sampler	59
VOC-Mole soil probe	61
Direct desorption	62

**An extensive range of
sampling accessories for
every TD application**

TC-20™ multi-tube conditioner and dry-purge unit

The TC-20 is used to clean or dry-purge up to 20 industry-standard sorbent tubes simultaneously. All it needs is power and a clean, high-purity gas supply (typically nitrogen).



TC-20 multi-tube conditioner and dry-purge unit

A uniform flow of gas is passed through each attached tube, at a rate that is independent of tube impedance. The temperature and time required are selected using the controls on the front of the instrument, and the flow rate is set by adjusting the pressure of gas supplied (displayed on the gauge).

Hints and tips

- ▶ We recommend the use of a secondary gas regulation system (e.g. the single regulator pneumatics accessory, U-GAS03^{p82}) and gas purifiers^{p83} on the carrier gas input line.
- ▶ For automated canister cleaning, we recommend the TO-CLEAN system – please see page 41 for details.

Sorbent tube conditioning

Sorbent tubes require stringent conditioning whenever they are:

- freshly packed with sorbent
- stored without being properly capped
- heavily contaminated during a sampling procedure
- required for trace-level monitoring.

Typically, tubes should be conditioned for 10–15 minutes, or at least as long as their standard desorption time. Where possible, temperatures and gas flow rates for conditioning should be higher than those used in the analytical method. Freshly packed tubes should be conditioned for much longer, typically 2–6 hours.

Many commercial thermal desorbers, such as (ULTRA-)UNITY and TD-100, offer a dedicated tube conditioning mode. Whilst this is a useful feature, it can take up valuable analytical instrument capacity.

The TC-20 tube conditioning system saves time and money by cleaning up to 20 industry-standard sorbent tubes simultaneously. It also eliminates any risk of contamination of the analytical system and allows expensive helium carrier gas to be replaced with lower-cost, high-purity nitrogen if required.

Hints and tips

- ▶ Note that electronic TubeTAGS^{p7} must be removed using the appropriate fixing/removal tool, before tubes can be inserted into the TC-20.
- ▶ After conditioning/dry-purging, tags can be reattached to the associated tubes, and the number of thermal cycles increased, if applicable.
- ▶ For more information on tube conditioning, please refer to Application Note TDTS 5^{p92}.

Get your tubes ultra-clean quickly and easily with the TC-20

TC-20 as a dry-purge unit

Although modern carbonised molecular sieves^{p28} are much less water-retentive than older molecular sieves or charcoal, some water will still be retained when sampling in humid atmospheres. The TC-20 can also be used to selectively remove this excess water from a batch of sampled sorbent tubes, thus eliminating its adverse effects on GC/MS analysis.

Water is eliminated by 'dry-purging' the tubes with a known volume of pure dry gas in the sampling direction before desorption. This is achieved by inserting the tubes into the TC-20 manifold block, with the sampling end first. Clean, dry nitrogen gas is then passed through the tubes in the sampling direction. Dry-purging is usually carried out at ambient temperature.

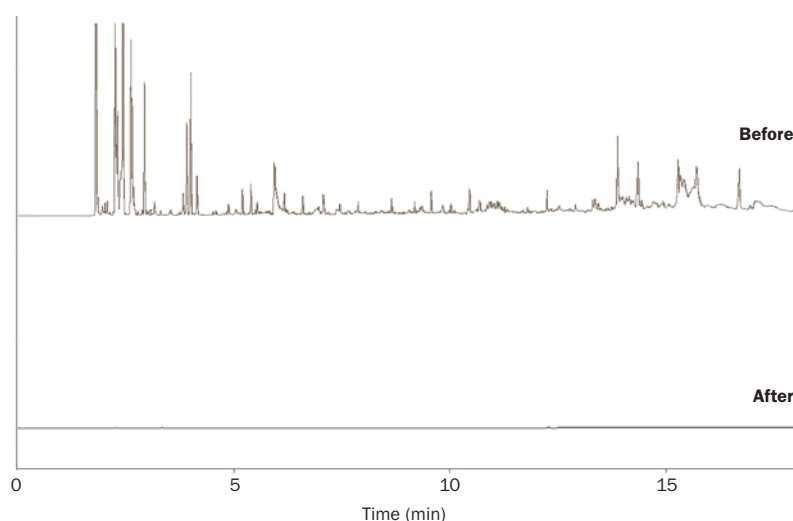
Hints and tips

- ▶ Care must be taken when dry-purging to ensure that safe sampling volumes are not exceeded for the most volatile target analytes, *i.e.* that volatile target analytes are not swept to vent along with the excess water.
- ▶ For further guidance on VOC retention and safe sampling volumes, please see Application Note TDTS 20^{p92}.
- ▶ Dry-purging is also available as an optional part of the tube desorption process on some configurations of Markes' TD autosamplers (e.g. Advanced models of TD-100, ULTRA 50:50, and any Markes tube autosampler configured with ISDP)^{pp 70,71}.

Gas purifiers

We recommend the use of gas purifiers to remove hydrocarbons, oxygen and water on carrier gas lines supplying all our analytical equipment and specialised sampling accessories. Full information on the range of available purifiers is available on page 83.

Description	Part number
TC-20 multi-tube conditioner and dry-purge unit (115 V)	R-TC20-1
TC-20 multi-tube conditioner and dry-purge unit (230 V)	R-TC20-2
Filter for TC-20, carbon, 120 mm × 120 mm, pk 4 (replacement filters for cooling fan at rear of TC-20)	R-FLTR4



Tenax tube before and after conditioning for 2 hours at 320 °C using the TC-20, showing its effectiveness for tube conditioning

Micro-Chamber/Thermal Extractor™ (μ -CTE™)

Markes' Micro-Chamber/Thermal Extractor (μ -CTE) units provide the perfect solution for monitoring vapour profiles and emissions from a wide variety of complex materials. Each micro-chamber has a capacity of 44 or 114 mL, and can operate anywhere from ambient temperature to 250 °C, giving real application versatility.

Clean, dry gas (air, nitrogen or helium) is purged through each micro-chamber at a flow rate between 10 and 500 mL/min. Compounds released from the test specimen are swept through the exhaust and collected onto sample tubes (sorbent tubes for (S)VOC analysis, DNPH cartridges for formaldehyde analysis). A constant flow is maintained through each chamber (independent of sorbent tube impedance), without need for pumps or electronic mass flow control equipment. The Micro-Chamber/Thermal Extractor is compatible with 6 mm and 6.4 mm (1/4") o.d. sorbent tubes. Adaptors are also available to connect DNPH cartridges with 4 mm Luer lock ends. Material emissions screening data from the Micro-Chamber/Thermal Extractor has been shown to correlate with reference methods¹.

The Micro-Chamber/Thermal Extractor is available in two versions:

Six-chamber Micro-Chamber/Thermal Extractor (max. 120 °C)

Comprises six inert-coated micro-chambers, each with a volume of 44 cm³ (45 mm i.d. × 28 mm deep), allowing surface or bulk emissions to be tested from up to six samples simultaneously. Samples can be heated from ambient temperature to 120 °C.

Four-chamber Micro-Chamber/Thermal Extractor (max. 250 °C)

Comprises four inert-coated micro-chambers, each with a volume of 114 cm³ (64 mm i.d. × 36 mm deep), allowing surface or bulk emissions to be tested from up to four samples simultaneously. Samples can be heated from ambient temperature to 250 °C.

Both the six- and four-chamber models can be supplied with toggle valves, enabling the gas flow in unused chambers to be turned off, and therefore reducing operating costs.

A world of applications

Markes' Micro-Chamber/Thermal Extractor is a highly versatile and convenient sample preparation tool for a wide range of TD-GC(MS) applications. Key examples include:

- **Material emissions screening:** Surface-only or bulk emissions testing can both be accommodated. Compatible materials include construction and decorative products, car trim components, furniture, furnishings, toys, electronics and general consumer goods
- **Aroma and fragrance profiling:** The Micro-Chamber/Thermal Extractor is ideal for everything from cheese and potato chips to soap powder and shampoo
- **Accelerated food shelf-life studies:** Product odours can be monitored as they change over time
- **Off-gassing of semi-volatiles:** High-boiling 'fogging' compounds from polymeric products can be evaluated according to ISO 16000-25.

Hints and tips

- ▶ The Micro-Chamber/Thermal Extractor is compatible with a variety of sample types including polymers, textiles, paints/resins, foodstuffs, wood-based products, plasterboard, insulation materials and adhesives. Samples can be weighed directly into an empty chamber, placed in a custom-made 'sample boat' within the chamber, or raised up to enable surface-only emissions.
- ▶ We recommend the use of a secondary gas regulation system (e.g. the single regulator pneumatics accessory, U-GAS03^{p82}) and gas purifiers^{p83} on the gas input line.



1. T. Schripp, B. Nachtwey, J. Toelke, T. Salthammer, E. Uhde, M. Wensing and M. Bahadir, A microscale device for measuring emissions from materials for indoor use, *Analytical and Bioanalytical Chemistry*, 2007, 387: 1907–1919.

Starter kits for the Micro-Chamber/Thermal Extractor

The starter kit for the 6-chamber Micro-Chamber/Thermal Extractor (max. 120 °C) (part number M-STUKTI) contains:

Sample pans, inert-coated, pk 6	M-MCHSI
Detachable sample lids, inert-coated, pk 6	M-MCTOPI
Tube interface caps, pk 6	M-TICAP
M4 flanged nuts for removable lids, pk 6	SERZ-NM4FLGSS
Nut driver tool (for releasing lids)	SERZ-0669
Adjustable sprung spacers, pk 6	M-SPGSC-120
Aluminium collar spacers (15 mm), pk 6	M-SPC15-120
Aluminium collar spacers (5 mm), pk 6	M-SPC05-120
Aluminium spacer discs (1.5 mm), pk 24	M-DSK15-120
Routine maintenance kit (selection of O-rings)	RMK-0006
Inert-coated stainless steel tubes, packed with Tenax TA, conditioned and capped, 2 x pk 10	2 x C1-CAXX-5003
CapLok tool	C-CPLOK

The starter kit for the 4-chamber Micro-Chamber/Thermal Extractor (max. 250 °C) (part number M-STUKT250I) contains:

Sample pans, inert-coated, pk 4	M-MCHSS250I
Detachable sample lids, inert-coated, pk 4	M-MCTOP250I
Tube interface caps, pk 6	M-TICAP
M3 hexagonal ball driver (spanner)	SERZ-0861
Adjustable sprung spacer assemblies, pk 4	M-SPGSC-250
Aluminium collar spacers (15 mm), 2 x pk 4	2 x M-SPC15-250
Aluminium collar spacers (5 mm), 3 x pk 4	3 x M-SPC05-250
Aluminium spacer disks (1.5 mm), pk 24	M-DSK15-250
Liquid sample inserts, pk 4	M-TSTIN
Routine maintenance kit (selection of O-rings)	RMK-0006HT
Inert-coated stainless steel tubes, packed with Tenax TA, conditioned and capped, pk 10	C1-CAXX-5003
CapLok tool	C-CPLOK

Micro-Chamber/Thermal Extractor – Rapid screening of product emissions and odour profiles

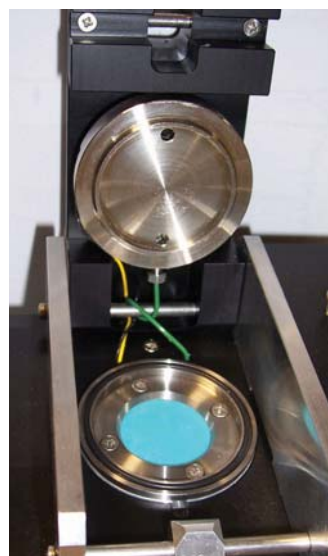
Accessory for permeation testing

Barrier materials are often used in protective clothing and product packaging to mitigate potentially harmful product emissions.

Typical examples include:

- Vehicle seat coverings – to prevent VOCs from polyurethane foam contaminating car cabin air
- Food packaging film – to prevent oxygen or VOCs tainting foodstuffs
- Protective gloves, masks, etc. – to protect against harmful chemicals, e.g. chemical warfare agents
- Membranes used in vehicle fuel systems to prevent the loss of fuel vapour.

Permeation testing of such materials is required by a number of standard methods¹⁻⁵. However, traditional methods for permeation testing require complex, expensive apparatus and can only accommodate one test material at a time. Markes' permeation accessory for the Micro-Chamber/Thermal Extractor enables permeation testing to be carried out on four or six samples simultaneously.



Permeation accessory in situ in a Markes Micro-Chamber/Thermal Extractor

1. ISO 15105-1 and -2; ASTM F1307-02: Plastic films, sheeting, laminates etc.
2. EN 374-3; ASTM F739: Gloves.
3. ISO 13994: Penetration test.
4. ASTM F739-99a: Resistance of protective clothing materials – continuous contact.
5. ASTM F1407-99a: Resistance of chemical protective clothing – liquid permeation.

To test the permeability of a material, a sample is stretched across the permeation accessory and secured in place as shown. A small droplet of test compound is then injected into a well at the bottom of the accessory. The complete assembly is then placed inside one of the micro-chambers, and clean air is passed over the surface of the stretched material. Permeation is then readily assessed by monitoring the air exiting each micro-chamber, using sorbent tubes and TD-GC/MS analysis in the normal way.



Latex sample secured in the permeation accessory

Accessories for surface emissions testing

Markes provides a range of sample supports that allow surface-only emissions to be studied using the Micro-Chamber/Thermal Extractor. Variable-depth spacers raise samples up, so that when the micro-chamber lid is closed the ring protruding from the lid precisely and reproducibly defines the area of material that will be sampled. This eliminates edge effects and allows area-specific emission rates to be quantitatively determined.



Adjustable sprung spacers for correctly positioning rigid planar materials within the Micro-Chamber/Thermal Extractor

Accessories for formaldehyde sampling

Markes provides O-rings and spacers that allow the Micro-Chamber/Thermal Extractor to be used for testing formaldehyde emissions. These fittings reduce the size of the connector on the micro-chamber, allowing it to accommodate the 4 mm Luer fitting of the standard DNPH cartridge sampler.

Other accessories for the Micro-Chamber/Thermal Extractor

[PTFE discs](#)

A pack of 1 mm thick PTFE discs is available for use with sticky or resinous samples such as adhesives and pastes. Applying such samples to the PTFE disc ensures that the chambers are kept clean during sampling. The discs can usually be re-used depending on the nature of the samples.

[Inserts for liquid standards](#)

PTFE inserts with centrally-positioned wells are available for use with small-volume (<1 mL) liquid samples and standards¹.

[Routine maintenance kits](#)

Maintenance kits are also available for the Micro-Chamber/Thermal Extractor. These contain a useful selection of O-rings and an O-ring insertion tool, and are recommended for routine operation.

Innovative sampling accessories from Markes extend the TD application range

1. Care should be taken when using liquids with the Micro-Chamber/Thermal Extractor. For further information please contact Markes Technical Support team (enquiries@markes.com).

Part numbers for the 6-chamber Micro-Chamber/Thermal Extractor (max. 120 °C)

Description	Part number
Micro-Chamber/Thermal Extractor, 6-chamber, inert	M-CTE120I
Micro-Chamber/Thermal Extractor, 6-chamber, inert, with 6 toggle valves	M-CTE120TI
Starter kit for Micro-Chamber/Thermal Extractor, inert	M-STUKTI
Sample pan, stainless steel, pk 6	M-MCHSS
Removable lids, stainless steel, pk 6	M-MCTOP
Sample pan, inert, pk 6	M-MCHSI
Removable lids, inert, pk 6	M-MCTOPI

Accessories for permeation testing

Description	Part number
Permeation accessory, stainless steel, pk 1	M-PRMIN1
Permeation accessory, stainless steel, pk 6	M-PRMIN
Permeation accessory, inert, pk 1	M-PRMINSS1-120
Permeation accessory, inert, pk 6	M-PRMINSS-120
O-Ring, 30 mm o.d., permeation accessory seal, pk 6	M-PRO30-120
Septa, ¼", for permeation accessory injection port, pk 6	M-PRSPT-120

Accessories for surface emissions testing

Description	Part number
Collar spacer, Al, 15 mm, pk 6	M-SPC15-120
Collar spacer, Al, 5 mm, pk 6	M-SPC05-120
Spacer disc, Al, 1.5 mm, pk 24	M-DSK15-120
Adjustable sprung spacer, pk 6	M-SPGSC-120

Accessories for formaldehyde sampling¹

Description	Part number
O-Ring, size 007, and spacer to connect 4 mm Luer cartridge, pk 6 (for DNPH cartridges)	M-TCN04

Other accessories

Description	Part number
Sample disc, 1.0 mm thickness, PTFE, pk 6	M-DSKPF
Routine maintenance kit for Micro-Chamber/Thermal Extractor	RMK-0006
Pneumatics accessory (single regulator) ²	U-GAS03
O-Ring, size 010, to connect ¼" o.d. tubes, pk 6 (for standard tubes)	M-TCN64
O-Ring, 5.92 mm i.d., to connect 6 mm o.d. tubes, pk 6	M-TCN06
O-Ring, size 006, for gas line connection to removable lid, pk 6	M-MC006
Tube interface cap for removable lid, pk 6	M-TICAP
O-Ring, micro-chamber pan seal, pk 6	M-MCHOR

1. DNPH cartridges are not included.

2. It is recommended that a pneumatics accessory (U-GAS03⁸²) is used with every Micro-Chamber/Thermal Extractor.

Part numbers for the 4-chamber Micro-Chamber/Thermal Extractor (max. 250 °C)

