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

Operators' Manual

DECEMBER 2011

QUI-1022

VERSION 3.5

MARKES international

www.markes.com

This page left intentionally blank

Table of Contents

List of figures

Preface

This manual provides detailed instructions on the use of the Micro Chamber/Thermal Extractor (μ-CTE). It is suitable for users with little or no prior experience of the system, and details the software/hardware interface and procedure for first sample runs.

I. Regulatory compliance

Our products are thoroughly tested and evaluated to ensure compliance with applicable domestic and international regulations. This system (hardware and software) is CE compliant and meets Electromagnetic Compatibility (EMC) Directive and the Low Voltage Directive. The product has been evaluated to the following safety standards: UL 61010/CSA C22.2 NO 61010-1-04 UPD 1, IEC 61010-1.

II. Warnings

- If the equipment is not used in a way specified by the manufacturer, the protection provided by the equipment may be reduced. System failures arising from such use may not be covered in standard warranty and service contract documents.
- Ensure that the plug (electrical isolator) can be *easily and quickly* accessed during equipment use.
- This instrument *must* be earthed.

III. Technical Specifications

Physical		**Electrical**	
Height (cm/inches):	31.5/12.4	Maximum Power (W):	360
Width (cm/inches):	12/4.7	Line voltage:	100-240
Length (cm/inches):	50/19.7	Frequency (Hz):	50-60
Mass (kg/lbs):	10.2/22.5	Input inrush current (A):	<25 (cold start)

Input/output connections are described in section 2.3

IV. Environment operating conditions

It is advisable to operate the system in a clean laboratory environment, with minimal atmospheric concentrations of organic vapours. Performance can be affected by sources of heat and cold from heating, air conditioning systems, or drafts.

Temperature: Recommended operating ambient temperature range is 15 to 30°C.

Humidity: Recommended operating humidity range is 5 to 95% non-condensing.

NOTE: For storage or shipping the allowable temperature range is -40 to 70°C and the allowable humidity range is 5-95% non-condensing. After instrument exposure to extremes of temperature or humidity, allow 2 hours for return to the recommended ranges before switching on.

The instrument should be protected from conditions that could cause exposure to frost, dew, percolating water, rain, excessive direct sunlight, *etc*.

The instrument has an IP20 rating.

V. Safety alerts

Warning: Precautions must be taken when preparing liquid samples. These should be prepared away from the Microchamber, with care taken not to allow liquid to be split into the chamber manifold. It is recommended that liquid samples are placed into a PTFE sample plate, glass dish or aluminium boat and not directly into the Microchamber. Liquids for use in permeation devices should be injected into the permeation device, sealed and then placed into the Microchamber manifold. If a spillage does occur switch the Microchamber off. For further information or assistance please call Markes Technical support on +44 (0)1443 230935.

The 'CAUTION – HOT SURFACE' symbol indicates a burn hazard. Make sure the instrument is at room temperature before touching, or you may incur burn injuries.

VI. Technical support contact details

In the first instance please contact your supplier. If they are unable to resolve your query, please contact Markes International on the details below.

Address: Gwaun Elai Medi Science Campus
LLANTRISANT
RCT
United Kingdom
CF72 8XL
Website: www.markes.com
E-Mail: enquiries@markes.com
Telephone: +44 (0) 1443 230935
Fax: +44 (0) 1443 231531

1. Introduction

The Micro-Chamber/Thermal Extractor (µ-CTE™) from Markes International provides industry and researchers with a versatile and automated tool for testing materials.

Key applications include:

- Testing emissions from material surfaces at low temperatures for:
  - correlation with data from conventional emission chambers/cells
  - intercomparison of products within a range (*e.g.* different colours/patterns)
  - testing prototype, "low-emission" materials
  - monitoring product uniformity in-between formal certification tests
- Testing VOCs and Semi-VOCs (SVOCs) in bulk materials for routine quality control (content and emissions testing)
- Testing vapour permeation into and through materials at various temperatures
- Flavour and Fragrance profiling

1.1. Summary of Operation

The system (figure 1) comprises six microchambers (up to 28 mm deep and ~45 mm in diameter) which allow surface or bulk emissions to be tested from up to six samples simultaneously. The µ-CTE is compatible with a range of sampling tubes and multiple standard analytical methods.

Figure 1: The Micro-chamber/ Thermal Extractor (µ-CTE)

Conditioned sorbent tubes are attached to each micro-chamber and a controlled flow of air or inert gas is passed through all six chambers simultaneously. (S)VOC vapours are swept from the sample material in the micro-chamber and onto the attached sorbent tube. After sample collection, trapped vapours are thermally desorbed and analysed by GC(/MS) as per standard methods.

The thermal desorption analytical process is carried out off-line allowing a fresh set of samples to be introduced to the µ-CTE even while analysis of vapours emitted by the previous set of samples is being performed. This also facilitates chemical analysis by third party laboratories, if preferred.

Alternative analysers, combining thermal desorption with process MS or ENose detectors, are also applicable in some cases - particularly during quality control of fragrance/odour of foods and consumer products.

