

FLEC - Field and Laboratory Emission Cell

Operators' Manual - QUI-1035

Version 2.0 (Updated June 2011)

Contents

Preface

I.	Regulatory Compliance.....	2
II.	Technical support contact details.....	2
1.	Introduction	2
2.	Typical FLEC Experimental Set Up	4
3.	Leak Testing	5
4.	Sample Preparation	5
4.1.	Paints and Coatings.....	5
4.2.	Carpet and flooring.....	5
4.3.	Subunits for non-planar surfaces and general applications.....	6
4.4.	Test kit for recovery measurements.....	7
4.5.	FLEC Telescope accessory for field measurement.....	8
5.	FLEC Air controller.....	8
6.	Emissions Testing	9
6.1.	Collecting and analysis emissions.....	9

Preface

This manual provides detailed instructions on the use of the FLEC. It is suitable for users with little or no prior experience of the instrument and details the sampling procedure and use of accessories.

I. Regulatory compliance

The Field and Laboratory Emission Cell (FLEC) is an easy-to-use device for the certification of indoor products/materials according to their VOC emission levels. EN ISO 16000-10, ASTM D7143 both describe the use of the FLEC from sampling materials and products.

II. Technical contacts

Please contact Markes International on the details below.

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1. Introduction

The Field and Laboratory Emission Cell (FLEC[®]) simplifies and standardises the measurement of organic emissions from building materials and domestic products. The cell conforms to **BS EN ISO 16000-9:2006**: *Indoor air - Determination of the emission of volatile organic compounds from building products and furnishing; Emission test chamber method* and **ASTM D7143 - 11** *Standard Practice for Emission Cells for the Determination of Volatile Organic Emissions from Indoor Materials/Product*.

Applications include floor/wall coverings, paints/coatings, sealants, glues, concrete, textiles, printed paper and domestic cleaning products. FLEC helps standardise test protocols and facilitates comparison of data which emission chambers of all sizes allowing reliable classification of materials according to emission characteristics.

The cell can be used in the laboratory or *in situ* in the field and is low cost and fast relative to conventional emission chamber tests. The FLEC is constructed of acid resistant stainless steel. The inner surface is hand polished and shaped like the mouth of a trumpet to optimise air velocity over the sampling surface and to eliminate sink effects. It is placed onto material to be tested such that the surface of the material effectively becomes one wall of a mini (~35 ml volume) test chamber.

A controlled flow of purified and humidified air enters the cell from a baffle around the perimeter of FLEC passing over the test material at flow rates simulating real-world conditions. Exhaust gases from FLEC are typically collected in sorbent tubes and analysed using thermal desorption – gas chromatography/mass spectrometry (TD-GC/MS). Air sampling and analytical methods for the determination of VOCs are described in **ISO 16000-6** and **ISO 16017-1**. Sampling, transport and storage of materials to be tested, and preparation of test specimens are described in **ISO 16000-11**. FLEC is also compatible with many alternative air quality analysis methods. For example when emission levels are high a portable detector may be directly coupled to FLEC for an instant measurement of total organic compounds.

FLEC testing enables the manufacturer or user to assess how emissions from a product will vary with time and to what extent they are likely to impact the indoor environment. It also allows direct comparisons to be made between products from different batches or manufacturers.

Testing is generally required to be carried out on a sample of new material soon after manufacture and is typically repeated 2 or 3 times as the product ages. Sample storage conditions are critical during the test period and the guidance given in **ISO 16000-11** or equivalent standards should be adhered to. FLEC is also used to investigate indoor air quality problems in existing buildings where old, damaged or incorrectly maintained materials can be a source of unacceptable indoor air quality.

2. Typical FLEC Experimental Set Up

A typical experimental set up is shown in figure 1 below.