Description	Part number
Micro-Chamber/Thermal Extractor, 4-chamber, inert	M-CTE250I
Micro-Chamber/Thermal Extractor, 4-chamber, inert, with 4 toggle valves	M-CTE250TI
Starter kit for Micro-Chamber/Thermal Extractor, inert	M-STUKT250I
Sample pan, stainless steel, pk 4	M-MCHSS250
Removable lids, stainless steel, pk 4	M-MCTOP250
Sample pan, inert, pk 4	M-MCHSS250I
Removable lids, inert, pk 4	M-MCTOP250I

Accessories for permeation testing

Description	Part number
Permeation accessory, stainless steel, pk 1	M-PRMIN1-250
Permeation accessory, stainless steel, pk 4	M-PRMIN-250
Permeation accessory, inert, pk 1	M-PRMINSS1-250
Permeation accessory, inert, pk 4	M-PRMINSS-250
O-Ring, 30 mm o.d., permeation accessory seal, pk 4	M-PRO30-250
Septa, ¼", for permeation accessory injection port, pk 6	M-PRSPT-250

Accessories for surface emissions testing

Description	Part number
Collar spacer, Al, 15 mm, pk 4	M-SPC15-250
Collar spacer, Al, 5 mm, pk 4	M-SPC05-250
Spacer disc, Al, 1.5 mm, pk 24	M-DSK15-250
Adjustable sprung spacer, pk 4	M-SPGSC-250

Accessories for formaldehyde sampling¹

Description	Part number
O-Ring, size 007, and spacer, to connect 4 mm Luer cartridge, pk 6 (for DNPH cartridges)	M-TCN04

Other accessories

Description	Part number
Sample disc, 1.0 mm thickness, PTFE, pk 6	M-DSKPF
Inserts for liquid standard introduction, PTFE, pk 6	M-TSTIN
Routine maintenance kit for Micro-Chamber/Thermal Extractor	RMK-0006HT
Pneumatics accessory (single regulator) ²	U-GAS03
O-Ring, size 010, to connect ¼" o.d. tubes, pk 6 (for standard tubes)	M-TCN64
O-Ring, 5.92 mm i.d., to connect 6 mm o.d. tubes, pk 6	M-TCN06
O-Ring, size 006, for gas line connection to removable lid, pk 6	M-MC006
Tube interface cap for removable lid, pk 6	M-TICAP
O-Ring, micro-chamber pan seal, standard (for applications <200°C), pk 4	M-MCHOR250
O-Ring, micro-chamber pan seal, ultra-high purity standard (for applications >200°C), pk 4	M-MCHOR250HT

Thermal analysis/evolved gas collection

Thermal desorption can also be used to investigate the nature of gases evolved during thermogravimetric analysis (TGA) and microthermal analysis. Gases evolved from these thermal analysis processes are pumped onto specially designed MacroTubes™ (TGA analysis) or MicroTubes™ (microthermal analysis). Both tube types are packed with sorbents and analysed by Markes' thermal desorption systems.

Evolved gas analysis is used for a range of applications including:

- Studies of degradation mechanisms for stabilisers, flame retardants, smoke suppressants, etc.
- Polymer characterisation
- Toxicity studies
- Catalyst investigations
- Studies of solid- or gas-phase reactions.



MacroTubes and MicroTubes for evolved gas analysis

Description	Part number
MacroTubes, general screening (n-C ₅ to n-C ₃₀), conditioned and capped, pk 5	E-MATBG5
MacroTubes, high volatility (n-C ₃ to n-C ₁₀), conditioned and capped, pk 5	E-MATBV5
Macro connector	E-MACNT
Macro connector carrier	E-MACAR
MicroTubes, general screening (n-C ₅ to n-C ₃₀), condition before use, pk 5	E-MITBE5
MicroTubes, general screening (n-C ₅ to n-C ₃₀), condition before use, pk 50	E-MITBE50
MicroTube carrier	E-MICAR
MicroTube carriers, pk 10	E-MICAR10
O-Ring, chemically inert, spare for MicroTube carrier	E-MICOR

SPE-tD and HS-TD – Extending the power of thermal desorption to the aqueous phase

SPE-tD™ sorptive extraction cartridges

Markes' SPE-tD cartridges offer a simple, convenient method for sampling less volatile impurities in aqueous samples – applications that would otherwise require manually intensive extraction or distillation techniques before GC/MS analysis. Applications include:

- Off-odours/taints in drinking water
- Volatiles and semi-volatiles in processed fruit juices
- Profiling of hydrosols (the aqueous fraction from steam distillation of natural oils).



SPE-tD cartridge alongside a glass tube

SPE-tD cartridges comprise a hollow tube, coated inside and out with poly(dimethylsiloxane) (PDMS) for optimum sampling capacity. The cartridge is placed into a sample and agitated, causing volatile and semi-volatile organics in the sample to partition between the aqueous matrix and the PDMS until equilibrium is reached. The cartridge is then removed, rinsed, and placed into an empty TD tube prior to analysis by direct TD-GC/MS. This allows semi-quantitative analysis of less volatile organics, and direct comparison of organic chemical concentrations in two similar samples.

An **SPE-tD starter kit** is also available, containing:

SPE-tD cartridges (30 mm length), pk 5	C-SPTD5
Glass tubes, empty, restriction at 15 mm, pk 10	CO-BXXX-0000
Springs, torsion, for 4 mm i.d. glass tubes, pk 10	C-GTSP10
Quartz wool (10 g)	C-QUTZW
Cold trap, Tenax TA, UNITY 2/TD-100	U-T9TNX-2S
Cap, storage, brass, ¼" & PTFE ferrule, pk 20	C-CF020

Description	Part number
SPE-tD cartridge (30 mm), pk 1	C-SPTD1
SPE-tD cartridge (30 mm), pk 5	C-SPTD5
SPE-tD cartridge (30 mm), pk 10	C-SPTD10
SPE-tD cartridge (6 mm), pk 1	C-SPTD1-6MM
SPE-tD cartridge (6 mm), pk 5	C-SPTD5-6MM
SPE-tD cartridge (6 mm), pk 10	C-SPTD10-6MM
Starter kit for SPE-tD	C-KITSP-2S

Headspace–Thermal Desorption (HS–TD)

Markes' HS–TD systems bring together two powerful GC introduction techniques: headspace (HS) and thermal desorption (TD). By combining an HS system with TD, users are offered optimum sensitivity for trace VOCs in solid, liquid and vapour-phase samples, all on one versatile analytical platform.

These HS–TD systems are based on Markes' world-leading UNITY 2 or ULTRA–UNITY 2 thermal desorbers, and are designed to integrate with a range of equilibrium HS systems to suit all applications and budgets.

The following equilibrium HS units can be integrated with (ULTRA–)UNITY 2 using the appropriate connection kit:

- Markes' HS5-TD: an entry-level system for up to five vials
- G1888: an automated HS system for 70 vials (Agilent Technologies)
- G1290: an automated HS system (HP7694) for 44 vials (Agilent Technologies)
- HS40 and HS40XL: automated HS systems for 40 vials (Perkin Elmer)¹.

In addition to these systems, the manual Universal Direct Inlet Accessory (U-INLET) for UNITY allows HS vapours from a wide range of sample containers to be focused directly on the UNITY cold trap.

Hints and tips

- ▶ These connection kits do not hinder standard tube desorption, and can be readily exchanged with the link to an ULTRA 2 autosampler for automated tube analysis.

An **HS5-TD starter kit** is also available, containing:

Crimp-top vials, pk 500	0.5 x U-HSV00
Crimp tops, pk 500	0.5 x U-HSVC0
Crimper tool	U-HSVCR

Mode of operation

In HS–TD, pressurised headspace vapours are transferred from the sample vial into the electrically cooled cold trap of the UNITY 2 thermal desorber by a 'pulsed direct sampling' process. This process can be repeated many times before the trap is finally desorbed and GC analysis starts.

The key advantages of HS–TD

- Typically 10–100 times more sensitive than static equilibrium headspace techniques, and without the foaming or aerosol issues that sometimes accompany purge-and-trap methods
- Increased recovery of higher-boiling analytes relative to conventional static headspace
- Automatic purging of the focusing trap with dry carrier gas prior to desorption selectively eliminates unwanted interferences such as water and ethanol, simplifying the chromatographic analysis of complex vapour profiles.



Markes' HS5-TD system with UNITY thermal desorber

HS5-TD™

The HS5-TD accessory for UNITY 2 is an entry-level, manually operated HS-trap system designed for up to five standard headspace vials. Vials are accommodated in a common heated zone, and are manually selected for analysis. An inert needle is inserted into the HS vial before sample pressurisation and extraction by the UNITY 2. In addition to HS-trap functionality, a UNITY 2 with HS5-TD is also fully compatible with standard TD operation with sorbent tubes.

For more information on Markes' HS5-TD accessory, please contact one of our specialists (enquiries@markes.com), or visit our website to download the brochure.

1. Not compatible with the Perkin Elmer TurboMatrix HS40 system.

Universal Direct Inlet Accessory (U-INLET™)

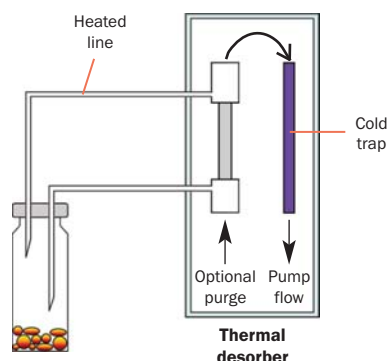
The Universal Direct Inlet Accessory can be added to any manual UNITY TD platform (series 1 or 2). It provides a simple and convenient mechanism for direct introduction of headspace vapours from a wide range of bulk sample containers.

U-INLET comprises a purge line (which can be used to direct carrier gas into the sample vessel) and a heated inert sampling line through which headspace vapours are pumped or purged straight into the UNITY cold trap. Compatible sample vessels include smaller, sealed containers (e.g. headspace vials or reaction vessels), and open or compressible containers such as bell jars or gas sampling bags.

If sampling is to be performed from a non-pressurised system, *i.e.* ambient air or a gas sampling bag, then a pump is required to draw sample through the system (e.g. the U-ASPM1 or U-ASPM2).

The accessory may also be used to sample vapours from the same vessel semi-continuously in a user-defined sequence. This is either done to increase the volume of vapour sampled, thus enhancing sensitivity, or to monitor vapour composition changes over time.

The U-INLET can operate in two sampling modes: **dynamic direct** and **pulsed direct**. Sampling times/sequences for both are controlled directly from the UNITY software.



Schematic of Universal Direct Inlet Accessory (U-INLET)

Dynamic direct sampling

In dynamic mode, U-INLET delivers a continuous flow of carrier gas that sweeps through the sample vessel, purging the headspace vapours into the UNITY cold trap for a defined time. This method is compatible with sampling from:

- a sealed reaction vessel (with/without an external gas supply)
- a pressurised container, e.g. a canister
- a non-pressurised system, e.g. ambient air or a sampling bag.

Pulsed direct sampling

This is the same approach used in the HS-trap systems described on page 57.

Applications for HS-TD

Typical HS-TD applications include:

- **Environmental monitoring and health & safety**
 - VOCs in drinking water, groundwater, soils and waste
 - Detection of trace odorants in drinking water.
- **Food, flavour and fragrance**
 - Profiling of consumer products
 - Off-odour and taint in foods and beverages
 - Residual solvents in packaging and investigation of odour complaints
 - Biological emissions (e.g. kinetic studies, fragrance profiling and species identification)
 - Tobacco profiling and smoking research.
- **Volatiles in materials**
 - Residual monomer in polymer
 - Product and materials emissions screening
 - Forensic applications (ink characterisation, fire debris, explosive residues, proscribed drugs, etc.)
 - Organics in water-based paints
 - Residual solvents in powdered pharmaceuticals, ointments and creams.

See our Applications Guides^{p91} and Application Notes TDTS 78, 88, 91 and 96^{p92} for examples of the use of HS-TD.

Description	Part number
HS5-TD headspace system	U-HS5TD
HS-TD connection kit, UNITY(e) to G1290	U-HSTD-G1290
HS-TD connection kit, UNITY(e) to G1888	U-HSTD-G1888
HS-TD connection kit, UNITY(e) to HS40	U-HSTD-HS40
Starter kit for HS5-TD	U-HSKIT
Vials, crimp-top, 20 mL, clear, pk 1000	U-HSV00
Crimps, 20 mm aluminium cap, silicone/PTFE liner, pk 1000	U-HSVC0
Crimper, 20 mm crimp-top vials	U-HSVCR
Decapper, 20 mm crimp-top vials	U-HSVDC
Routine maintenance kit for HS5-TD	RMK-0008
Replacement needle assembly for HS5-TD	U-HSNAS
Universal Direct Inlet Accessory (U-INLET)	U-INLET
Pump (115 V)	U-ASPM1
Pump (230 V)	U-ASPM2



20 mL crimp-top vials

Bio-VOC™ breath sampler

Based on pioneering work carried out at the UK Health & Safety Laboratory¹, Markes' Bio-VOC breath sampler is a simple-to-use device designed for non-invasive biological exposure monitoring of volatile organic compounds (VOCs). Elevated levels of one or more VOCs within the body may indicate:

- Environmental or occupational exposure (*i.e.* absorption of chemicals from the environment or workplace through the skin, or by ingestion or inhalation)
- A clinical condition (there is evidence that VOC patterns in exhaled breath can be characteristic of certain diseases, and this is an area of continued research).

Conventional workplace biological monitoring methods measure target compounds or their metabolites directly in blood or urine. However, these methods are invasive and may require medically trained staff. This has made it expensive and difficult to undertake large-scale surveys of biological exposure in the past, either in the workplace or of the general public. As a result, occupational and environmental scientists have had to rely on standard tests of chemical concentrations in the atmosphere, and ignore (or estimate) potential exposure *via* skin absorption and ingestion.

The sampler harnesses the close relationship between chemical concentrations in the blood and the air deep down in the lungs – known as end-tidal (or alveolar) air. There is a rapid, almost instantaneous, partitioning of VOCs between the blood and alveolar air. Measurement of the VOCs in end-tidal air is therefore an ideal non-invasive method of monitoring the blood concentration and body burden of VOCs.



Taking a breath sample using the Bio-VOC

Constructed of safe, non-emitting plastic, the Bio-VOC can be operated with minimal training and without medically qualified staff in attendance. Each Bio-VOC is supplied with a disposable cardboard mouthpiece. Additional packs of mouthpieces are available to order.

An adult, exhaling deeply, typically breathes out over 4 L of air, of which just the last 127 mL is retained by the Bio-VOC. The sampler therefore collects a representative sample of end-tidal air, without contamination or dilution with breath from the bronchial tubes or mouth.



Bio-VOC parts

Once the breath has been collected, a screw-in plunger is used to steadily discharge the sample into a sorbent tube (or a direct read-out instrument). After collection onto a sorbent tube, the sample is sealed^{p20}, ensuring the breath sample is stable for transportation and analysis – another distinct advantage over blood and urine samples. The Bio-VOC sampler may be used repeatedly by the same individual during the course of a day (typically using a new mouthpiece each time), and is then discarded or cleaned before re-use.

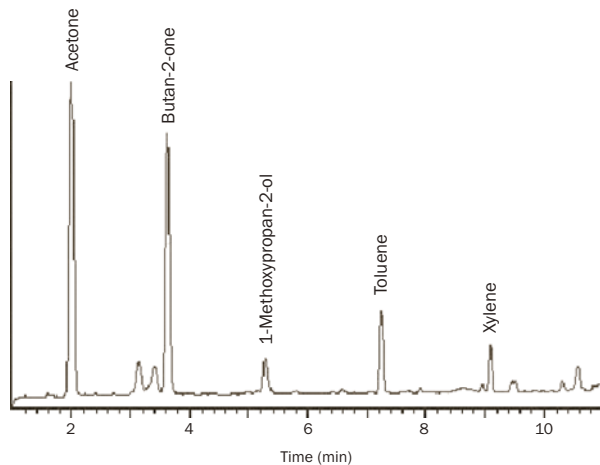
**Bio-VOC breath sampling –
A simple non-invasive approach
to biological monitoring and
disease diagnosis**

1. H.K. Wilson, Breath analysis. Physiological basis and sampling techniques, *Scandinavian Journal of Work, Environment & Health*, 1986, 12: 174–192.

Industrial applications of breath sampling

Biological monitoring, *i.e.* measuring the actual body burden of VOCs, is a way of assessing total exposure by all routes (dermal, inhalation, ingestion), and is the ultimate exposure test for workers in high-risk industries such as paint, petrochemicals and dry-cleaning.

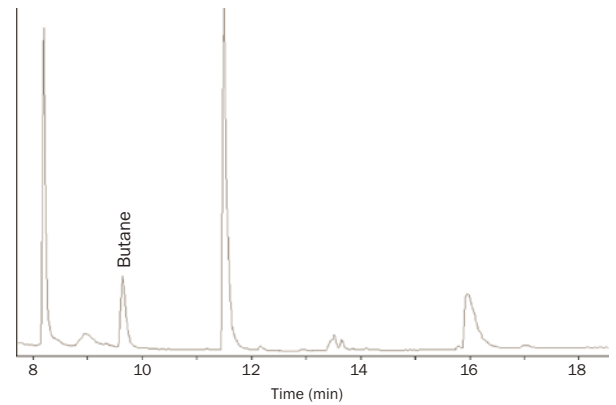
Such monitoring can also provide vital information on the potentially harmful build-up of chemicals in the body, particularly in fatty tissues, after prolonged low-level (chronic) exposure, *e.g.* to halogenated solvents. In addition, breath monitoring provides a valuable check on the efficacy of respiratory protective apparatus and protective clothing at work. It can also be used to assess risk, by taking samples before and after the operation of a particular task and recording changes in the VOC profile of the breath. Guidance notes are available¹ that provide information on interpreting solvent exposure with respect to occupational limits.