2. System Installation and Set-up

2.1. Pre-installation

2.1.2. Services Required

2.1.2.1. Power

µ-CTE is automatically compatible with all conventional mains power supplies ranging from 115 to 230 V and 50 or 60 Hz. It is not necessary to manually select or switch voltages. The maximum power consumption is 205 W.

2.1.2.2. Laboratory requirements

The µ-CTE occupies minimal bench space, (50 cm x 12 cm) and requires sufficient space to allow unhindered access to all of the microchambers. Access to the rear of the µ-CTE will be required when changing the gas inlet line (see section 2.3.2).

2.1.2.2.1. Laboratory conditions

As the µ-CTE is a powerful concentrator of VOCs and is often used to determine trace levels of organic analytes, it is advisable to store and operate the µ-CTE in a clean laboratory environment with minimal atmospheric concentrations of organic vapours.

2.1.2.3. Gas supply

The µ-CTE requires a pressure regulated supply of clean air, nitrogen or helium, between the ranges of 10-60 psi as a carrier gas through the microchambers.

2.1.2.3.1. Cleanliness of gas lines and supply

As the µ-CTE is a concentrator, even trace level contaminants in laboratory gas lines can become significant interferents in the sample obtained. It is recommended that the gas line be constructed of refrigeration-grade copper tubing connected using approved swage-fittings. Laboratory gas line joins and connections must never be brazed. Position the gas supply as close to the µ-CTE gas inlet (Figure 2) so that the gas lines are as short as possible. Use a high quality, stainless steel diaphragm cylinder head regulator for the gas supply. The cleanliness of the gas and supply can be validated prior to installation of the µ-CTE (see section 2.3.1).

2.2. Unpacking the Micro-Chamber/Thermal Extractor

Remove the instrument from its packaging and inspect the contents. Check every item against the packing list (see 2.2.1. below). Retain the instrument packaging and re-use if ever the system is to be shipped using conventional carriers.

2.2.1. Packing List

Please refer to the customer check list included in your order package.

2.2.2. Installation - tools required

To complete the installation you will need the following tools: 7/16 wrench/spanner

2.3. Installing the gas lines

Unique technology maintains a constant flow of air or gas through each sample chamber at any given backing pressure, independent of sorbent tube impedance and whether or not a sorbent tube is attached. No pump or mass flow controller is required.

2.3.1. Checking the cleanliness of the gas supply

It is recommended that the gas supply and lines are checked for cleanliness prior to using the µ-CTE. This can be quickly and easily checked by sampling ~ 10 L of gas through a conditioned Tenax tube and then analysing the tube using a Markes UNITY - GC(-MS/FID) system. Artefact levels of less than 30 ng total compounds are generally acceptable depending on the type of application to be undertaken. If the gas supply is not sufficiently clean then a suitable filter should be placed in-line immediately prior to the µ-CTE. The cleanliness of supply should be re-checked after fitting the filter.

2.3.2. Connecting the gas supply to the µ-CTE inlet

The gas supply should be connected to one of the inlets found on the rear of the µ-CTE (figure 2).

Figure 2: Rear view of µ-CTE

The left-hand inlet is the low-flow gas inlet which allows the user to operate at flows between 10 and 70 mL/min. The right-hand inlet is the high-flow gas inlet which allows the user to operate at flows between 50 and 500 mL/min. In both cases a gas backing pressure of between 10 and 60 psi must be maintained to ensure flow stability of the gas particularly at the lower flow rates.

Once the gas supply is connected, ensure that the unused inlet is capped with the blanking plug supplied.

The flow rate is determined by measuring the flow (with an appropriate flow meter) from the back of a sorbent tube inserted into the lid of the μ-CTE with the lid closed (figure 3). The choice of sorbent tube used for setting flow rates will ideally be the same type of tube being used during sampling from the μ-CTE. The flow rate is adjusted by regulating the carrier gas pressure. The flow rate can be set with the μ-CTE heated to the desired temperature if required (see section 2.5).