Skin-absorbed solvents in the breath of workers in a shoe factory collected using the Bio-VOC

Clinical applications of breath sampling

The Bio-VOC sampler is also used for research into the clinical diagnostic potential of breath. Clinicians have long used the fruity smell of acetone on the breath as an early indication of diabetes and the pungent smell of ammonia as a sign of possible kidney failure. It is now widely hypothesised that the presence of specific chemicals or specific combinations of chemicals in the breath may provide a reliable diagnosis of certain otherwise difficult-to-diagnose and disabling diseases – among them psychiatric conditions, various cancers and metabolic failure in premature infants. Laboratory and clinical research in this area has previously been hampered by the lack of a simple and reliable method of sampling the alveolar portion of breath from patients and control groups. However, several research groups worldwide are now using the Bio-VOC to pursue this exciting field of study.



Bio-VOC breath sample from a patient. Trace levels of VOCs, *e.g.* butane, are used to assist in clinical diagnoses

Chromatogram reproduced by kind permission of Psychiatric Diagnostics Ltd, Inverness, Scotland

Description	Part number
Bio-VOC breath sampler, pk 1	C-BIO01
Bio-VOC breath sampler, pk 10	C-BIO10
Bio-VOC breath sampler, pk 50	C-BIO50
Bio-VOC breath sampler, pk 100	C-BIO100
Disposable cardboard mouthpieces, pk 100	C-B100M

1. Breath sampler guidance notes – Information on interpreting solvent exposure, UK Health & Safety Laboratory (available from Markes International).

VOC-Mole™ soil probe

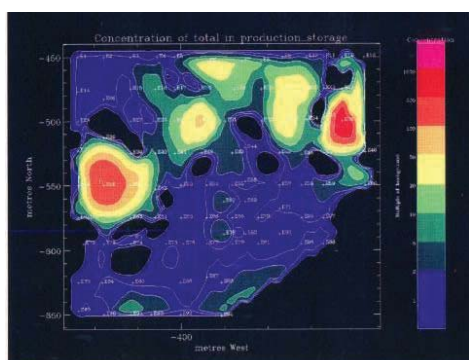
Underground fuel or chemical leaks can present a grave environmental risk and slow down the remediation of brownfield sites. Markes' VOC-Mole provides a simple method of screening for volatile organic compounds in contaminated land. It facilitates effective surveys of commercial, waste and brownfield sites, pinpointing underground leaks or surface spills and cost-effectively tracking pollution flow.



VOC-Mole soil probe and additional cap assembly with sample tube

Soil probes allow cost-effective *in situ* screening of large areas of land, including active production sites. They can also be placed along the length of fuel pipelines to provide early warning of a leak. Diffusive tubes inside the soil probes can monitor the soil gases for ~24 hours. Pumped tubes can also be used.

VOC-Moles are typically arranged in a grid pattern over the site of interest, allowing organic pollutants to migrate into the hollow probe and collect (either diffusively or by active sampling) onto sorbent tubes inside. Automated TD-GC/MS analysis allows rapid identification of the nature, source and spread of ground contamination, and gives a good indication of soil gas/vapour levels.



VOC-Mole soil probes arranged in a grid pattern around an industrial site allow low-cost mapping of contaminated ground

Constructed of stainless steel, the VOC-Mole can be left *in situ* for long periods of time, with vapour samples collected onto sorbent tubes at whatever frequency is demanded by the application.

The VOC-Mole is available in three probe lengths and there is also a modified version for use in marshy ground. The unique aluminium sampling cap (a Markes copyrighted design) makes the probe suitable for both diffusive and pumped sampling. The cap contains O-ring seals to prevent the ingress of water, wildlife and general soil debris. Tube and sampling cap assemblies can be prepared in the laboratory and sealed ready for transportation to the field (where the probes may already be *in situ*).

A variety of different sampling regimes can be undertaken, for example:

- Standard diffusive monitoring over a long time period (*i.e.* 24 hours)
- Pumped monitoring, with the sample tube placed within or outside the probe
- Pumped sampling using two tubes in series, to monitor potential breakthrough of highly volatile components
- Using hand-held PID or FID detectors to screen organic vapour levels inside the VOC-Mole.

Description	Part number
VOC-Mole assembly, 29.5 cm long, pk 1	P-0001
VOC-Mole assembly, 29.5 cm long, pk 10	P-00010
VOC-Mole assembly, 44.5 cm long, pk 10	P-00020
VOC-Mole assembly, 89.5 cm long, pk 10	P-00030
VOC-Mole assembly, 89.5 cm long, modified for use in marshy ground, pk 10	P-00040
VOC-Mole cap assembly, pk 1	P-CP001
VOC-Mole cap assembly, pk 10	P-CP010
Brass impact former for driving soil probes into the ground	P-FORMR
O-Rings, for VOC-Mole cap assembly, 23 mm x 3 mm i.d., pk 20	P-CP020
Unions, for VOC-Mole cap assembly, pk 10	P-CPU10
Blanking plugs, for VOC-Mole cap assembly, pk 10	P-CPP10
Dowty seals, for VOC-Mole cap assembly, pk 20	P-CPS20
Ferrules, PTFE, for VOC-Mole cap assembly, pk 10	P-CPF10

Soil gas and underground leaks – VOC-Mole takes air monitoring underground

Direct desorption

Thermal desorption isn't just for sorbent tubes and vapour samples. It can also be used for the direct desorption (extraction) of VOCs from a wide range of sample matrices, e.g. powdered solids, sugar/salt solutions, suspensions, resins, creams, fibres and films (see Application Note TDTS 9^{p92}). Applications include:

- Residual volatiles in ointments, packaging films, pharmaceuticals/drug powders and polymer beads
- VOC emissions from consumer goods (e.g. paints, car trim components, moulded PVC and adhesives)
- Characteristic vapour profiles from foodstuffs and fragrant products (e.g. soap powder and shampoo).

Direct desorption provides information on the (S)VOC content of materials that is complementary to that obtained by conventional emissions testing. It facilitates selective concentration of the compounds of interest, while water or other solvents are purged to vent, and features in several standard methods^{1,2}.

To carry out direct desorption using TD tubes, a known amount of sample is weighed into an empty tube or tube liner and desorbed (normally at low temperatures). In this case, sample cleanup, analyte extraction and sample injection are all combined into one simple, automated operation. The method can be tailored to meet specific analytical requirements, e.g. to obtain a representative vapour profile, or to achieve complete quantitative extraction of one or more specific target volatiles.

Hints and tips

- ▶ Some samples (materials/products) are homogeneous and suitable for direct thermal desorption/extraction in empty TD tubes (see below). Other materials require larger samples to be representative. In these cases, the Micro-Chamber/Thermal Extractor^{p52} or HS-TD^{p57} are often used.
- ▶ Glass tubes are ideal for direct desorption. Their transparency makes method development easier, as the physical state of the sample can be easily seen after each desorption.
- ▶ Empty, unrestricted glass tubes can be used if the product is retained between two plugs of quartz wool, held in place with a small torsion spring^{p18}. Alternatively, glass tubes can be used that have a restriction at 30 mm (this ensures the sample is positioned correctly with respect to the thermal desorption oven). A quartz wool plug and a torsion spring are positioned behind the sample to retain it in the tube.

If direct desorption in an empty tube could cause irreversible contamination of that tube, it's best to place the sample in a disposable tube liner. Markes' direct desorption liners are made from PTFE and designed for use with stainless steel tubes. They protect the tube walls and simplify sample weighing. Two types of liners are available:

- **Snug-fit liners**, which should be used for most powdered/granular samples
- **Loose-fit liners**, suitable for semi-solid samples, which need to be smeared around the inside of the liner.



PTFE liners for direct sampling shown alongside an empty tube

Hints and tips

- ▶ In all cases, it is critical that the sample does not plug the liner and that carrier gas can continue to flow through unimpeded.
- ▶ Loose-fit liners may also be inserted into tubes packed with a small bed (~1 cm) of sorbent, preventing high-boiling debris from the sample matrix migrating into the flow path.

Direct desorption starter kit

This kit contains:

Glass tubes, empty, restriction at 30 mm, pk 10	CO-NXXX-0000
Stainless steel tubes, empty, pk 10	CO-AXXX-0000
Cold trap, material emissions, UNITY 2/TD-100 <i>Compatible with the simultaneous analysis of analytes from n-C₄ to n-C₃₂</i>	U-T12ME-2S
PTFE liners, snug-fit, pk 10	C-PI010
PTFE liners, loose-fit, pk 10	C-PL010
Quartz wool, 10 g	C-QUTZW
Sorbent, Tenax TA (35/60), 10 g	C-TNXTA
Springs, torsion, for 4 mm i.d. glass tubes, pk 10	C-GTSP10

Description	Part number
Tube, empty, glass, restriction at 30 mm, pk 10	CO-NXXX-0000
Tube, empty, glass, restriction at 15 mm, pk 10	CO-BXXX-0000
Tube, empty, glass, unrestricted, pk 10	CO-FXXX-0000
Tube, empty, stainless steel, pk 10	CO-AXXX-0000
Tube, empty, inert, pk 10	CO-CXXX-0000
Liner, PTFE, snug-fit, pk 10	C-PI010
Liner, PTFE, snug-fit, pk 100	C-PI100
Liner, PTFE, loose-fit, pk 10	C-PL010
Liner, PTFE, loose-fit, pk 100	C-PL100
Direct desorption starter kit	C-KITDD-2S

1. VDA 278 – Determination of organic emissions from non-metallic trim components used to manufacture the interior of motor vehicles by TD.
2. US EPA Method 311 – Hazardous air pollutants in paints and coatings.

Starter kits

Markes provides a range of general-purpose and application-specific kits to get you started in thermal desorption. These kits contain all the consumables you need to set up your Markes TD system for application in question.

Details of additional kits, specific to individual instruments or accessories, can be found on the relevant pages within other sections, as follows:

- Page 19 for the TubeTAG starter kit
- Page 33 for the Easy-VOC starter kit
- Page 53 for the Micro-Chamber/Thermal Extractor starter kits
- Page 56 for the SPE-tD starter kit.

Should you have any questions about which accessories or consumables are best suited to your application, please don't hesitate to contact us (enquiries@markes.com).

General TD starter kits	64
Chemical warfare agent starter kit	64
Environmental monitoring starter kits	65
Material emissions starter kits	66

Kits to get you up and running quickly

General TD starter kits

Two general-purpose TD starter kits (with standard 3½" tubes) are available for the UNITY 2 and TD-100.

The **Basic TD starter kit** contains:

Stainless steel sorbent tubes, packed with Tenax TA/Carbograph 1TD, conditioned and capped, pk 10 <i>Suitable for pumped sampling of VOCs from n-C_{5/6} to n-C_{30/32}</i>	C2-AAXX-5032
CapLok tool for tightening and undoing ¼" brass storage caps	C-CPLOCK
Cold trap, general-purpose carbon, UNITY 2/TD-100, n-C _{4/5} to n-C _{30/32}	U-T11GPC-2S
Quick-seal column connector, pk 10	C-QSC10

The **Advanced TD starter kit** contains:

Stainless steel sorbent tubes, packed with Tenax TA/Carbograph 1TD/Carboxen 1003, conditioned and capped, pk 10 <i>Suitable for pumped sampling of VOCs from C_{2/3} to n-C_{30/32}</i>	C3-AAXX-5266
Stainless steel sorbent tubes, packed with Tenax TA/Carbograph 1TD, conditioned and capped, pk 10 <i>Suitable for pumped sampling of VOCs from n-C_{5/6} to n-C_{30/32}</i>	C2-AAXX-5032
Stainless steel sorbent tubes, packed with Tenax TA, conditioned and capped, pk 10 <i>Suitable for pumped or diffusive sampling of VOCs from n-C_{6/7} to n-C_{30/32}</i>	C1-AAXX-5003
Diffusion caps, pk 10	C-DF010
Empty stainless steel tubes, pk 10	C0-AXXX-0000
Quartz wool, 10 g	C-QUTZW
Spring, gauze-retaining, pk 10	C-SP010
Penclip, pk 10	C-CL010
Ferrule, ¼" PTFE, pk 20	C-FP020
PTFE liners, loose fit, pk 10	C-PL010
Cold trap, TO-15/TO-17 air toxics, UNITY 2/TD-100 <i>Compatible with the simultaneous analysis of analytes from C_{2/3} to n-C_{30/32}</i>	U-T15ATA-2S
Easy-VOC pump, including CapLok tool and carry-case	C-EZVOCPO
Check-standard (BTX, isobornyl methacrylate (IBMA) and dioctyl phthalate), 90 ng/µL (nominal), Tenax TA, pk 10	C-CHK10

N.B. Markes' Comprehensive TD starter kit (C-KIT02-2S) is still available for those people who wish to re-order.

Description	Part number
Basic TD starter kit	C-KIT012-2S
Advanced TD starter kit	C-KIT03-2S

Chemical warfare agent starter kit

Markes' TD technology provides the ultimate pre-concentration and high-sensitivity analytical solution for detecting airborne chemical warfare agents (CWAs). Military and civilian security agencies and government scientists from across the world are using Markes' TD systems for monitoring:

- CWA stockpile sites
- Personal exposure of military personnel
- Performance of protective equipment
- Agent destruction facilities
- Key civilian locations (counter-terrorism).

The **CWA starter kit** is compatible with standard UNITY 2 or TD-100 systems and is intended specifically for analysts in the field of military and homeland defence. It contains:

Inert-coated stainless steel 3½" × ¼" o.d. sorbent tubes, packed with quartz wool/Tenax TA, conditioned and capped, pk 10 <i>Suitable for sampling of G-type nerve agents, mustard gas (HD) and VX</i>	C2-CAXX-5138
Inert-coated stainless steel 3½" × ¼" o.d. sorbent tubes, packed with HayeSep D/Tenax TA, conditioned and capped, pk 10 <i>Suitable for sampling of G-type nerve agents, mustard gas (HD), VX and the G-analogue of VX</i>	C2-CAXX-5250
Cold trap, chemical warfare agents, UNITY 2/TD-100 <i>Compatible with the simultaneous analysis of all the above-mentioned analytes</i>	U-T10CW-2S

Note that equivalent 4½" long DAAMS tubes are also available for ULTRA-X and UNITY-X TD configurations – contact a Markes specialist (enquiries@markes.com) for more details.

For examples of Markes' technology being used in real-world situations across the field of CWAs and forensics, please refer to our Application Notes^{P92} and the publication *Thermal Desorption: A Practical Applications Guide. Volume III. Defence and Forensic*^{P91}.

Description	Part number
CWA starter kit	C-KITCW-2S



Environmental monitoring starter kits

TD is now recognised as the technique of choice for environmental air monitoring and occupational health & safety. A number of standard methods are relevant to this area, including tube-based methods (ISO 16017, ASTM D6196, ISO 16000-6, EN 14662 parts 1 and 4, and US EPA Method TO-17), plus US EPA Method TO-15 and ASTM D5466 for canister-based sampling.

Complementing our leading range of analytical equipment for environmental and workplace air monitoring, we now also offer a number of environmental starter kits for those new to the field. Four kits are available¹:

The **Basic environmental starter kit** is suitable for pumped tube sampling. It contains:

Stainless steel tubes, packed with Tenax TA/Carbograph 5TD, conditioned and capped, pk 10 <i>Suitable for pumped sampling of VOCs from n-C₄ to n-C_{30/32}</i>	C2-AAXX-5149
Cold trap, TO-15/TO-17 air toxics, UNITY 2/TD-100 <i>Compatible with the simultaneous analysis of analytes from C_{2/3} to n-C_{30/32}</i>	U-T15ATA-2S
Easy-VOC pump, including CapLok tool and carry-case	C-EZVOCPO

The **Diffusive monitoring starter kit** is perfect for TD users new to diffusive (passive) air sampling. It contains:

Stainless steel tubes, packed with Tenax TA, conditioned and capped, pk 10 <i>Please see Application Notes TDTS 1 and TDTS 20^{p92} for analyte ranges</i>	C1-AAXX-5003
Stainless steel tubes, packed with Carbograph 1TD, conditioned and capped, pk 10 <i>Please see Application Notes TDTS 1 and TDTS 20^{p92} for analyte ranges</i>	C1-AAXX-5009
Diffusion caps, aluminium, 2 × pk 10	2 × C-DF010
CapLok tool for tightening and undoing ¼" brass storage caps	C-CPLOK
Penclips, 2 × pk 10	2 × C-CL010
Cold trap, TO-15/TO-17 air toxics, UNITY 2/TD-100 <i>Compatible with the simultaneous analysis of analytes from C_{2/3} to n-C_{30/32}</i>	U-T15ATA-2S
Certified reference standard (BTX), 100 ng, pk 10 (includes certificate, chromatogram and shipping blank)	C-BTX100-10

Application-specific starter kits from the TD experts at Markes

1. Note that all the tubes included in environmental monitoring starter kits are 3½" long × ¼" o.d., in compliance with standard methods.