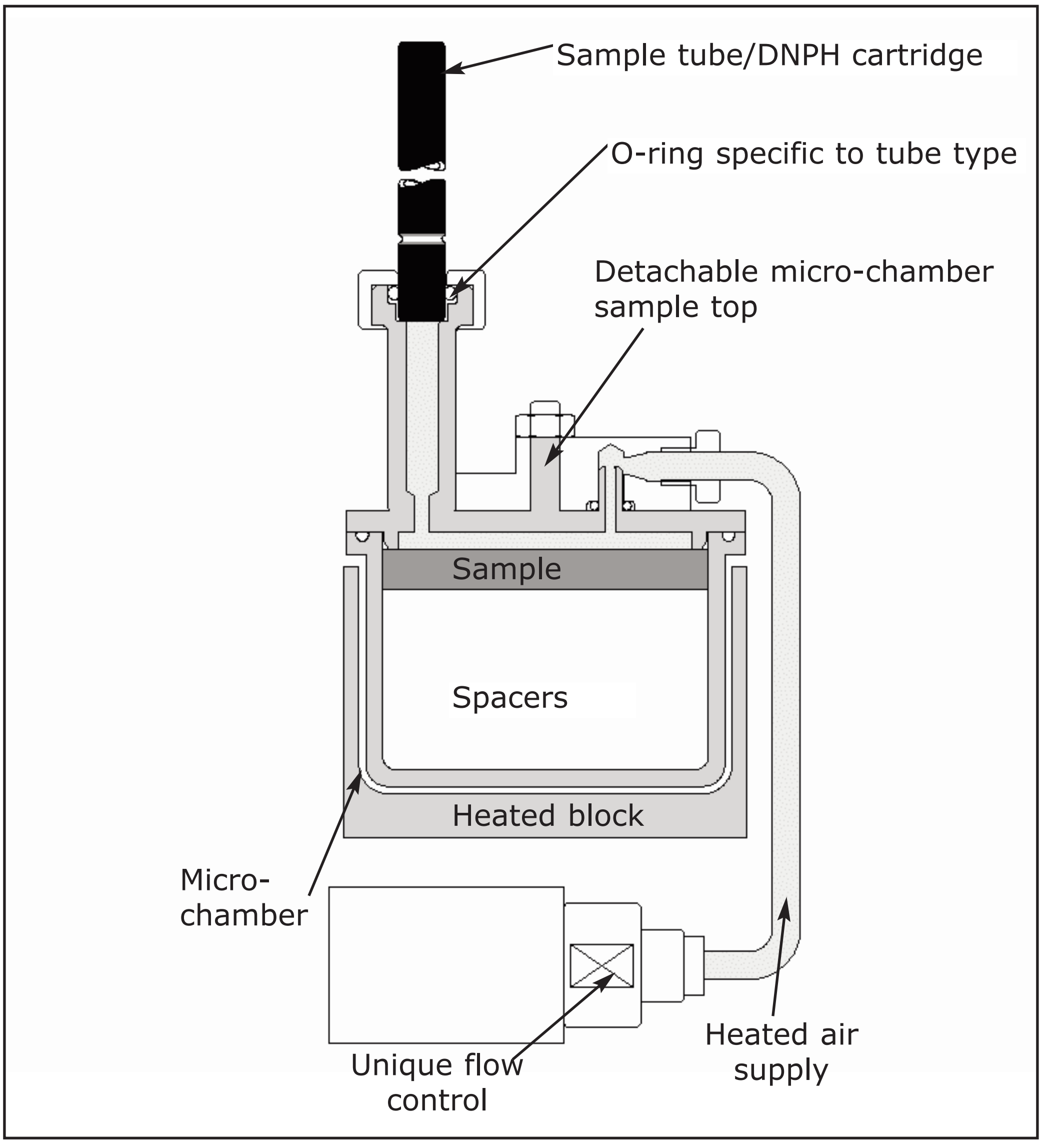

Figure 3: Schematic showing where to put tube

2.4. Connecting the µ-CTE

Connect the power cable supplied to the power socket on the rear of the µ-CTE (figure 2) and turn the power switch on.

2.5. Setting the temperature

Independent heating of all µ-CTE chamber components *e.g.* sample pans, chamber lids, air/gas supply tubing, is controlled by the temperature controller on the front panel of the µ-CTE (figure 4).

Figure 4: Front of µ-CTE

Depending on the requirements of the application, microchamber sampling can be performed at ambient or elevated temperatures (up to 120°C).

Once the µ-CTE is switched on, the temperature controller should be lit up and displaying the current temperature *set point* in green and the *actual* temperature of the µ-CTE in red (figure 5).

Figure 5: Temperature controller

To change the set point push the **'P'** button once on the temperature control panel. The red display will change to a flashing **'SP 1'** (Set Point 1). While **'SP 1'** is flashing the set point can be adjusted using the up and down arrows on the control panel. To confirm the new set point push **'P'** once more. Alternatively, wait ten seconds after setting the new temperature and the controller will automatically save the new set point. If the temperature is changed, allow sufficient time for the temperature to equilibrate (green and red displays should both show the same value) before beginning sampling.

3. Sampling methods and testing

3.1. Sorbent selection

Regardless of the type of testing (bulk or surface emissions) the gases evolved from the µ-CTE must be collected onto a sorbent tube for subsequent analysis by thermal desorption - GC(-MS/FID). The selection of the sorbent and the conditioning of the tube prior to sampling are critical to the success of the testing as incorrectly selected sorbents may not trap the compounds of interest (or may not release them quantitatively during desorption).

Sorbent selection principally depends upon the volatility (specifically the vapour pressure) of the analyte(s) concerned. In short, the sorbent or series of sorbents selected must quantitatively retain the compounds of interest from the volume of air/gas sampled and must then release those compounds as efficiently as possible when heat is applied and the flow of (desorption) gas reversed. As vapour pressure data are not always readily available, a useful rule of thumb is to use the boiling point of the component as a guide to its volatility. In general, the more volatile the analyte to be trapped, the stronger the sorbent must be. If the analytes to be collected cover a wide boiling point range then it may be necessary to use sorbent tube packed with two or more sorbents in series.

3.1.1. Typical sorbents

There are a large number of sorbents available for use and Appendix 1 gives details of the most commonly used, along with analyte range they are suitable for and other information such as maximum temperature *etc.*

Generally, sorbents can be classified as weak, medium or strong as follows:

> **Weak** - porous polymers such as Tenax TA, Tenax GR, graphitised carbon blacks such as Carbograph 2TD, Carbotrap C, Carbopack C.
>
> **Medium** - porous polymers such as the Chromosorb series, Porapak series, HayeSep series, graphitised carbon blacks such as Carbograph 1TD, Carbopack B, Carbotrap.
>
> **Strong -** molecular sieves 13X & 5Å, carbonised molecular sieves such as the Carboxen series, Carbosieve SIII, UniCarb

3.1.2. Conditioning and storage of sorbent tubes

After selecting the correct sorbent tube for the analytes of interest, it is essential that the sorbent tubes are correctly conditioned prior to sampling. It is advisable to check the cleanliness of a representative proportion of tubes prior to sampling. Appendix 1 gives further information regarding conditioning temperatures and attainable artefact levels.

Conditioned tubes and sampled sorbent tubes should be capped with a 0.25 inch brass SwageLok type caps fitted with PTFE ferrules. Single sorbent tubes are generally stable for periods of over 1 year at room temperature. However, multi-bed tubes should usually be analysed within 1 week of sampling. Storage times longer than 1 week are possible under refrigerated conditions. However, in this case care must be taken to ensure that the brass caps remain tight after refrigeration and the tubes must be allowed to equilibrate to room temperature before analysis. Further information is given in Markes International Thermal Desorption Technical Support Note 19 ('Minimising artefacts - considerations for storage and transportation of sorbent tubes'). This can be downloaded after registering on the Markes website (www.markes.com).

3.2. Bulk emission testing

After setting the required gas flow rate and temperature, materials for bulk emissions testing, (or odour/fragrance profiling), may simply be weighed and placed directly into an empty microchamber - or into a custom made inert "sample boat" which is placed directly into the chamber itself.

Allow the sample to equilibrate - typically for 5 - 10 minutes - and then insert a conditioned sample tube into the µ-CTE tube insert to commence collecting emissions. At the end of the sampling interval, remove the tube and cap with brass storage caps as described above.

Sampled tubes are thermally desorbed and analysed by GC (-MS/FID) following standard methods such as ISO 16000-6, ASTM WK 3464, ISO/EN 16017-1, ASTM D6196-03 *etc*. Alternative analysers, for example systems combining thermal desorption with process MS or ENose detectors, are also applicable in some cases.

Note: If sampling at elevated temperatures, sample tubes may be hot when they are removed from the µ-CTE.

Depending on the type of sample material analysed, after sampling the chamber may require cleaning before subsequent use. See Section 4.1 for cleaning techniques.

3.3. Surface emissions testing

Surface emissions testing requires a 4.5 cm diameter circular sample specimen to be cut from the product/material so that it fits snugly into the microchamber on top of the supplied spacers. A collar projecting down from the chamber lid helps define both the exposed sample surface area and the depth of the air space above the sample (figure 3). When testing surface emissions 12.82 cm^2 of sample surface area is exposed to the air/gas flow, and the air/gas volume above the sample surface is 3.2 cm^3.

The μ-CTE is supplied with a complete set of sample spacers which are used to raise the surface of the test sample so that it is flush with the top of the microchamber pot. The spacers are placed inside the microchamber, underneath the sample, such that the emitting surface is presented to the air flow at the correct height, whatever its original thickness. When using the spring mounted stage (p/n M-SPGSC), ensure that the nuts to the 3 screws are facing down and the stage is supported by at least 1 aluminium spacer ring. Failure to do so will prevent the stage from compressing.

After setting the required gas flow rate and temperature, place the sample inside the microchamber and allow the sample to equilibrate - typically for 5 - 10 minutes - and then insert a conditioned sample tube into the μ-CTE tube insert to commence collecting emissions. At the end of the sampling interval, remove the tube and cap with brass storage caps as described above.

Sampled tubes are thermally desorbed and analysed by GC(-MS/FID) following standard methods such as ISO 16000-6, ASTM WK 3464, ISO/EN 16017-1, ASTM D6196-03 *etc*. Alternative analysers, for example systems combining thermal desorption with process MS or ENose detectors, are also applicable in some cases.

Note: If sampling at elevated temperatures, sample tubes may be hot when they are removed from the μ-CTE.

Depending on the type of sample material analysed, the chamber may require cleaning after sampling, before subsequent use. See Section 4.1 for cleaning techniques.

4. Maintenance

4.1. Cleaning

The μ-CTE (p/n M-CTE100) sample pots, tube inserts and lids are constructed from stainless steel to minimise contamination and carryover effects. However, cleaning of the chamber pots and lids may occasionally be required depending upon the type of sample analysed and the conditions in which they were sampled.

Note: The inert microchamber (M-CTE100i) has sample pots, tube inserts and lids constructed in inert coated stainless steel to minimise breakdown of labile compounds.