The **TO-15 starter kit** is ideal for analysts setting up canister-based sampling compliant with US EPA Method TO-15 (see Application Note TDTS 81^{p92}). Note that although canisters are compatible with ultra-volatiles such as the lightest freons and C₂ hydrocarbons, they are inherently limited to analytes more volatile than n-C₉₋₁₂. The kit contains:

Cold trap, TO-15/TO-17 air toxics, UNITY 2/TD-100 <i>Compatible with the simultaneous analysis of analytes from C_{2/3} to n-C_{30/32}</i>	U-T15ATA-2S
5 × TO-Can, 1 L, with gauge and ¼" valve	5 × C-TOCAN1
2 × Canister air sampling kit, stainless steel	2 × C-ASK1168SS
Frit, stainless steel, for critical orifice, pk 3	C-ASK2USS

The **TO-17 starter kit** is designed for those wishing to monitor air toxics using pumped tubes in compliance with US EPA Method TO-17 – see Application Note TDTS 86^{p92}. The kit contains:

Glass tubes, packed with Carbograph 1TD/Carboxen 1003, conditioned and capped, pk 10 <i>Suitable for pumped sampling of VOCs from C_{2/3} to n-C₁₄</i>	C2-BAXX-5259
Stainless steel tubes, packed with Tenax TA/Carbograph 1TD/Carboxen 1003, conditioned and capped, pk 10 <i>Suitable for pumped sampling of VOCs from C_{2/3} to n-C_{30/32}</i>	C3-AAXX-5266
CapLok tool for tightening and undoing ¼" brass storage caps	C-CPLOK
Cold trap, TO-15/TO-17 air toxics, UNITY 2/TD-100 <i>Compatible with the simultaneous analysis of analytes from C_{2/3} to n-C_{30/32}</i>	U-T15ATA-2S
Certified reference standard, 9-component TO-17 mix, 100 ng, pk 10 (plus certificate, chromatogram and shipping blank)	C-TO17XX-10

Note that pumps such as Easy-VOC^{p33} or an ACTI-VOC low-flow pump^{p32} are not included, and should be obtained separately.

Within the field of environmental monitoring, TD is also used for monitoring gas and vapour intrusion in soil, fugitive/stack emissions, and for testing odorants, volatiles and semi-volatiles in water (HS-TD^{p57} and SPE-tD^{p56}). For further details on these and other applications related to environmental monitoring, please refer to our Application Notes^{p92} and the publication *Thermal Desorption: A Practical Applications Guide. Volume I. Environmental Monitoring & Exposure to Chemicals at Work*^{p91}.

Description	Part number
Basic environmental starter kit	C-KITEV01-2S
Diffusive monitoring starter kit	C-KITEV02-2S
TO-15 starter kit	C-KITEV03-2S
TO-17 starter kit	C-KITEV04-2S

Material emissions starter kits

Increasing awareness of harmful VOCs emitted from furnishings, construction materials and consumer goods is driving new legislation requiring the measurement and reporting of VOC emissions from everyday products. This in turn is increasing pressure on manufacturers to control the levels of (S)VOCs released by their products.

The chemicals of interest cover a wide volatility range and many compound types. Standard reference or screening methods specify some form of chamber, cell or micro-chamber sampling followed by TD-GC(MS) analysis (IS 16000-6, ASTM D6196, etc.)

Markes offers three kits for material emissions testing and chemical content analyses¹:

The **Basic material emissions starter kit** is ideal for those carrying out routine in-house tests of product emissions in compliance with ISO 16000, ISO 12219 or equivalent ASTM standards. It contains:

Inert-coated stainless steel sorbent tubes, packed with Tenax TA, conditioned and capped, pk 10 <i>Suitable for sampling VOCs from n-C_{6/7} to n-C_{30/32}</i>	C1-CAXX-5003
Stainless steel sorbent tubes, packed with quartz wool/Tenax TA/Carbograph 5TD, conditioned and capped, pk 10 <i>Suitable for sampling VOCs from n-C₄ to n-C₃₂</i>	C3-AAXX-5304
CapLok tool for tightening and undoing ¼" brass storage caps	C-CPLOCK
Cold trap, material emissions <i>Compatible with the simultaneous analysis of analytes from n-C₄ to n-C₃₂</i>	U-T12ME-2S
Quick-seal column connector, pk 10	C-QSC10

The **Comprehensive material emissions starter kit** provides a wider range of parts ideal for high-throughput service or manufacturing laboratories carrying out product emissions testing using standard reference or screening methods. It contains:

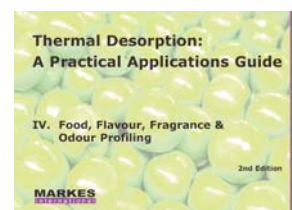
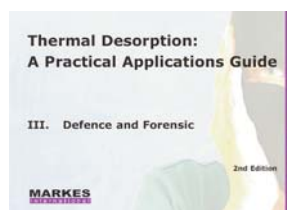
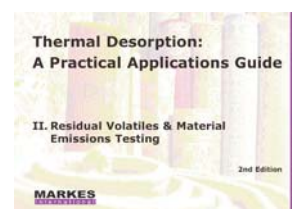
Inert-coated stainless steel sorbent tubes, packed with Tenax TA, conditioned and capped, 2 × pk 10 <i>Suitable for sampling VOCs from n-C_{6/7} to n-C_{30/32}</i>	2 × C1-CAXX-5003
Stainless steel sorbent tubes, packed with quartz wool/Tenax TA/Carbograph 5TD, conditioned and capped, 2 × pk 10 <i>Suitable for sampling VOCs from n-C₄ to n-C₃₂</i>	2 × C3-AAXX-5304
Glass sorbent tube with restriction at 30 mm, empty, for direct desorption, pk 10	C0-NXXX-0000
CapLok tool for tightening and undoing ¼" brass storage caps	C-CPLOCK
Spring, gauze-retaining, pk 10	C-GTSP10
Quartz wool, 10 g	C-QUTZW
Ferrule, PTFE, one-piece, pk 20	C-FP020
Check-standard (material emissions), 100 ng, Tenax TA, pk 10	C-CHK10-ME
Cold trap, material emissions <i>Compatible with the simultaneous analysis of analytes from n-C₄ to n-C₃₂</i>	U-T12ME-2S
Quick-seal column connector, pk 10	C-QSC10

The **Direct desorption starter kit** contains a range of consumables for measuring chemical content or emissions from small samples of materials using direct desorption in glass tubes according to VDA 278 or equivalent methods. It contains:

Glass tubes, empty, restriction at 30 mm, pk 10	C0-NXXX-0000
Stainless steel tubes, empty, pk 10	C0-AXXX-0000
Cold trap, material emissions, UNITY 2/TD-100 <i>Compatible with the simultaneous analysis of analytes from n-C₄ to n-C₃₂</i>	U-T12ME-2S
PTFE liners, snug-fit, pk 10	C-PI010
PTFE liners, loose-fit, pk 10	C-PL010
Quartz wool, 10 g	C-QUTZW
Sorbent, Tenax TA (35/60), 10 g	C-TNXTA
Springs, torsion, for 4 mm i.d. glass tubes, pk 10	C-GTSP10

The need to measure chemicals released from products and materials has an impact on a large number of trades and manufacturing sectors – everything from paints to carpet and from toys to car trim components. For a summary of relevant applications please refer to our Application Notes⁹² and the publication *Thermal Desorption: A Practical Applications Guide. Volume II. Residual Volatiles & Material Emissions Testing*⁹¹.

Description	Part number
Basic material emissions starter kit	C-KITME01-2S
Comprehensive material emissions starter kit	C-KITME02-2S
Direct desorption starter kit	C-KITDD-2S



Thermal desorption applications guides – See page 91 for more details

1. Note that all the tubes included in material emissions starter kits are 3½" long × ¼" o.d., in compliance with standard methods.

Instrument spares

Since 1997, Markes has pioneered and commercialised enhancements to analytical TD instrumentation and associated sampling apparatus. In this section we briefly describe our instruments and detail the associated spares and accessories that will ensure ongoing high performance.

For more information about Markes' range of TD instruments, please request a brochure or talk to one of our specialists.

UNITY 2	68
TD-100	70
ULTRA 2	71
Air Server and Canister Interface Accessory (CIA) systems	72
CIA <i>Advantage</i>	73
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Cold traps (focusing traps)	77
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Routine maintenance kits	79

Spares and accessories for the world's leading TD systems



General information

UNITY 2, Markes' second-generation TD platform, incorporates every system innovation of the last 15 years and the field-proven reliability inherent to all Markes' instrumentation. The main features of UNITY 2 are:

- **Compatibility** with electronically-tagged^{P7} or untagged tubes, (versions available for 3½" or 4½" tubes with ¼" or 6 mm o.d.)
- Provides a **single platform for all TD applications** – *i.e.* labile species, semi-volatiles (up to n-C₄₀) and ultra-volatiles (including acetylene and freons) – both at trace levels (ppt) and high concentrations (ppm/%)
- **Repeat analysis** using SecureTD-Q™ overcomes the one-shot limitation of conventional TD systems
- **Cryogen-free operation** – electrically-cooled sorbent trapping to –30°C prevents down-time and reduces running costs
- **Full compliance** with key international standard methods¹:
 - No-flow ambient-temperature leak testing
 - Pre-purging of air to vent
 - Inert flow path
 - Cryogen-free cold trap.

Electronic control of split and desorb flows

UNITY 2 instruments can be configured with one or two electronic mass flow controllers (MFCs), which provide versatile electronic control of both split and desorption flows (2–500 mL/min). The MFC modules also accommodate split rates between zero and 125,000:1 with standard (60 m × 0.25 mm i.d.) columns, and also facilitate flow-rate recall during an automated sequence with multiple TD methods.

1. Examples include EN ISO 16017, ISO 16000-6, ASTM D6196-03, US EPA Method TO-17, and NIOSH 2549.

TubeTAG read/write technology

See page 7 for details of how Markes' TubeTAG technology can help you track your sorbent tubes.

Automation accessories

Markes provides a comprehensive range of automation upgrades for UNITY 2. Options include:

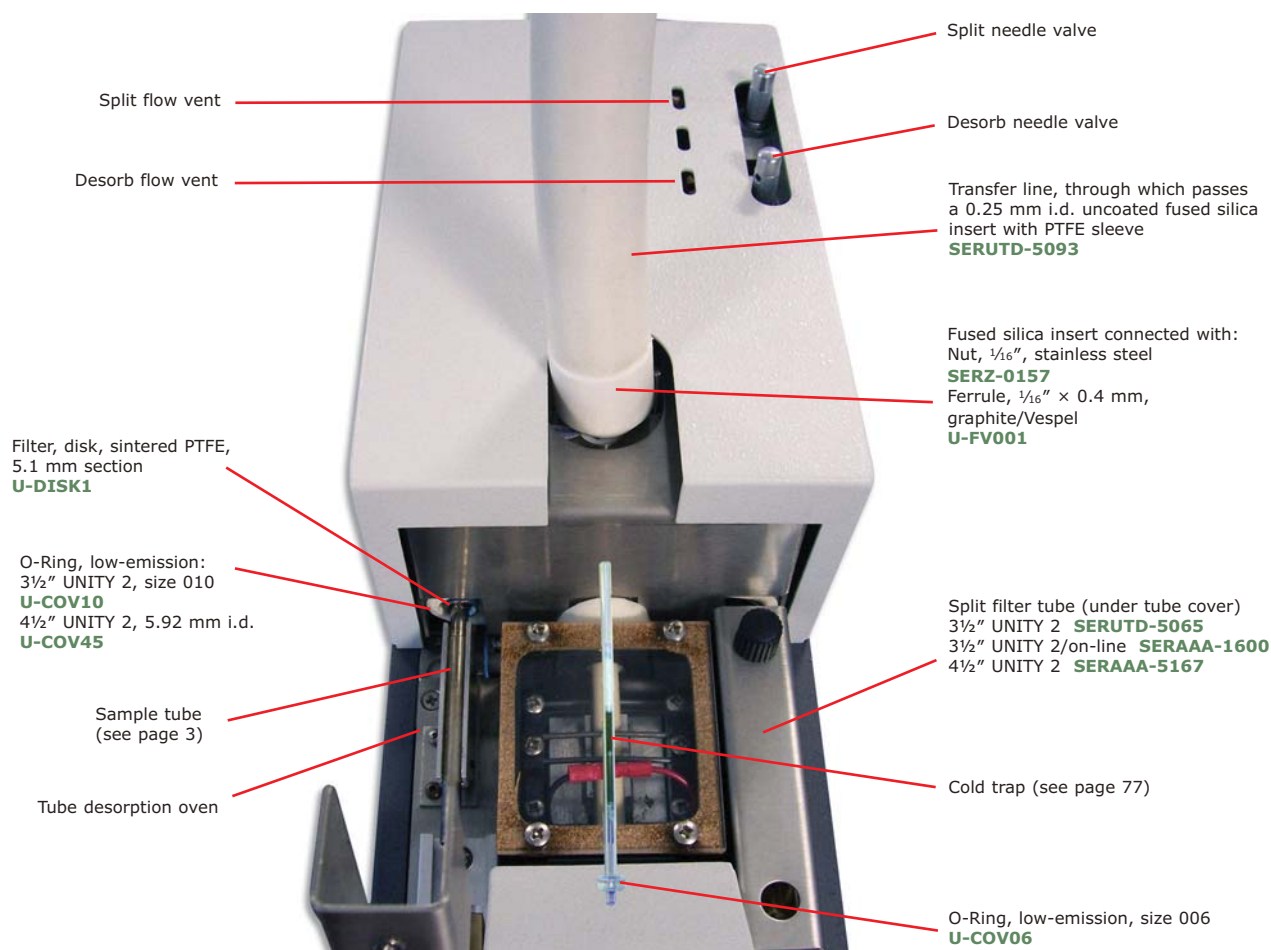
- The ULTRA autosampler for 100 (3½" or 4½") tubes^{P71}
- 3-Channel Air Server accessory (3½" or 4½" tubes)^{P72}
- 8-Channel Air Server accessory (3½" or 4½" tubes)^{P72}
- The CIA Advantage for automated canister analysis^{P73}
- The HS5-TD for headspace analysis^{P57}.

Further information on all accessories for UNITY 2 is available on our website and in the relevant brochures. Please email us (enquiries@markes.com) for more information, or contact your local distributor.

Spares and consumables

General (see diagram on next page)

Description	Part number
O-Ring, low-emission, size 006, pk 10	U-COV06
O-Ring, low-emission, size 010, pk 10	U-COV10
O-Ring, low-emission, size 010, pk 100	U-COV100
O-Ring, low-emission, 5.92 mm i.d., pk 10	U-COV45
Split filter tube, stainless steel, 3½", packed with charcoal	SERUTD-5065
Split filter tube, glass, 3½", packed with charcoal (used for on-line systems)	SERAAA-1600
Split filter tube, glass, 4½", packed with charcoal	SERAAA-5167
Fused silica transfer line insert (0.25 mm i.d.) and PTFE sleeve	SERUTD-5093
Ferrule, ¼" × 0.4 mm graphite/Vespel®, pk 10 (connects fused silica transfer line)	U-FV001
Ferrule, ¼" × ¼" graphite/Vespel, pk 10 (PEEK connections/bypass line/bulkhead union)	U-FV002
Ferrule, ⅜" × ¼" graphite/Vespel, pk 10 (PEEK connections/gas supply connections)	U-FV003
Filter, disk, sintered PTFE, 5.1 mm section, pk 10	U-DISK1
Quick-seal column connector, pk 10 (connects fused silica to column)	C-QSC10
Nut, ¼", for unions, stainless steel (to connect fused silica insert)	SERZ-0157



Tools and installation connections

Description	Part number
O-Ring insertion tool	SERZ-0285
O-Ring extraction tool	SERZ-0351
O-Ring service kit, 3½" tubes only (includes U-COV10, U-DISK1, SERZ-0285, SERZ-0351)	U-ORKIT
Tube extractor tool	SERUTD-5062
Trap alignment tool	SERUTD-5064
Standard tool kit	SERUTD-5063
UNITY-to-GC transfer line clamp (for use as spacer inside GC oven)	SERUTD-1125
Washer, ¼" × 1" (for use with SERUTD-1125)	SERZ-0371
Washer, ¼" × 1½" (for use with SERUTD-1125)	SERZ-0372
Nut, ¼"-20 UNC, stainless steel, for end of transfer line	SERZ-NU14SS
Quick-seal column connector, pk 10	C-QSC10

Cables¹

Description	Part number
Cable assembly, lead, null modem (PC to TD communications cable)	SERZ-0189
Cable assembly, UNITY 2 to GC, standard	SERUTE-5141
Cable assembly, UNITY 2 to GC, Agilent	SERUTE-5142
Cable assembly, UNITY 2 to GC, Thermo	SERUTE-5143
Cable assembly, UNITY 2 to GC, Varian/Bruker	SERUTE-5144

Miscellaneous spares and accessories

Description	Part number
UNITY 2 software CD (includes automation)	U-SW001-2S
Markes' technical manual for series 2 TD systems on CD	U-TECHCD
UNITY to UNITYe conversion kit (converts UNITY 2 from manual to electronic carrier control)	SERUTE-5103
UNITY 2 tube oven conversion kit, 3½" to 4½" (user-installable)	U-35TO45KT
UNITY 2 tube oven conversion kit, 4½" to 3½" (user-installable)	U-45TO35KT
Mass flow controller (MFC), digital, 2-500 mL/min	U-DMFC-2S
Universal Direct Inlet Accessory ^{p58} , 3½"	U-INLET
Universal Direct Inlet Accessory ^{p58} , 4½"	U-INLET-XZ

1. UNITY 1 cables are also compatible with UNITY 2.



General information

The TD-100 is a highly versatile and robust TD instrument, dedicated to automated tube desorption. With capacity for 100 industry-standard 3½" tubes, the TD-100 integrates all the main features and functionality of the series 2 ULTRA-UNITY system into a single unit.

The **TD-100 Standard system** features manual re-collection of samples and in-built TubeTAG read/write functionality. The following upgrade options are available for this system:

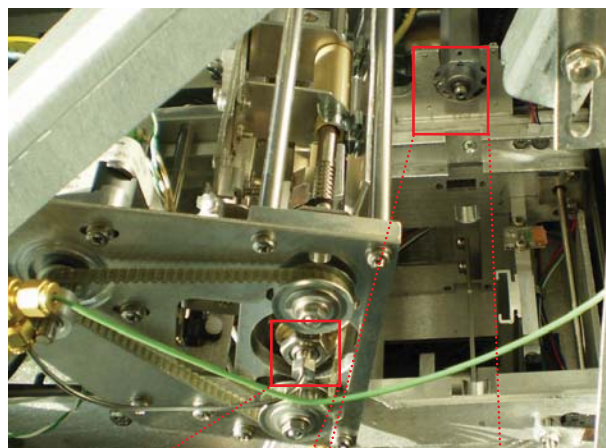
- Electronic mass flow control (MFC) of split and desorption flows (2–500 mL/min)
- Automated sample re-collection for repeat analysis (also includes dry-purge functionality)
- Internal standard/dry-purge (ISDP) functionality.