The physical nature of some samples *e.g.* viscous compounds, molten polymers *etc*. will be more prone to contaminating the chamber than more rigid samples. As a result, cleaning of the sample pots and lids in between sampling such products may be necessary. For more rigid samples, cleaning of the sample pots and lids will be required less frequently and less rigorously.

Having first removed all sealing O-rings, the micro-chamber pots, chamber lids and spacers can be cleaned by one of two methods:

1. The inner surface can be washed with detergent, followed by two separate rinsings

with freshly distilled water. The surface is then rinsed again with non-denatured ethanol or another appropriate solvent.

2. Inserting all components, with the exception of the chamber lids, into a vacuum oven.

Individual microchamber pots and lids can be removed from the μ-CTE and placed directly into a vacuum oven at an elevated temperature (200-300°C) for approximately 2 hours. Instructions on how to remove pot lids are described in Section 4.1.1. Before placing the sample pots into an oven, ensure that the O-rings have been removed from the rim of the microchamber pots, from the tube connector attached to the lids, and from the sample pot lid. See section 4.2 for further details on O-ring removal.

4.1.1. Removing pot lids

Note: Under no circumstances should the 4 posidrive screws (M3) on top of the hinged cover be adjusted (see figure 6)

1. Unscrew the cap from the tube connector and remove O-ring
2. Using a 7 mm nut drive spanner remove the M4 nut and washer located in the centre of the hinged μ-CTE lid (see figure 6)
3. Grasp the edges of the removable pan lid (see figure 7) and gently pull away from the hinged cover
4. Remove gas inlet O-ring (see figure 8)
5. Place in a vacuum oven up to 300°C for approximately 2 hours
6. O-rings can be cleaned by placing in a vacuum oven (<200°C) for approximately 2 hours

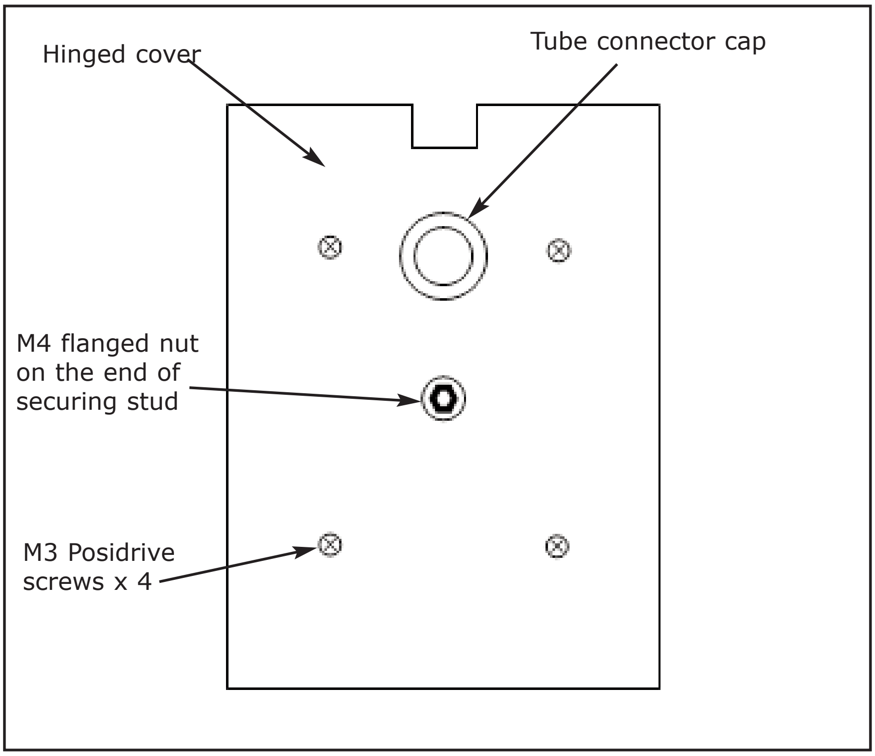

Figure 6: Lid assembly top elevation

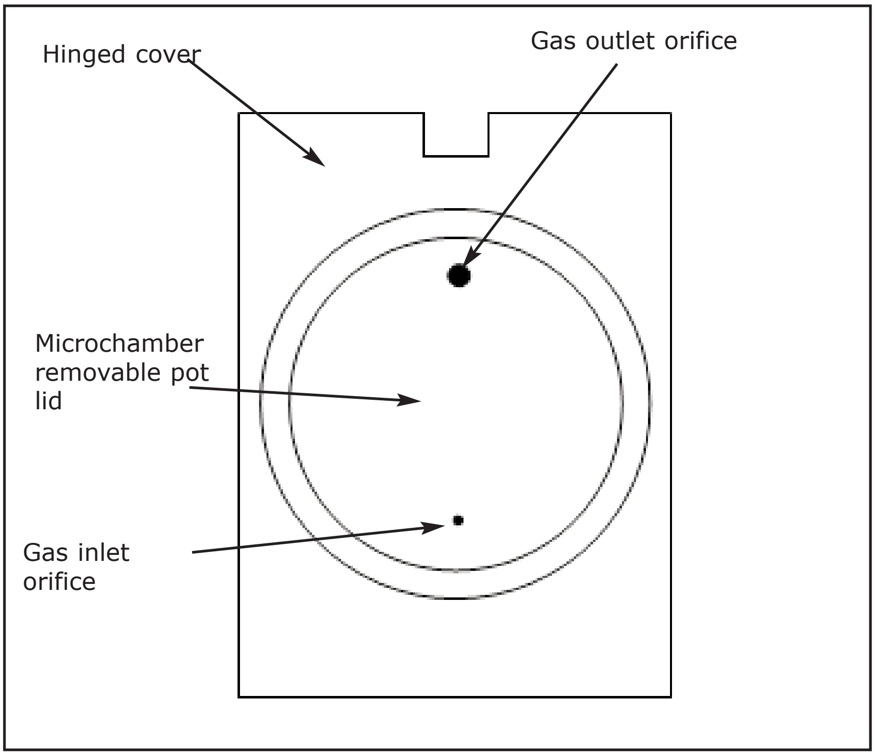

Figure 7: Lid assembly bottom elevation

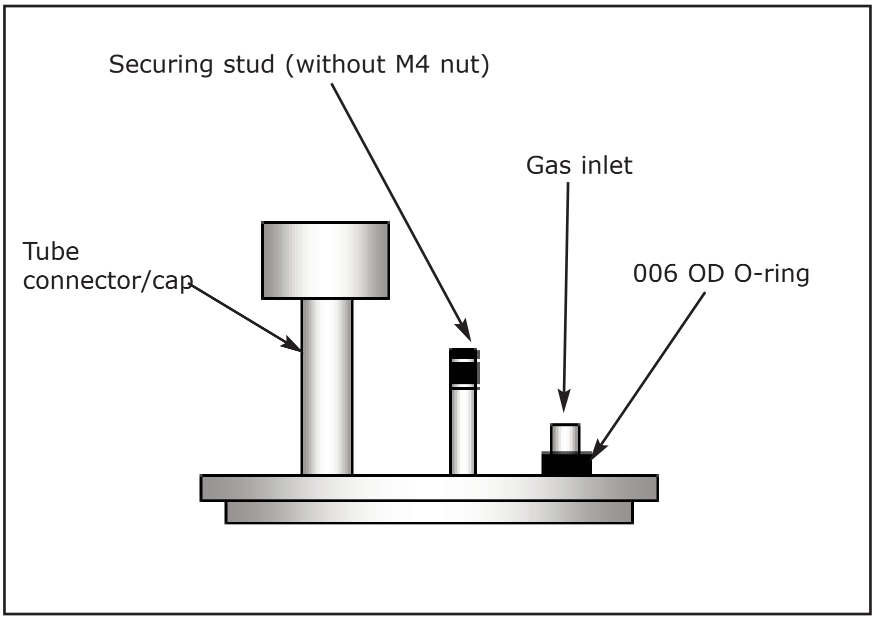

Figure 8: Removed pot lid - side elevation

4.1.2. Securing pot lids

1. Ensure that gas inlet O-ring is in place

2. Ensure that the tube connector cap IS NOT in place

3. While using oil free, lint free, gloves (so that the clean lid is not contaminated from handling) position the removable lid so that the tube connector, securing studs and gas inlet are aligned with their corresponding orifices (see figure 9)

4. Gently push pot lid towards the hinged cover until the lid can go no further
5. Using a 7 mm drive spanner tighten the M4 flanged nut onto the securing stud

(Tip: Use the drive spanner to hold onto the M4 flanged nut. Open the hinged lid and use the drive spanner to position the flanged nut onto the securing stud before tightening. Lower the lid onto the pot and lock before the final tightening of the M4 flanged nut)