In addition to TubeTAG, the **TD-100 Advanced system** offers automated sample re-collection (including dry-purge functionality) and dual-electronic MFC as standard. It can also be upgraded to incorporate ISDP functionality if required.

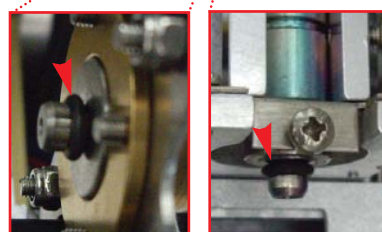
Please note: TD-100 systems are not compatible with Air Server, CIA 8, CIA Advantage or HS-TD units.

Further information on all accessories for the TD-100 is available on our website and in the relevant brochures. Please email us (enquiries@markes.com) for more information, or contact your local distributor.

Spares and consumables



Enlarged region not visible from angle in main image



O-Ring, low-emission, size 007 **U-COV07**

Cables

Description	Part number
Cable assembly, lead, null modem (PC to TD communications cable; two per instrument)	SERZ-0189
Cable assembly, UNITY 2 to GC, standard	SERUTE-5141
Cable assembly, UNITY 2 to GC, Agilent	SERUTE-5142
Cable assembly, UNITY 2 to GC, Thermo	SERUTE-5143
Cable assembly, UNITY 2 to GC, Varian/Bruker	SERUTE-5144

Miscellaneous

Description	Part number
O-Ring, low-emission, size 006, pk 10	U-COV06
O-Ring, low-emission, size 007, pk 10	U-COV07
O-Ring, low-emission, size 010, pk 10	U-COV10
O-Ring, low-emission, size 010, pk 100	U-COV100
Ferrule, ¼" × 0.4 mm graphite/Vespel, pk 10 (connects fused silica transfer line)	U-FV001
Ferrule, ¼" × ¼" graphite/Vespel, pk 10 (PEEK connections/bypass line/bulkhead union)	U-FV002
Ferrule, ⅛" × ¼" graphite/Vespel, pk 10 (PEEK connections/gas supply connections)	U-FV003
ULTRA/TD-100 O-ring insertion tool	SERMTD-1382
Fused silica transfer line insert (0.25 mm i.d.) and PTFE sleeve	SERUTD-5093
Split filter tube, stainless steel, 3½", packed with charcoal	SERUTD-5065
Filter, disk, sintered PTFE, 5.1 mm section, pk 10	U-DISK1
Tray assemblies for autosampler, 3½", including 20 tray labels, pk 10	U-TRAY
Labels, autosampler tray, 3½", strip of 10, blue	SERMTD-1213BU
Quick-seal column connector, pk 10 (connects fused silica to column)	C-QSC10

ULTRA™ 2

General information

The ULTRA 2 is a multi-functional TD autosampler that adds to any UNITY, featuring:

- Capacity for up to 100 tubes. Versions are available for 3½" tubes (standard model) and 4½" tubes (ULTRA-X model)
- TubeTAG^{P7} compatibility
- Stringent sample sealing before and after desorption with patented DiffLok^{P21} caps
- Full compliance with key international standard methods.

ULTRA 2 autosamplers can be factory-configured with either or both of the following options:

- **50:50 option** – Allows automatic re-collection of trap desorption (outlet) split flow. This means that the outlet split flow from up to 50 samples can be re-collected on to 50 fresh sorbent tubes. It can also be used to dry-purge tubes prior to desorption/analysis and, if necessary, can incorporate either one or two mass flow controllers (MFCs)
- **Internal standard/dry-purge (ISDP) option** – Allows an aliquot of gaseous internal standard to be added to the sampling end of each tube before desorption to aid analytical quality assurance. Can also be used to dry-purge tubes prior to desorption/analysis. See page 47 for a schematic.

Further information on all accessories for the ULTRA 2 is available on our website and in the relevant brochures. Please email us (enquiries@markes.com) for more information, or contact your local distributor.

Spares and consumables



O-Ring, low-emission, size 007 **U-COV07**

Description	Part number
Cap, DiffLok, stainless steel, ¼", pk 10	C-DL010
Cap, DiffLok, stainless steel, ¼", pk 100	C-DL100
Cap, DiffLok, inert, ¼", pk 10	C-DLS10
Cap, DiffLok, inert, ¼", pk 100	C-DL150
Cap, DiffLok, one stainless steel, one inert-coated, ¼", pk 10 pairs	C-DLP10
Cap, DiffLok, one stainless steel, one inert-coated, ¼", pk 100 pairs	C-DL1P0
Cap, DiffLok, stainless steel, 6 mm, pk 10	C-DL010-XZ
Cap, DiffLok, stainless steel, 6 mm, pk 100	C-DL100-XZ
Cap, DiffLok, inert, 6 mm, pk 10	C-DLS10-XZ
Cap, DiffLok, inert, 6 mm, pk 100	C-DL150-XZ
Cap, DiffLok, one stainless steel, one inert-coated, 6 mm, pk 10 pairs	C-DLP10-XZ
Cap, DiffLok, one stainless steel, one inert-coated, 6 mm, pk 100 pairs	C-DL1P0-XZ
O-Ring, low-emission, size 010, pk 10 (for ¼" DiffLok caps)	U-COV10
O-Ring, low-emission, size 010, pk 100 (for ¼" DiffLok caps)	U-COV100
O-Ring, low-emission, 5.92 mm i.d., pk 10 (for 6 mm DiffLok caps)	U-COV45
O-Ring, low-emission, size 007, pk 10 (ULTRA tube receiver)	U-COV07
Tray assemblies for autosampler, 3½", including 20 tray labels, pk 10	U-TRAY
Labels, autosampler tray, 3½", strip of 10, blue	SERMTD-1213BU
Tray assemblies for ULTRA, 4½", including 20 tray labels, pk 10	U-TRAY-XZ
Labels, ULTRA tray, 4½", strip of 10, blue	SERMTD-1394BU
ULTRA/TD-100 U-COV07 O-ring insertion tool	SERMTD-1382
AutoSecureTD™ interface kit, 3½" (to add a second ULTRA 2 to UNITY 2)	U-USKIT-2S
AutoSecureTD interface kit, 4½" (to add a second ULTRA 2 to UNITY 2)	U-USKIT-XZ
AutoSecureTD interface kit, 3½" (to add a second ULTRA 2 to UNITY 1)	U-USKIT
TubeTAG read/write option for ULTRA 2	U-TAGRW-2S
Connection kit, to connect series 2 Air Server 3/8 and ULTRA 2 to the same UNITY 2, 3½"	U-UASK2-2S
Connection kit, to connect series 2 Air Server 3/8 and ULTRA 2 to the same UNITY 2, 4½"	U-UASK2-XZ



Tray assemblies for autosampler

Air Server™ and Canister Interface Accessory (CIA) systems

General information

Markes' cryogen-free TD systems for on-line air monitoring and canister analysis include 3- or 8-channel Air Servers and Canister Interface Accessories (CIA). These add to any UNITY 2 (or ULTRA-UNITY 2) system to deliver a controlled flow of air or gas (2–250 mL/min) directly into the electrically-cooled cold trap of the desorber.

With 3- and 8-channel systems available, Air Server systems are ideal for automated round-the-clock unattended monitoring of ambient-temperature on-line air/gas streams. They are also compatible with canister and bag samples.

The CIA 8 and its successor the CIA Advantage (see next page), are designed for automated analysis of air/gas samples from canisters or bags. They offer multiple channels, heated lines and internal standard addition.

Further information is available on our website and in the relevant brochures. Please email us (enquiries@markes.com) for more information, or contact your local distributor.

Filter, disk, sintered PTFE
(inside sample ports)
U-DISK4

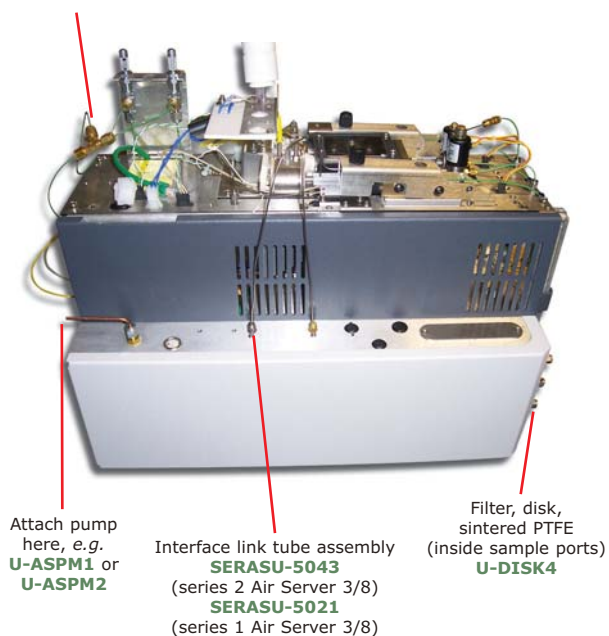
Sample transfer line
SERASU-5041
(CIA 8)



CIA 8

Spares and consumables

Ferrule, 1/8" × 1/16"
U-FV003



UNITY 2 thermal desorber with 3-channel Air Server

Description	Part number
Ferrule, 1/8" × 1/16", graphite/Vespel, pk 10 (PEEK to 1/8" brass unions)	U-FV003
Tubing, PEEK, 1/16" o.d. × 0.03" bore, 1 m	SERZ-0108
Split filter tube, glass, 3 1/2", packed with charcoal	SERAAA-1600
Tubing, PTFE, 1/8", 1 m	SERZ-0062
Interface link tube assembly (series 1 Air Server 3/8)	SERASU-5021
Interface link tube assembly (series 2 Air Server 3/8)	SERASU-5043
Sample transfer line (ASIS 8™ and CIA 8 only)	SERASU-5041
Pump, 115 V, for unpressurised samples	U-ASPM1
Pump, 230 V, for unpressurised samples	U-ASPM2
Ferrule, 1/8" × 1/8", Vespel (used on UNITY copper vents)	U-FV004
Filter, disk, sintered PTFE, 3.2 mm section, pk 10	U-DISK4
Dryer kit for series 2 Air Server and CIA systems	U-ASDRY
Dryer kit for series 1 Air Server 3/8	U-ASDRY-1S
Connection kit, to connect series 1 Air Server 3/8 (or CIA 8) and ULTRA (50:50) to the same UNITY 1	U-UASK2
Connection kit, to connect series 2 Air Server 3/8 and ULTRA 2 to the same UNITY 2, 3 1/2"	U-UASK2-2S
Connection kit, to connect series 2 Air Server 3/8 and ULTRA 2 to the same UNITY 2, 4 1/2"	U-UASK2-XZ

CIA Advantage™



General information

The CIA Advantage is an advanced system for automated analysis of VOCs in canister air. The main features are:

- Cryogen-free operation, leading to substantial cost savings
- Heated internal lines (up to 200 °C) and uniquely efficient purging combine to eliminate carryover and increase sample throughput
- Compatibility with high- and low-concentration samples in the same sequence
- Compatibility with both canisters and sorbent tubes, allowing a wider range of applications to be accommodated.

Two models are available:

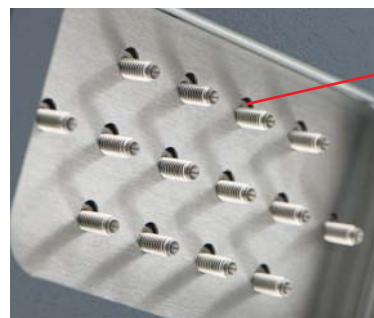
- The **CIA Advantage-T™** incorporates mass flow control technology and provides a dedicated system for analysis of trace-level components. Up to four canisters are accommodated on the standard T model, and the minimum sample volume is 10 mL
- The **CIA Advantage-HL™** is a versatile system for analysis of both high- and low-concentration samples and for screening unknowns. It incorporates gas-loop sampling in addition to mass flow control. Up to fourteen canisters are accommodated on the standard HL model, and the minimum sample volume is 0.5 mL.

Accessories available for the CIA Advantage include:

- The **CIA Satellite™** module increases the capacity of both CIA Advantage models by 13 channels
- Markes' **diluter^{P41}** offers accurate dilution of a standard gas, allowing the creation of multiple calibration levels from a single original standard
- Markes' **canister racks^{P41}** hold up to 15 canisters (14 samples and one internal standard)
- The addition of Markes' **Ultra autosampler^{P71}** to CIA Advantage systems allows up to 100 sorbent tubes to be processed automatically.

Further information on all accessories for the CIA Advantage is available on our website and in the relevant brochures. Please email us (enquiries@markes.com) for more information, or contact your local distributor.

Spares and consumables



Filter, disk, sintered PTFE (inside sample ports)
U-DISK4

Description	Part number
Dryer kit for CIA Advantage systems	U-ASDRY
Humidifier, for humidification of purge gas	U-HUMID
Heated sample lines (14 lines, each 1.8 m length)	U-HTLNKT
Filter, disk, sintered PTFE, 3.2 mm section, pk 10	U-DISK4
Pump, 115 V, for unpressurised samples	U-ASPM1
Pump, 230 V, for unpressurised samples	U-ASPM2
Split filter tube, glass, 3½", packed with charcoal	SERAAA-1600
Sample loop, 0.1 mL	SERZ-0993
Sample loop, 0.5 mL	SERZ-0994
Sample loop, 1 mL	SERZ-0516
Sample loop, 2 mL	SERZ-0995



General information

In February 2008, UNITY 1 was replaced by UNITY 2. However, key accessories and consumables are still available from Markes International to enhance your existing UNITY 1 installation.

For further information on all accessories for UNITY 1, please email us (enquiries@markes.com), or contact your local distributor.

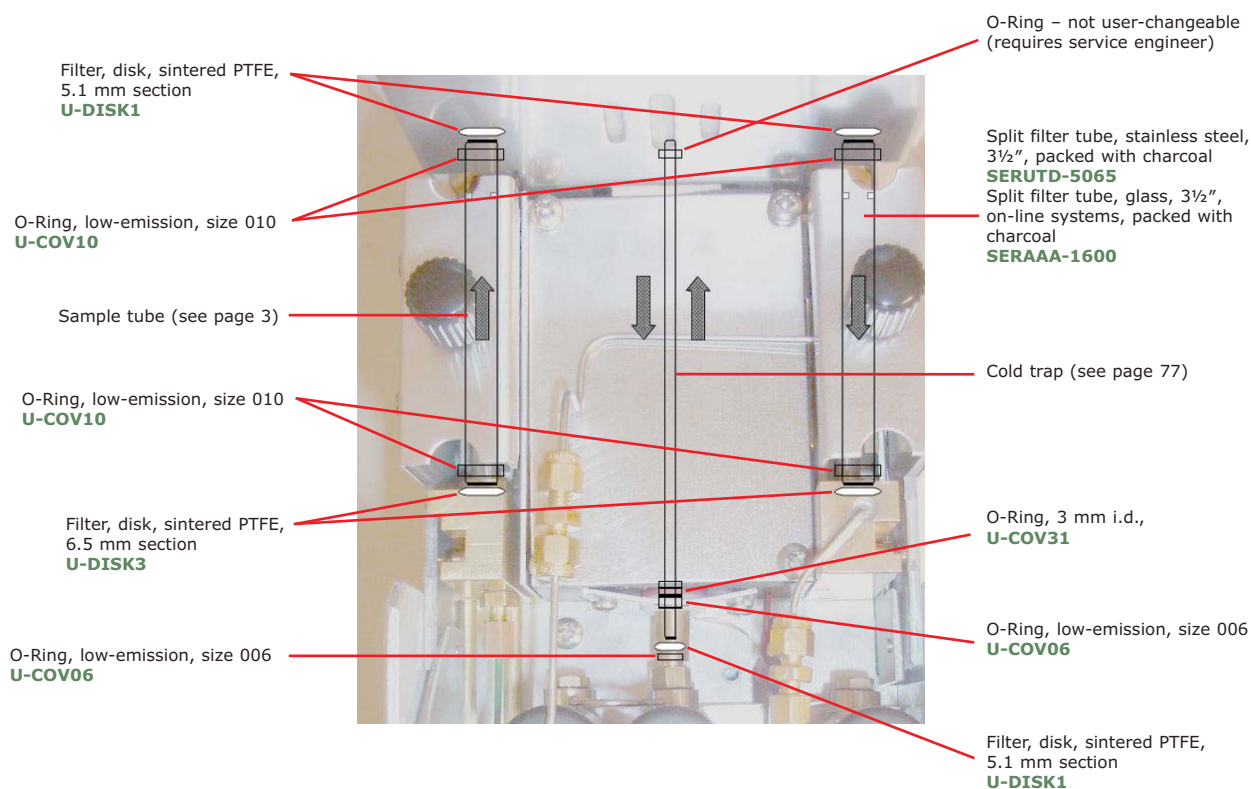
Spares and consumables

[General \(see diagram on next page\)](#)

Description	Part number
O-Ring, low-emission, size 006, pk 10	U-COV06
O-Ring, low-emission, size 010, pk 10	U-COV10
O-Ring, low-emission, size 010, pk 100	U-COV100
O-Ring, 3 mm i.d., pk 10	U-COV31
Fused silica transfer line insert (0.25 mm i.d.) and PTFE sleeve	SERUTD-5093
Split filter tube, stainless steel, 3½", packed with charcoal	SERUTD-5065
Split filter tube, glass, 3½", packed with charcoal (used for on-line systems)	SERAAA-1600
Fuse, 5 mm × 20 mm, 6.3 A, antisurge	SERZ-FS6A3
Ferrule, ¼" × 0.4 mm graphite/Vespel, pk 10 (connects fused silica transfer line)	U-FV001
Ferrule, ¼" × ¼" graphite/Vespel, pk 10 (PEEK connections/bypass line)	U-FV002
Ferrule, ⅜" × ¼" graphite/Vespel, pk 10 (PEEK connections/bulkhead unions)	U-FV003
Filter, disk, sintered PTFE, 5.1 mm section, pk 10	U-DISK1
Filter, disk, sintered PTFE, 6.5 mm section, pk 10	U-DISK3
Quick-seal column connector, pk 10 (connects fused silica to column)	C-QSC10

[Tools and installation connections](#)

Description	Part number
O-Ring insertion tool	SERZ-0285
O-Ring extraction tool	SERZ-0351
O-Ring service kit, 3½" tubes only (includes U-COV10, U-DISK1, SERZ-0285, SERZ-0351)	U-ORKIT
Tube extractor tool	SERUTD-5062
Trap alignment tool	SERUTD-5064
Standard tool kit	SERUTD-5063
UNITY-to-GC transfer line clamp (for use as spacer inside GC oven)	SERUTD-1125
Washer, ¼" × 1", for use with SERUTD-1125	SERZ-0371
Washer, ¼" × 1½", for use with SERUTD-1125	SERZ-0372
Nut, ¼"-20 UNC, stainless steel, for end of transfer line (for UNITY 1 from U-10284)	SERZ-NU14SS
Nut, M6, stainless steel, for end of transfer line (for UNITY 1 prior to U-10284)	SERZ-NM6FSS



Cables

Description	Part number
Cable assembly, lead, null modem (PC to TD communications cable)	SERZ-0189
Cable assembly, PCB GC interface and cable, standard	SERUTD-5095
Cable assembly, PCB GC interface and cable, Agilent	SERUTD-5098
Cable assembly, PCB GC interface and cable, Thermo	SERUTD-5108
Cable assembly, PCB GC interface and cable, Varian/Bruker	SERUTD-5116

Miscellaneous spares and accessories

Description	Part number
UNITY to UNITYe conversion kit (converts UNITY 1 from manual to electronic carrier control)	SERUTD-5103
Universal Direct Inlet Accessory ^{P58} , 3½"	U-INLET



General information

The TT24-7 is an advanced thermal desorption (TD) system for continuous near-real-time (NRT) monitoring of volatile and semi-volatile organic compounds in air or gas.