6. Place O-ring into tube connector and attach tube connector cap

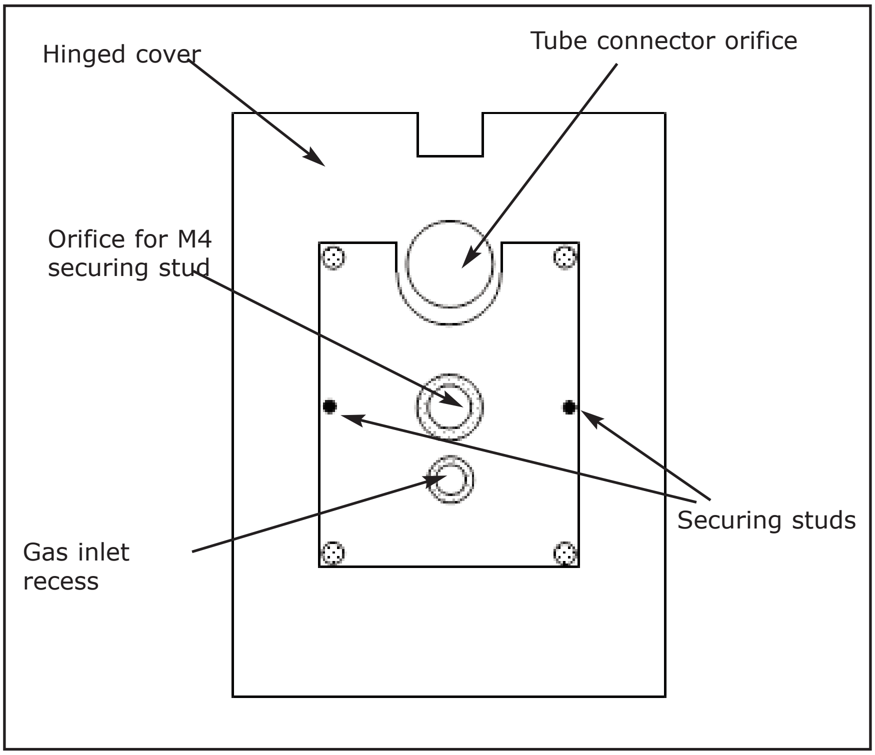

Figure 9: Lid assembly with chamber pot lid removed - bottom elevation

4.2. Changing O-ring seals

The microchamber pot O-ring seal (p/n M-MCHOR (pk 6)) can be found on the top rim of the pot. The tube insert O-ring can be found by unscrewing the retaining cap.

If the O-rings require removal they should be hooked out with the O-ring extraction tool (p/n SERZ-0351) available from Markes International.

New seals should be pushed into position using the O-ring insertion tool (p/n SERZ-0285) available from Markes International, and gently nudged evenly into the seating. Also use the O-ring insertion tool to smooth around the inner diameter of the O-ring as it is being pushed into place to avoid distortion.

Appendix One - Sorbent Selection

What follows is summary information on a selection of the most commonly used sorbents including maximum operating temperatures, recommended conditioning temperatures and typical operating temperatures. Sorbent tubes should typically be conditioned using higher temperatures and faster gas flows than those selected for analysis, however this must **NOT** exceed the temperature limit of the sorbents selected.

When using multi-bed tubes with two, three or even four sorbents it is essential to note the following points:

- sorbents should be packed into the tubes in order of increasing strength, with the weakest sorbent nearest the front (grooved/fritted) end of the tube.
- multi-bed tubes should only contain mixtures of sorbents of similar maximum temperatures otherwise it will not be possible to comprehensively condition the tubes.

Commonly Used Sorbents

Carbograph 2TD (20/40; 40/60; 60/80)
Carbopack C (60/80)
Carbotrap C (20/40)

Sorbent Type:	Graphitised carbon black
Sorbent Strength:	Very weak
Specific Surface Area (m^2/g):	~12
Approx analyte volatility range:	n-C_8 to n-C_{20}
Example analytes:	Alkyl benzenes Hydrocarbons to n-C_{20}
Sorbent Max Temperature:	>400°C
Recommended Conditioning Temperature:	350°C to 400°C
Recommended Desorption Temperature:	300°C to 350°C
Notes:	Hydrophobic Minimal (<0.1 ng) artefacts Some activity with labile compounds Friable

Tenax TA (35/60; 60/80)
Tenax GR (35/60; 60/80)

Sorbent Type:	Porous polymer
Sorbent Strength:	Weak
Specific Surface Area (m^2/g):	~35
Approx analyte volatility range:	n-C_7 to n-C_{30} Bp 100°C to 450°C
Example analytes:	Aromatic compounds except benzene Apolar compounds bp >100°C Polar compounds bp >150°C PAHs and PCBs
Sorbent Max Temperature:	350°C

Recommended Conditioning Temperature:	325°C
Recommended Desorption Temperature:	Up to 300°C
Notes:	Hydrophobic
	Low inherent (<1 ng) artefacts Inert Graphitised form best for PAHs/PCBs
	Efficient desorption
	Use 35/60 mesh to minimise fines and eliminate "leakage" through conventional sorbent retaining gauzes

Carbograph 1TD (20/40; 40/60; 60/80)
Carbopack B (60/80)
Carbotrap (20/40)

Sorbent Strength:	Medium / Weak
Specific Surface Area (m^2/g):	~100
Approx analyte volatility range:	n-C_5 to n-C_{14}
Example Analytes:	Ketones, alcohols, aldehydes & apolar components within the above volatility range
	Perfluorocarbon tracer gases
Sorbent Maximum Temperature:	>400°C
Recommended Conditioning Temperature:	350°C to 400°C
Recommended Desorption Temperature:	300°C to 350°C
Notes:	Hydrophobic
	Low artefacts (<0.1 ng)
	Some activity with labile compounds
	Friable

Chromosorb 102 (60/80)

Sorbent Strength:	Medium
Specific Surface Area (m^2/g):	~350
Approx analyte volatility range:	Bp 50°C to 200°C
Example Analytes:	Alcohols, oxygenated compounds
	haloforms less volatile than methylene chloride
Sorbent Maximum Temperature:	250°C
Recommended Conditioning Temperature:	225°C (250°C for short (<15 mins) periods only)
Recommended Desorption Temperature:	No higher than 220°C
Notes:	High artefacts (at least 10 ng) - for trace level analysis condition at 225°C and desorb sample tubes no higher than 200°C to reduce background levels
	Artefacts generated on storage - for trace level analysis analyse tubes immediately after sampling

	Hydrophobic
	Inert

Chromosorb 106 (60/80)

Sorbent Strength:	Medium
Specific Surface Area (m^2/g):	~750
Approx analyte volatility range:	n-C_5 to n-C_{12} Bp 50°C to 200°C
Example Analytes:	Hydrocarbons, benzene, volatile oxygenated compounds
Sorbent Maximum Temperature:	225°C to 250°C
Recommended Conditioning Temperature:	225°C (250° C for short (<15 mins) periods only)
Recommended Desorption Temperature:	No higher than 200°C
Notes:	High artefacts (at least 10 ng) - for trace level analysis, condition at 225°C and desorb sample tubes at no higher than 200°C to reduce background levels Artefacts generated on storage - for trace level analysis analyse tubes immediately after sampling Hydrophobic Inert

Porapak N (50/80)

Sorbent Strength:	Medium
Specific Surface Area (m^2/g):	~300
Approx analyte volatility range:	n-C_5 to n-C_8 Bp 50°C to 150°C
Example Analytes:	Volatile nitriles *e.g.* acrylonitrile, acetonitrile, propionitrile Pyridine Volatile alcohols, ethanol, Methyl ethyl ketone
Sorbent Maximum Temperature:	190°C
Recommended Conditioning Temperature:	180°C to 190°C
Recommended Desorption Temperature:	No higher than 180°C
Notes:	High artefacts (at least 10 ng) - for trace level analysis condition at 180°C and desorb sample tubes no higher than 160°C to reduce background levels Artefacts generated on storage - for trace level analysis analyse tubes immediately after sampling Repack after 50 thermal cycles Hydrophobic Inert

Porapak Q (50/80)

Sorbent Strength:	Medium
Specific Surface Area (m^2/g):	~550
Approx analyte volatility range:	n-C_5 to n-C_{12} Boiling point 50°C to 200°C
Example Analytes:	VOCs within volatility range above Oxygenated compounds
Sorbent Maximum Temperature:	250°C
Recommended Conditioning Temperature:	225°C (250°C for short (<15 mins) periods only)
Recommended Desorption Temperature:	No higher than 225°C
Notes:	High artefacts (at least 10ng) - for trace level analysis, condition at 180°C and desorb sample tubes at no higher than 160°C to reduce background levels Artefacts generated on storage - for trace level analysis, analyse tubes immediately after sampling Repack after 50 thermal cycles Hydrophobic Inert

UniCarb (60/80)

Sorbent Strength:	Strong
Specific Surface Area (m^2/g):	~1200
Approx analyte volatility range:	C_3 to n-C_8 Bp 30°C to 100°C
Example Analytes:	Very volatile compounds *e.g.* VCM, ethylene oxide, carbon disulphide, dichloromethane, chloromethane Volatile polar compounds *e.g.* methanol, ethanol, acetone
Sorbent Maximum Temperature:	>400°C
Recommended Conditioning Temperature:	350°C to 400°C *N.B.* Increase temp from 250°C stepwise and slowly
Recommended Desorption Temperature:	300°C to 350°C
Notes:	Some hydrophilicity Low artefacts (<0.1 ng) Excellent batch-to-batch reproducibility Inert Non-friable

Carbosieve SIII (60/80)

Sorbent Strength:	Very Strong
Specific Surface Area (m^2/g):	~800, but primarily operates on molecular sieve principle with 15/40Å pores
Approx analyte volatility range:	Primarily for C_2 hydrocarbons and smaller molecules. Bp -60°C to 80°C
Example Analytes:	Ultra volatile hydrocarbons

Sorbent Maximum Temperature:	>400°C
Recommended Conditioning Temperature:	350°C *N.B.* Slow conditioning required as for UniCarb
Recommended Desorption Temperature:	300°C
Notes:	Some hydrophilicity Low artefacts (<0.1 ng) Easily & irreversibly contaminated by higher boiling components - protect with front bed of weaker sorbent

Carboxen 1000 (Range of mesh sizes available)

Sorbent Strength:	Very strong for small molecules
Specific Surface Area (m^2/g):	>1200
Approx analyte volatility range:	Permanent gases and light hydrocarbons (C_2, C_3). Bp -60°C to 80°C
Example Analytes:	Ultra volatile hydrocarbons
Sorbent Maximum Temperature:	>400°C
Recommended Conditioning Temperature:	350°C *N.B.* Slow conditioning required as for UniCarb
Recommended Desorption Temperature:	To suit analyte
Notes:	Some hydrophilicity Low artefacts (<0.1 ng) Easily & irreversibly contaminated by higher boiling components - protect with front bed of weaker sorbent

Molecular Sieve (13X, 5Å)

Sorbent Strength:	Very strong for small molecules
Approx analyte volatility range:	Bp -60°C to 80°C
Example Analytes:	1,3 butadiene (13X), nitrous oxide (5Å)
Sorbent Maximum Temperature:	350°C
Recommended Conditioning Temperature:	300°C (increase temperature gradually)
Recommended Desorption Temperature:	To suit analyte
Notes:	Significantly hydrophilic - do not use in humid conditions High artefacts (>10 ng) Easily & irreversibly contaminated by higher boiling components