With its high-performance analytical capability, reciprocating dual-trapping functionality and cryogen-free operation, it is ideal for continuous unattended monitoring, either in static or mobile laboratories.

The TT24-7 offers reliable, near-real-time monitoring of chemical warfare agents in military and government installations. It is also an ideal choice for a wide range of challenging civilian applications: advanced environmental research, monitoring pollution levels, controlling air/gas purity, and continuous odour or fragrance profiling.

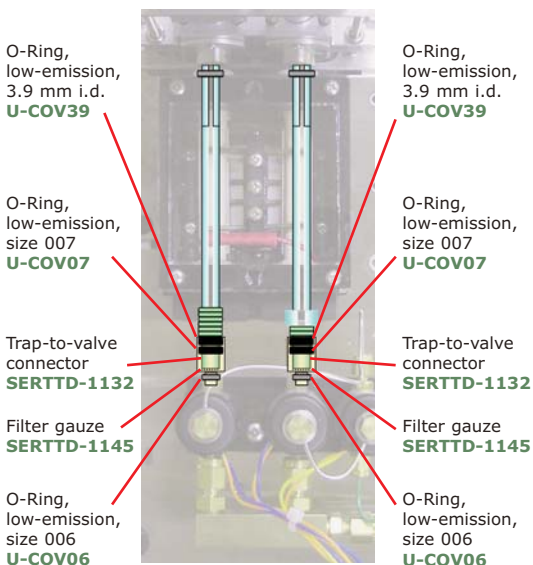
The TT24-7 is normally used in combination with GC or GC/MS technology, but can also be interfaced to direct read-out instrumentation such as process MS systems.

Further information on all accessories for the TT24-7 is available on our website. Please email us (enquiries@markes.com) for more information, or contact your local distributor.

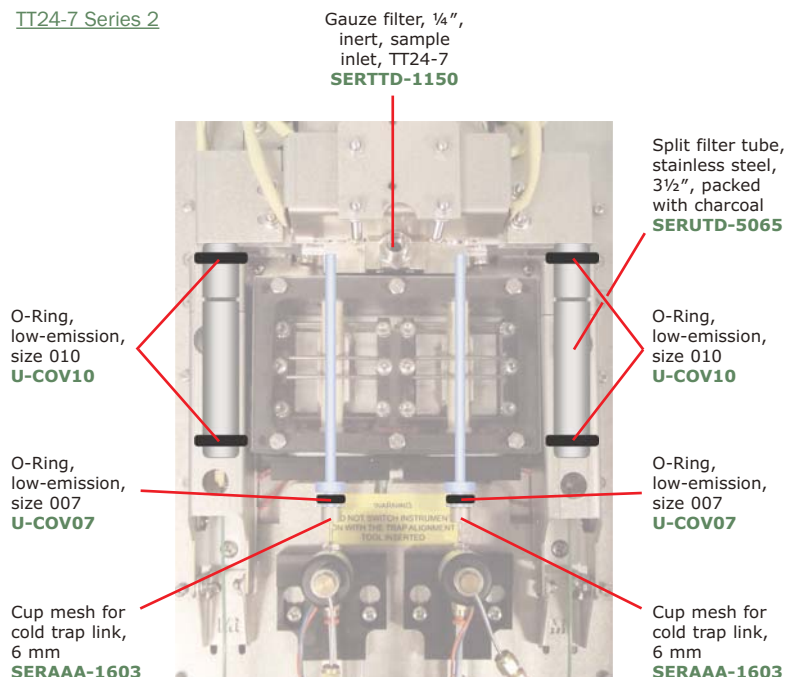
Spares and consumables

In June 2013, the TT24-7 Series 1 was replaced by the TT24-7 Series 2. However, key spares and consumables for the Series 1 instrument are still available from Markes International, and these are listed in the tables opposite.

TT24-7 Series 1



TT24-7 Series 2



Part numbers for the TT24-7 Series 1

General (see diagram on previous page)

Description	Part number
O-Ring, low-emission, size 006, pk 10	U-COV06
O-Ring, low-emission, size 007, pk 10	U-COV07
O-Ring, low-emission, size 010, pk 10	U-COV10
O-Ring, low-emission, 3.9 mm i.d., pk 10	U-COV39
Filter, disk, sintered PTFE, 5.1 mm section, pk 10	U-DISK1
Filter, disk, sintered PTFE, 6.5 mm section, pk 10	U-DISK3
Gauze filter, flexible link	SERTTD-1145
Gauze filter, ¼", inert, sample inlet, TT24-7	SERTTD-1150
Fused silica transfer line insert (0.25 mm i.d.) and PTFE sleeve	SERUTD-5093
Split filter tube, stainless steel, 3½", packed with charcoal	SERUTD-5065
Ferrule, ⅙" × 0.4 mm graphite/Vespel, pk 10 (connects fused silica transfer line)	U-FV001
Trap-to-valve connector	SERTTD-1132

Miscellaneous spares and accessories

Description	Part number
Recycle power box for TT24-7 (assists remote operation)	U-RCYBX
Pump, 115 V, for unpressurised samples	U-ASPM1
Pump, 230 V, for unpressurised samples	U-ASPM2
Dual regulator pneumatics accessory (for dry gas and carrier gas regulation)	U-GAS01

Part numbers for the TT24-7 Series 2

General (see diagram on previous page)

Description	Part number
O-Ring, low-emission, size 007, pk 10	U-COV07
O-Ring, low-emission, size 010, pk 10	U-COV10
Filter, disk, sintered PTFE, 5.1 mm section, pk 10	U-DISK1
Filter, carbon, TT24-7 Series 2 air inlet	U-FLTRTT-C
Cup mesh for cold trap link, 6 mm	SERAAA-1603
Gauze filter, ¼", inert, sample inlet, TT24-7	SERTTD-1150
Fused silica transfer line insert (0.25 mm i.d.) and PTFE sleeve	SERUTD-5093
Split filter tube, stainless steel, 3½", packed with charcoal	SERUTD-5065
Split filter tube, glass, 4½", packed with charcoal	SERAAA-5167
Ferrule, ⅙" × 0.4 mm graphite/Vespel, pk 10 (connects fused silica transfer line)	U-FV001
Quick-seal column connector, pk 10	C-QSC10

Miscellaneous spares and accessories

Description	Part number
Dryer kit for series 2 Air Server and CIA systems	U-ASDRY
Heated sample line, inert, 2 m	U-HSLTT
Mass flow controller (MFC), digital, 2–500 mL/min	U-DMFC-2S
UNITY 2 tube oven conversion kit, 3½" to 4½" (user-installable)	U-35TO45KT
Pump, 115 V, for unpressurised samples	U-ASPM1
Pump, 230 V, for unpressurised samples	U-ASPM2
Dual regulator pneumatics accessory (for dry gas and carrier gas regulation)	U-GAS01

Cold traps (focusing traps)

The following cold traps are recommended for UNITY and TD-100 instruments. Note that UNITY 2 and TD-100 cold traps are not compatible with UNITY 1 and vice versa – be sure to order the trap which is compatible with your thermal desorber.

Description	Part number	
	UNITY 1	UNITY 2 & TD-100
Cold trap, high-boilers, n-C ₆ to n-C ₄₀	U-T1HBL	U-T1HBL-2S
Cold trap, general-purpose hydrophobic, n-C _{4/5} to n-C _{30/32}	U-T2GPH	U-T2GPH-2S
Cold trap, sulfur/labile	U-T6SUL	U-T6SUL-2S
Cold trap, empty	U-T7EMP	U-T7EMP-2S
Cold trap, custom-packed	U-T8CUS	U-T8CUS-2S
Cold trap, chemical warfare agents	U-T10CW	U-T10CW-2S
Cold trap, general-purpose carbon, n-C _{4/5} to n-C _{30/32}	U-T11GPC	U-T11GPC-2S
Cold trap, material emissions, n-C ₄ to n-C ₃₂	U-T12ME	U-T12ME-2S
Cold trap, TO-15/TO-17 air toxics, C _{2/3} to n-C _{30/32}	U-T15ATA	U-T15ATA-2S
Cold trap, greenhouse gases, C ₂ to n-C ₁₄	U-T16GHG	U-T16GHG-2S
Cold trap, ozone precursors	U-T17O3P	U-T17O3P-2S

The following cold traps are recommended for the TT24-7 Series 1 and Series 2 instruments (two are required for each system):

Description	Part number
Cold trap, TT24-7, for CWAs (in particular VX)	T-1VX
Cold trap, TT24-7, for CWAs (in particular HD)	T-2HD
Cold trap, TT24-7, for CWAs (in particular the GB/GE analog of VX)	T-3GBGE
Cold trap, TT24-7, for air toxics	T-4ATX
Cold trap, TT24-7, empty for packing	T-6EMP
Cold trap, TT24-7, custom-packed	T-7CUS
Cold trap, TT24-7, for material emissions	T-8MAT
Cold trap, TT24-7, general-purpose carbon black	T-9GPC
Cold trap, TT24-7, for ozone precursors	T-11OP

Please note: Packs of 10 cold traps can be ordered by adding '10' to the end of the main section of the part number, e.g. U-T15ATA**10**, U-T15ATA**10**-2S.



Empty (top) and packed (bottom) cold traps for UNITY 2/TD-100

The entire range of previously listed traps is still available from Markes International. Email us (consumables@markes.com) for further details.

Instrument starter kits

UNITY 2

The **Basic TD starter kit**, for 3½" (standard) tubes, contains:

Stainless steel sorbent tubes, packed with Tenax TA/Carbograph 1TD, conditioned and capped, pk 10 <i>Suitable for pumped sampling of VOCs from n-C_{5/6} to n-C_{30/32}</i>	C2-AAXX-5032
CapLok tool for tightening and undoing ¼" brass storage caps	C-CPLOCK
Cold trap, general-purpose carbon, UNITY 2/TD-100, n-C _{4/5} to n-C _{30/32}	U-T11GPC-2S
Quick-seal column connector, pk 10	C-QSC10

The **Advanced TD starter kit**, for 3½" (standard) tubes, contains:

Stainless steel sorbent tubes, packed with Tenax TA/Carbograph 1TD/Carboxen 1003, conditioned and capped, pk 10 <i>Suitable for pumped sampling of VOCs from C_{2/3} to n-C_{30/32}</i>	C3-AAXX-5266
Stainless steel sorbent tubes, packed with Tenax TA/Carbograph 1TD, conditioned and capped, pk 10 <i>Suitable for pumped sampling of VOCs from n-C_{5/6} to n-C_{30/32}</i>	C2-AAXX-5032
Stainless steel sorbent tubes, packed with Tenax TA, conditioned and capped, pk 10 <i>Suitable for pumped or diffusive sampling of VOCs from n-C_{6/7} to n-C_{30/32}</i>	C1-AAXX-5003
Diffusion caps, pk 10	C-DF010
Empty stainless steel tubes, pk 10	C0-AXXX-0000
Quartz wool, 10 g	C-QUTZW
Spring, gauze-retaining, pk 10	C-SP010
Penclip, pk 10	C-CL010
Ferrule, ¼" PTFE, pk 20	C-FP020
PTFE liners, loose fit, pk 10	C-PL010
Cold trap, TO-15/TO-17 air toxics, UNITY 2/TD-100 <i>Compatible with the simultaneous analysis of analytes from C_{2/3} to n-C_{30/32}</i>	U-T15ATA-2S
Easy-VOC pump, including CapLok tool and carry-case	C-EZVOCPO
Check-standard (BTX, isobornyl methacrylate (IBMA) and dioctyl phthalate), 90 ng/µL (nominal), Tenax TA, pk 10	C-CHK10

N.B. Markes' Comprehensive TD starter kit (C-KIT02-2S) is still available for those people who wish to re-order.

ULTRA 2 and TD-100

The **Automated TD starter kit** for the ULTRA 2 autosampler and TD-100, compatible with 3½" (standard) tubes, contains:

Cap, DiffLok, stainless steel, ¼", pk 160 <i>(sufficient for 80 tubes, for routine analysis¹)</i>	C-DL160
O-Rings, size 007, pk 10 <i>(for ULTRA tube receiver)</i>	U-COV07
O-Rings, size 010, pk 10 <i>(for tube interface seal)</i>	U-COV10

ULTRA-X™

The **Automated TD starter kit** for the ULTRA-X (the model of the ULTRA 2 autosampler compatible with 4½" tubes with 6 mm o.d. ends) contains:

Cap, DiffLok, pk 80 pairs (80 stainless steel, 80 inert-coated) <i>(sufficient for 80 tubes, for routine analysis)</i>	C-DLP80-XZ
O-Rings, size 007, pk 10 <i>(for ULTRA tube receiver)</i>	U-COV07
O-Rings, 5.92 mm i.d., pk 10 <i>(for tube interface seal)</i>	U-COV45

For kits specific to accessories or applications, please see:

- Page 19 for the TubeTAG starter kit
- Page 33 for the Easy-VOC starter kit
- Page 53 for the Micro-Chamber/Thermal Extractor starter kits
- Page 56 for the SPE-tD starter kit
- Page 62 for the direct desorption starter kit
- Pages 64–66 for application-specific starter kits.

Description	Part number
Basic TD starter kit	C-KIT012-2S
Advanced TD starter kit	C-KIT03-2S
Automated TD starter kit, for 3½" tubes	U-ULKIT
Automated TD starter kit, for 4½" tubes	U-ULKIT-XZ

1. Note that if thermally labile or reactive species are to be analysed, the use of inert-coated DiffLok caps^{p21} at the sampling end is highly recommended.

Routine maintenance kits

Routine maintenance kits are available for UNITY 1 and 2, TD-100, TT24-7, Air Servers and CIA systems. Kits contain sufficient consumable items (O-rings, PTFE filters, etc.) for approximately 12 months' use. Where indicated, the relevant cold trap is included (specify trap type^{P77} with order).

Suggested maintenance schedule

Suggested maintenance frequencies are given below. However, in some cases (depending on the application), items may need replacing more frequently.

UNITY 1 and 2

Condition/change charcoal filter (split tube)	3 months ¹
Replace/repack cold trap	12 months ¹
Replace fused silica transfer line	12 months
Change sample tube O-rings/filters	12 months, or if damaged/leaking
Cold trap seals	12 months, or if damaged/leaking

TD-100

Condition/change charcoal filter (split tube)	3 months ¹
Replace/repack cold trap	12 months ¹
Replace fused silica transfer line	12 months
Change sample tube O-rings/filters	12 months, or if damaged/leaking
Cold trap seals	12 months, or if damaged/leaking
Replace O-rings in DiffLok caps	If damaged/leaking
Change nozzle seals	If damaged/leaking

ULTRA

Replace O-rings in DiffLok caps	If damaged/leaking
Change nozzle seals	If damaged/leaking

Air Server 3/8, CIA 8 and CIA Advantage

Replace filter disks	12 months
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Hints and tips

- ▶ As well as routine maintenance procedures carried out by the user, it is strongly recommended that a routine maintenance service is carried out on your TD system, by a trained service engineer, at least once a year.

1. Note that these parts may require changing more frequently in automated systems.

Description	Part number
Routine maintenance kit, UNITY 1, specify cold trap	RMK-0001
Routine maintenance kit, UNITY 1, without cold trap	RMK-0004
Routine maintenance kit (ECC), UNITY 1, contains U-T11GPC cold trap	RMK-012
Routine maintenance kit, UNITY 2, 3½", specify cold trap	RMK-0001-2S
Routine maintenance kit, UNITY 2, 3½", without cold trap	RMK-0004-2S
Routine maintenance kit (ECC), UNITY 2, 3½", with U-T11GPC-2S cold trap	RMK-012-2S
Routine maintenance kit, UNITY 2, 4½", specify cold trap	RMK-0001-XZ
Routine maintenance kit, UNITY 2, 4½", without cold trap	RMK-0004-XZ
Routine maintenance kit, TD-100, specify cold trap	RMK-0009
Routine maintenance kit, TD-100, without cold trap	RMK-0010
Routine maintenance kit for TT24-7, without cold traps	RMK-0005
Routine maintenance kit, 3½", Air Servers and CIA systems	RMK-0003-2S



Markes' TD service support specialists – There to support you and to back up our global network of service providers

Laboratory accessories

Markes offers a range of laboratory accessories and tools to assist with successful thermal desorption (TD)-GC/MS analyses.

Pneumatic control accessories	82
Helium leak detector	82
Flowmeter	82
Gas purifiers	83
Syringes	83
Miscellaneous supplies	84

A comprehensive range of accessories for your TD-GC(MS) laboratory

Pneumatic control accessories

Dual regulator pneumatics accessory

TD equipment typically requires a supply of high-purity carrier gas (usually helium) and a supply of dry gas (either air or nitrogen).

The dual regulator pneumatics accessory controls both these gas supplies immediately upstream of the TD system. It consists of a high-quality stainless steel regulator (0–60 psig) for control of the carrier gas, and a standard regulator (0–100 psig) for control of the dry gas. Both lines also have on/off toggle valves.



Markes strongly recommends that all thermal desorbers (UNITY, TD-100 and TT24-7) are configured with a dual regulator pneumatics accessory.

Single regulator pneumatics accessory

The single regulator pneumatics accessory consists of a high-quality (stainless steel) regulator (0–60 psig) and an on/off toggle valve.



It is recommended for use in the following configurations:

- Controlling purge gas supply on ULTRA and TD-100 autosamplers with internal standard functionality
- Regulating the pressure of internal standard (IS) gas if no other appropriate regulation is supplied
- Controlling the supply gas to the Micro-Chamber/Thermal Extractor^{p52} or TC-20^{p50}.

Description	Part number
Dual regulator pneumatics accessory (for dry gas and carrier gas regulation)	U-GAS01
Single regulator pneumatics accessory (for carrier gas regulation)	U-GAS03

Helium leak detector

Accurate, sensitive and rapid detection of carrier gas leaks is essential for TD–GC(MS) troubleshooting.

Traditional ‘wet’ methods of leak detection using soap solution should be avoided, as this can lead to contamination of the gas lines and TD flow path. Markes offers a portable, highly sensitive leak detector, designed to detect helium leaks in TD–GC systems. It works on thermal conductivity principles, with gas leaks being indicated by an LED display. The detector uses rechargeable batteries and is supplied with a mains-powered battery charger.



Description	Part number
Helium leak detector including 230 V charger	C-HEL23
Helium leak detector including 115 V charger	C-HEL11

Flowmeter

Markes offers a solid-state digital flowmeter for measuring TD gas flows (split flow, desorb flow, etc.). The flowmeter allows measurement of eight gases: air, argon, argon–5% methane, carbon dioxide, helium, hydrogen, nitrogen and oxygen, in the range 0.1–500 mL/min. Resolution is 0.1 mL/min and accuracy is typically better than $\pm 2.5\%$. Calibration is traceable to the UK National Physical Laboratory (NPL) standards, and an annual recalibration service (for helium, air and nitrogen) is offered on a return-to-factory basis.

Description	Part number
Digital flowmeter	C-FLMTR
Recalibration service for digital flowmeter (return to Markes)	C-FLCAL

Gas purifiers

Markes strongly recommends the use of carrier gas purifiers upstream of the analytical system to remove hydrocarbons, oxygen and water. General-purpose purifiers are available for standard TD–GC(MS) operation as well as high-capacity purifiers for specialised applications.

Hydrocarbon trap

The hydrocarbon trap is suitable for the removal of C₃₊ hydrocarbons in helium, hydrogen, nitrogen, argon–methane and air. Refill kits are also available. The trap has a maximum flow capacity of 2 L/min and the stated life is 16 cylinders¹.

Water vapour trap

Molecular sieve 5 Å efficiently removes water from helium, hydrogen, nitrogen, air, etc. A refill kit is available. The trap has a maximum flow capacity of 2 L/min and the stated life is 68 cylinders¹.

Oxygen/water trap

This trap reduces O₂ levels to less than 2 ppb². It can extract contaminating oxygen at 10 ppm from at least three 8.5 m³ cylinders, and the maximum flow capacity is 250 mL/min.

Helium purifier

Removes O₂, H₂O, hydrocarbons, CO₂ and CO from helium, giving an output gas which is 99.99999% pure. The maximum flow capacity is 8 L/min, and the stated life is 13 standard cylinders² of 99.999% helium.

High-capacity gas purifier

This specialised gas purifier removes both O₂ and H₂O from any common carrier gas (except hydrogen) by a catalytic reaction. It can purify up to 60 tanks of heavily contaminated gas containing 100 ppm O₂ and/or H₂O at flow rates of up to 1.1 L/min. A pressure gauge should be fitted at the outlet to monitor the pressure drop across the purifier – when the drop exceeds 10 psi the purifier tube should be replaced. Replacement purifier tubes are available.

1. Based on standard 218 ft³ cylinder containing 50 ppm contaminants.
2. When the level in the incoming gas does not exceed 10 ppm.

Description	Part number
Gas purifier, hydrocarbon trap, 120 cc, 1/8" fittings	C-HCTRP
Gas purifier, hydrocarbon trap, refill material	C-RFHCT
Gas purifier, water vapour trap, 200 cc, 1/8" fittings	C-MSTRP
Gas purifier, water vapour trap, refill material	C-RFMST
Gas purifier, oxygen/water trap, 120 cc, 1/8" fittings	C-O2TRP
Gas purifier, helium purifier, 1/8" fittings	C-HEPUR
Gas purifier, high-capacity, 230 V, 1/8" fittings	C-HCP23
Gas purifier, high-capacity, 110 V, 1/8" fittings	C-HCP11
Gas purifier, high-capacity, replacement purifier tube, 1/8" fittings	C-HCPTB
Gas purifier, high-capacity, replacement element, 230 V	C-HCE23
Gas purifier, high-capacity, replacement element, 110 V	C-HCE11
Gas purifier, high-capacity, outlet pressure gauge	C-HCPPG

Syringes

Markes offers a selection of precision syringes, for both liquid and gas injections.

[1 µL liquid syringe](#)

A 1 µL plunger-in-needle syringe fitted with a repeating adaptor provides ±2% accuracy and reproducibility for injection volumes down to 0.1 µL.

[5 µL liquid syringe](#)

A 5 µL plunger-in-barrel syringe provides ±1% accuracy and reproducibility for injection volumes between 1 and 5 µL.

[50 mL and 100 mL gas syringes](#)

50 mL and 100 mL removeable Luer lock gas-tight syringes provide ±1% accuracy and reproducibility for injection volumes down to 10 mL. Maximum gas temperature is 120 °C.

Description	Part number
Syringe, 1 µL, plunger-in-needle with repeating adaptor, 50 mm needle length, 0.63 mm needle o.d.	C-SYL00-1UL
Syringe, 1 µL, replacement needle and plunger repair kit	C-SYLRP-1UL
Syringe, 5 µL, plunger-in-barrel fixed needle, 50 mm needle length, 0.47 mm needle o.d.	C-SYL00-5UL
Syringe, 50 mL, gas-tight, removeable Luer lock	C-SYG00-50ML
Syringe, 50 mL, gas-tight, replacement plunger	C-SYGPL-50ML
Syringe, 50 mL, gas-tight, replacement Luer lock needles, 50 mm needle length, 0.63 mm needle o.d., pk 5	C-SYGND-50ML
Syringe, 100 mL, gas-tight, removeable Luer lock	C-SYG00-100ML
Syringe, 100 mL, gas-tight, replacement plunger	C-SYGPL-100ML
Syringe, 50 mL, gas-tight, replacement Luer lock needles, 50 mm needle length, 0.63 mm needle o.d., pk 5	C-SYGND-100ML

Miscellaneous supplies

Capillary column cutting tool

Used to cut the ends of fused silica tubing (e.g. transfer line insert or capillary columns) to ensure burr-free square ends, and reliable capillary–capillary connections.

Fused silica capillary column connectors

[Quick-seal column connector](#)

Quick-fit capillary column connectors are supplied with every Markes TD system. They are used to connect the fused silica transfer line insert to the GC capillary column inside the GC oven, and are suitable for most routine applications. The connectors are single-use, and a new one must be used must be discarded each time the connection is remade.



Quick-seal column connectors

[SilTite™ mini-unions](#)

For TD–GC systems incorporating an MS detector, a mini-union is recommended for capillary–capillary connections. SilTite mini-unions use nuts and ferrules to make the connection, and can therefore be reused (with new ferrules when applicable).



SilTite mini-union – The optimum capillary–capillary connector for high-performance TD–GC(MS) systems

Copper tubing and unions

Gases supplied to TD–GC(MS) systems (i.e. carrier gas and dry gas) should be supplied in solvent-washed refrigeration-grade $\frac{1}{8}$ " copper tubing. This tubing should never be brazed, and should only be connected using GC-compatible Swage-type unions.

Description	Part number
Fused silica column-cutting tool	C-FSCCT
Quick-seal column connector, pk 10	C-QSC10
SilTite mini-union, connects 0.25 mm fused silica transfer line to capillary column (up to 0.25 mm i.d.)	C-MU000
Ferrules, SilTite mini-union, 0.1–0.25 mm i.d. (columns up to 0.25 mm i.d.), pk 10	C-MUF25
Ferrules, SilTite mini-union, 0.32 mm i.d. (0.32 mm i.d. columns), pk 10	C-MUF32
Copper tubing, 3 m	C-CUTUB-3M
Union, brass, $\frac{1}{8}$ ", T-shaped	SERZ-0104
Union, brass, $\frac{1}{8}$ "– $\frac{1}{8}$ "	SERZ-0026

GC/MS software

ClearView and TargetView are innovative software packages providing powerful post-run processing of GC/MS data in an easy-to-learn software environment.

ClearView provides dynamic baseline compensation (DBC) for GC/MS chromatograms (TICs). This suppresses baseline anomalies such as column bleed and air/water background by minimising ions that are not related to chromatographic peaks, thus dramatically improving signal-to-noise ratios and spectral purity.

TargetView software builds on ClearView and provides sophisticated GC/MS data-mining for the identification of trace compounds in complex TIC profiles. Processing includes spectral deconvolution and principal components analysis, allowing reliable identification of co-eluting compounds. A simple report then allows the analyst to see exactly which target and non-target compounds are present.

Both packages can process data in a matter of seconds, and are compatible with GC/MS data files from major vendors.

ClearView	86
TargetView	87

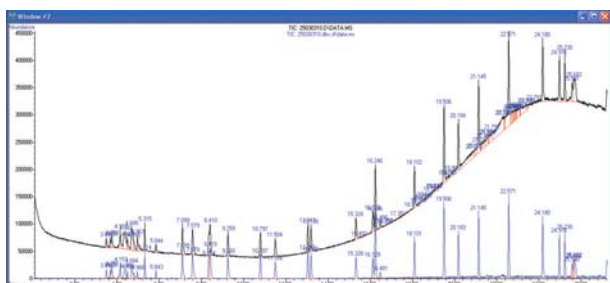
Simplifying the analysis of complex mixtures

ClearView™

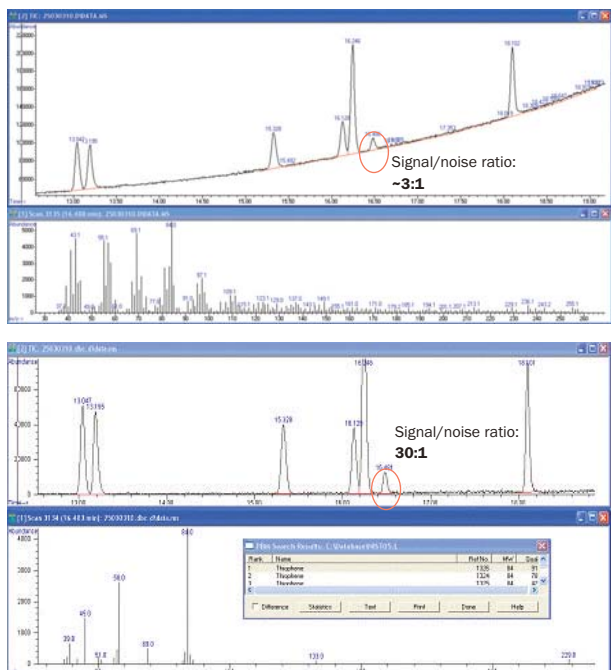
ClearView uses sophisticated dynamic background compensation (DBC) algorithms to distinguish between chromatographic peaks and baseline anomalies, such as GC column bleed, humps of unresolved sample matrix, extended solvent tails and air ingress. By removing such interferences, ClearView:

- reduces noise and increases sensitivity in full-scan mode
- improves the accuracy of peak integration
- aids compound identification
- improves laboratory productivity, by reducing the need for manual re-integration of complex chromatograms.

The software is fast and intuitive, and files can be processed individually or as a batch for optimum efficiency. Processing generates a separate file, with the original GC/MS file remaining intact for comparison or future reference.



TD-GC/MS analysis of a landfill-gas standard with high column bleed. The top chromatogram is the original TIC data, and the bottom chromatogram shows the same data following ClearView reprocessing



Benefit of ClearView reprocessing for a landfill-gas standard. Top: Analysis of the TIC data does not correctly identify the trace component circled. Bottom: ClearView reprocessing enables automatic identification of the circled component as thiophene

Compatible GC/MS file formats

The following GC/MS file types are accommodated by ClearView:

- ChemStation® (.d) format
- Xcalibur® (.raw) format
- ANDI/netCDF (.cdf) format, for compatibility with other vendors (e.g. PerkinElmer, Shimadzu)
- ALMSCO (.lsc) format for BenchTOF-dx™.

Free 30-day ClearView trial

A free 30-day trial copy of ClearView is available directly from Markes International. Contact clearview@markes.com to request your copy, or download directly from www.markes.com/software.

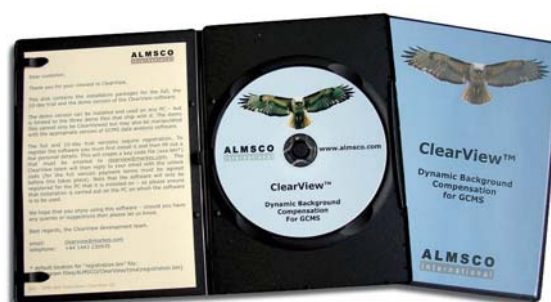
Buying and operating ClearView

A single-user copy of ClearView can be delivered on CD or downloaded from the Markes website via the online shop.

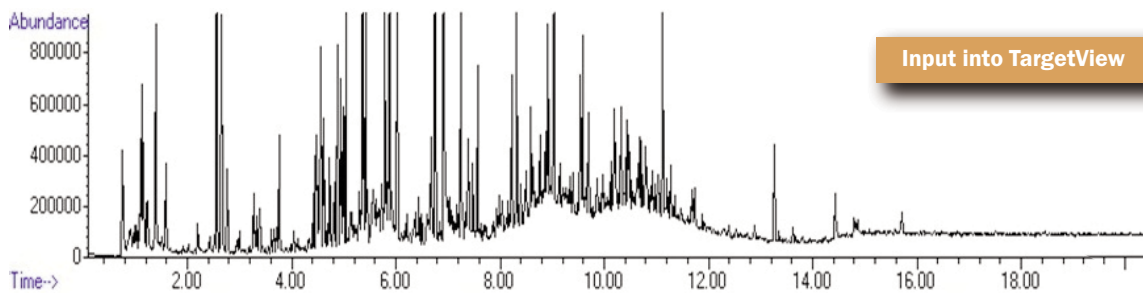
ClearView will only operate on the PC used for initial software installation. (Contact Markes to renew your ClearView licence if the installation PC is replaced within 12 months.)

Please contact Markes directly if you require any other combination of licences (clearview@markes.com).

Description	Part number
ClearView GC/MS software (single user licence)	C-CVIEW1
ClearView GC/MS software (12-month licence)	C-CVIEWYR



TargetView™



Output from TargetView

Target compound	CAS no.	Retention time (min)	Expected retention time (min)	delta RT (seconds)	Retention index	Library	Matching coefficient	Peak sum (TIC)	Peak sum (extr. ion)	Extracted ion
Benzene	71-43-2	1.2922	1.4	-0.1	-	-	0.900	2597105	1072842	76
Benzaldehyde	100-52-7	4.4889	-	-	-	-	0.940	1111967	-	-
Furfural	98-01-1	2.9679	-	-	-	-	0.939	122888	-	-
Toluene	108-88-3	2.2035	2.2	0.2	-	-	0.930	333561	159989	91
Ethanol, 2-phenoxy-	122-99-6	6.9186	-	-	-	-	0.928	7005198	-	-
Phenol	100-95-2	4.6100	-	-	-	-	0.920	1303299	-	-
Hexanal	66-25-1	2.5614	-	-	-	-	0.927	4439104	-	-
Acetic acid	64-19-7	1.1198	-	-	-	-	0.925	1921949	-	-
Benzene, 1,3,5-trimethyl-	108-87-8	4.8044	-	-	-	-	0.903	150284	-	-
Dibutyl phthalate	84-74-2	11.7303	-	-	-	-	0.899	430225	-	-
Ethyl Acetate	141-78-6	1.2027	-	-	-	-	0.882	447989	-	-
Nonane	111-94-2	3.7127	-	-	-	-	0.867	202743	-	-
o-Xylene	95-47-6	3.2824	-	-	-	-	0.867	580400	-	-

TargetView data-mines a complex total ion chromatogram and automatically generates a report of target hits together with associated peak abundances

TargetView incorporates a similar dynamic background compensation (DBC) algorithm to that used by ClearView, and takes the analysis further, providing a complete identification solution for post-run GC/MS data processing. Powerful deconvolution algorithms separate co-eluting compounds, while advanced chemometrics provide confident matching against target libraries.

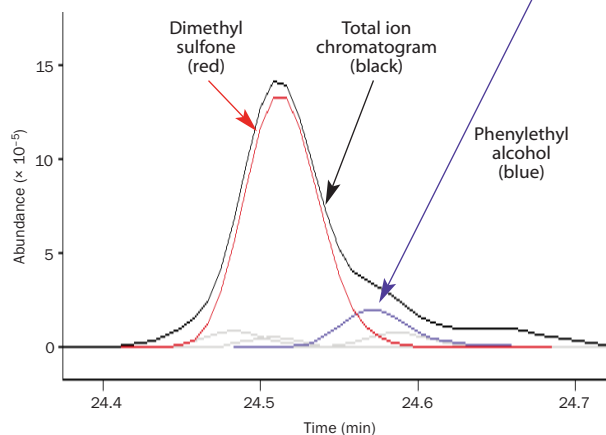
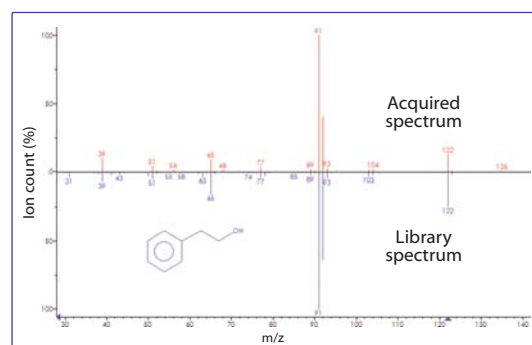
TargetView is simple to use, and ideal for those who analyse trace compounds in challenging mixtures. The rapid and effective processing offered by TargetView improves efficiency and saves valuable time.

Elimination of background interferences

As in ClearView, the DBC algorithm selectively eliminates ions due to chromatographic background noise, such as column bleed. This minimises interference, making it much easier to analyse compounds of interest.

Separation of co-eluting components

With background interferences removed, TargetView then deconvolves all individual components (targets and unknowns), providing accurate peak areas and clean mass spectra even when there are co-eluting components present. This is especially useful in complex chromatograms where complete peak separation is not always possible.



TargetView's deconvolution algorithms enable high-quality mass spectra to be obtained from overlapping peaks, simplifying compound identification

Library searching for targets and 'unknowns'

TargetView applies advanced chemometric algorithms to match each deconvolved mass spectrum against a library. Individual compounds are indicated on the total ion chromatogram (TIC) by a red bar overlay (see image below). A simple, customisable report is then generated, which provides the full details (retention time, match coefficient, abundance, etc.) of all target compounds. Residual non-target compounds can also be automatically cross-searched against external databases, e.g. NIST.

Easy library creation

Creation of TargetView libraries is simple, whether from in-house datasets or using spectra imported from databases such as those provided by NIST and Wiley.

One-click report generation

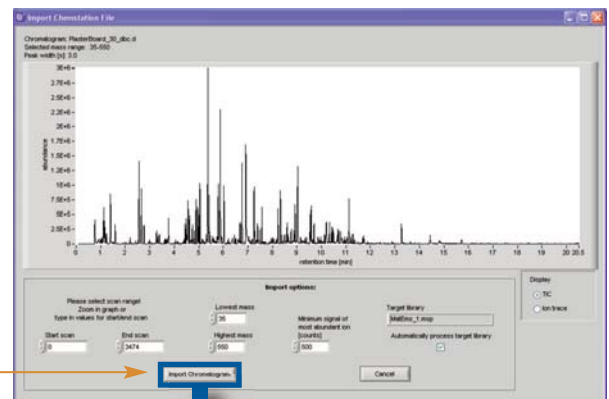
TargetView creates a simple report that can be either viewed in the application or exported in an Excel®-compatible format for subsequent processing. Data exported includes compound name and CAS number, retention time, matching coefficient, peak abundances and extracted-ion data (if specified).

Quantitation

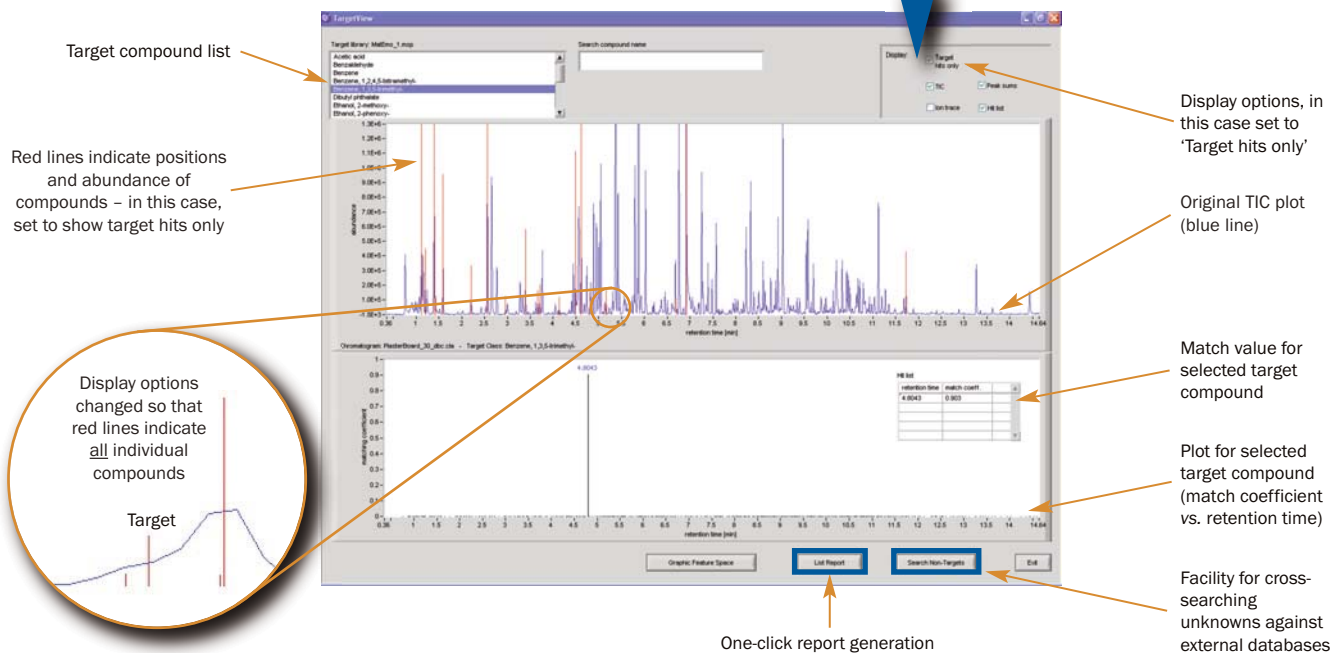
The removal of background interferences and deconvolution processes carried out by TargetView means that peak areas of chromatographic peaks are uncompromised by background ions and co-eluting components. Exported data can therefore be confidently used to quantitate compounds of interest.

Batch processing

Files can be processed individually or in batch mode, with the original files always being retained for future reference, providing an audit trail for contract laboratories.



Simple chromatogram import



The simple user interface of TargetView. Top: imported GC/MS chromatogram. Bottom: Results generated in TargetView, with retention time and abundance of target compounds indicated by vertical red lines. Inset: Plot showing target compound identified amongst co-eluting components, with the display options changed so that all individual compounds are marked with red lines

File preview

Double-clicking a class file in the main project window opens up an instant preview of the file content.

Compatible GC/MS file formats

The following GC/MS file types are accommodated by TargetView:

- ChemStation® (.d) format
- Xcalibur® (.raw) format
- ANDI/netCDF (.cdf) format, for compatibility with other vendors (e.g. PerkinElmer, Shimadzu)
- ALMSCO (.lsc) format for BenchTOF-dx™.

Free 60-day TargetView trial

A free 60-day trial copy of TargetView is available directly from Markes International. Contact targetview@markes.com to request your copy, or download directly from www.markes.com/software.

Description	Part number
TargetView GC/MS software (single-user 12-month licence)	MS-TVYR
TargetView GC/MS software (single-user full licence)	MS-TV01

Buying and operating TargetView

A single-user copy of TargetView can be delivered on CD or downloaded from the Markes website via the online shop.

TargetView will only operate on the PC used for initial software installation. (Contact Markes to renew your TargetView licence if the installation PC is replaced within 12 months.) Please contact Markes directly if you require any other combination of licences (targetview@markes.com).

Please see the TargetView brochure and Markes' website for additional information.



**Simple, reliable, automatic –
Speed up your TD-GC/MS data
analysis with TargetView**

Applications Guides

Four comprehensive and clearly illustrated TD Applications Guides are available **FREE** from Markes. Each one contains 20–50 pages of representative applications across the following areas:

I. Environmental Monitoring & Exposure to Chemicals at Work

Covering:

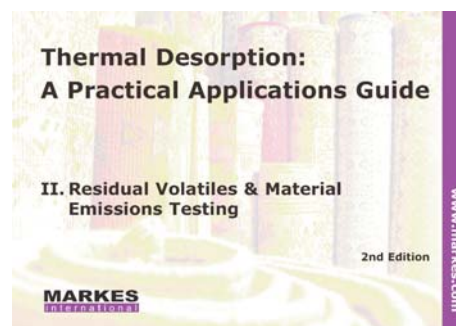
- *Industrial emissions* – stack tests, fence-line monitoring, soil gas and vapour intrusion.
- *Detection of VOCs in air* – whether urban or rural, workplace or residential.
- *Assessment of personal exposure* – by diffusive (passive) monitoring or breath testing.



II. Residual Volatiles & Material Emissions Testing

Covering:

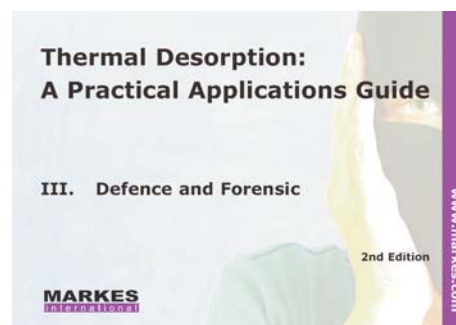
- *VOC emissions* – from vehicle trim, paint, adhesives, flooring tiles, carpet, plasterboard, wood, children's toys, computer components, ointments and textiles.
- *VOC content* – of raw materials and products.
- *Residual compounds* – monomers in polymers, additives/solvents in food packaging, solvents in drugs and pharmaceutical powders.



III. Defence and Forensic

Covering:

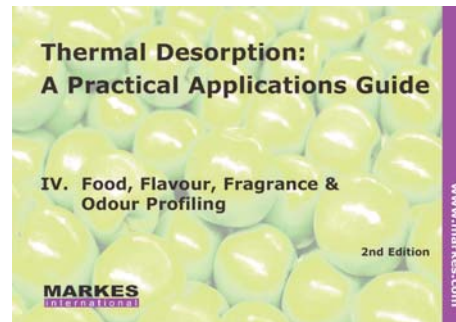
- *Detection of chemical warfare agents* – continuous near-real-time monitoring of military/civilian facilities, studies of permeation through protective material.
- *Forensic analysis* – drugs of abuse, arson residues, explosive vapours, shotgun propellant, inks, paper and paint.



IV. Food, Flavour, Fragrance & Odour Profiling

Covering:

- *VOC characterisation of foods and beverages* – cheese, meat, dried foodstuffs, fruit juices, wine, whisky, beer and milk.
- *Detection of off-odours or contaminants* – off-odour/taint analysis in wine and water, residual volatiles from packaging, halitosis in breath
- *Fragrance/odour profiling* – toiletries, essential oils, tobacco, incense, mosquito coils, fabrics.



Please email us (enquiries@markes.com) to request your free copy

For more detailed information on individual applications, our Application Notes may also be of interest – see the next page.

Providing a wealth of in-depth information, our Application Notes deal with a variety of aspects of thermal desorption, including technical guidance and know-how as well as experimental conditions for a wide range of applications. Our most popular Application Notes are given below – visit our website to view the full list or to download PDF files.

General

- TDTS 4 Publications and presentations citing Markes' products
 TDTS 12 Analytical thermal desorption: History, technical aspects and application range
 TDTS 14 Monitoring labile, high-boiling organic vapours such as those found in cleanroom air in semiconductor plants
 TDTS 32 Analysis of sulfur compounds using on-line and off-line TD-GC
 TDTS 53 Quantitative recovery and method validation of high-boiling SVOCs using TD-GC-MS
 TDTS 64 Simultaneous TD-GC analysis of VOCs and SVOCs
 TDTS 79 Air monitoring – The advantages and applications of canisters and tubes

Technical support

- TDTS 1 Uptake rates for tube-type axial diffusive samplers
 TDTS 5 Advice on sorbent selection, tube conditioning, tube storage and air sampling
 TDTS 7 Calibration: Preparing and introducing thermal desorption standards using sorbent tubes
 TDTS 8 Principles of diffusive monitoring
 TDTS 19 Minimising artefacts: Considerations for storage and transport of sorbent tubes
 TDTS 20 Confirming sorbent tube retention volumes and checking for analyte breakthrough
 TDTS 21 Developing and optimising TD methods
 TDTS 22 Selection of gas flows and split ratios during thermal desorption
 TDTS 26 Minimising analytical interference from water during the analysis of sorbent tubes
 TDTS 75 Liquid standard injection, tube impedance and other factors that may cause discrimination during the calibration of TD methods

Application area – Environmental monitoring

- TDTS 16 Round-the-clock, on-line and cryogen-free monitoring of hydrocarbons from acetylene to trimethylbenzene in ambient air
 TDTS 29 VOC air monitoring technology and its application to contaminated land
 TDTS 49 Fenceline and ambient monitoring of benzene and other hydrocarbons using diffusive sampling and TD analysis
 TDTS 77 Using thermal desorption for industrial (stack) emission testing
 TDTS 80 Evaluation of a 'soil gas' sorbent tube for improving the measurement of volatile and semi-volatile fuel vapours in contaminated land
 TDTS 81 Analysis of canister air using cryogen-free thermal desorption in compliance with US EPA Method TO-15
 TDTS 86 Monitoring 'air toxics' in ambient air using sorbent tubes by automated cryogen-free thermal desorption in accordance with US EPA Method TO-17

- TDTS 87 A cryogen-free method for monitoring trace greenhouse gases in air
 TDTS 97 Analysis of polycyclic aromatic hydrocarbons from vehicle exhaust using TD-GC-MS
 TDTS 99 Using the CIA *Advantage* for automated cryogen-free analysis of canister air and gas

Application area – Residual volatiles and material emissions

- TDTS 33 Analysis of the interior atmosphere of a passenger car by TD-GC-MS
 TDTS 40 Direct desorption of VOCs and SVOCs from leather furnishings
 TDTS 56 TD-GC-MS analysis of VOCs for material emissions testing
 TDTS 59 Direct desorption of car trim materials for VOC and SVOC analysis in accordance with VDA Method 278
 TDTS 62 Material emissions testing in the semiconductor and electronics industries
 TDTS 67 Using the Micro-Chamber/Thermal Extractor for rapid emissions screening of products and materials
 TDTS 89 Thermal desorption technology for testing chemical emissions from construction products and consumer goods
 TDTS 91 Using headspace-thermal desorption to enhance the measurement of residual solvents in drugs
 TDTS 103 Enhancing the development of low-emitting products and materials

Application area – Defence and forensic

- TDTS 44 The analysis of free-VX from sorbent tubes at low and sub-nanogram levels
 TDTS 58 The application of thermal desorption to forensic investigations
 TDTS 63 Continuous monitoring of trace-level toxic chemicals in air

Application area – Food, flavour, fragrance and odour profiling

- TDTS 78 Detecting low-ppt levels of odorants in drinking water using headspace-thermal desorption
 TDTS 84 Using thermal desorption to enhance aroma profiling by GC-MS
 TDTS 88 Enhancing olfactory profiling of fruit juices and wine using complementary thermal desorption techniques
 TDTS 94 Automating 'High/Low' thermal desorption analysis of a complex beer sample
 TDTS 95 Food decomposition analysis using the Micro-Chamber/Thermal Extractor and TD-GC-MS
 TDTS 96 Comparing the VOC content of Indian and UK tobacco by headspace-thermal desorption
 TDTS 98 Analysis of a betel-nut foodstuff by direct thermal desorption
 TDTS 100 Comprehensive analysis of aroma compounds released from incense sticks using TD-GC-MS
 TDTS 101 Rapid aroma profiling of cheese using a Micro-Chamber/Thermal Extractor with TD-GC-MS analysis
 TDTS 104 Rapid and sensitive aroma profiling of strawberries using dynamic headspace sampling and TD-GC-TOF MS
 TDTS 105 Near-real-time profiling of fragrance components and potential allergens released from an air freshener using TD-GC-TOF MS

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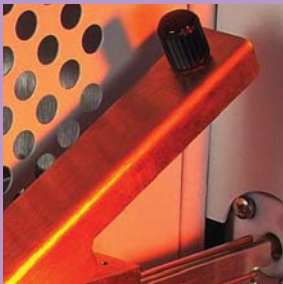
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