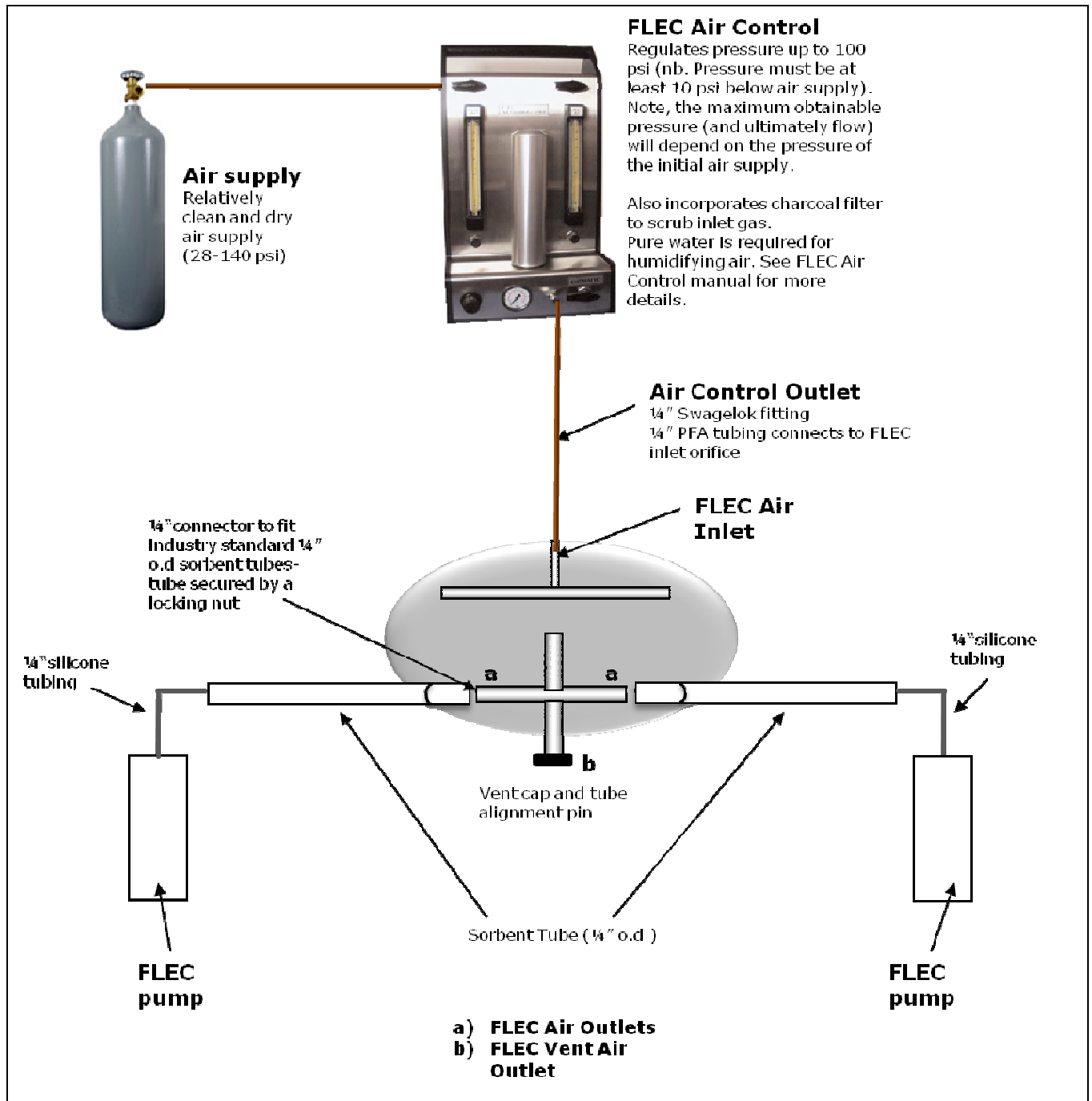


Figure 1. FLEC experimental set up

3. Leak Testing

Before testing it is important to ensure that the FLEC cell is air tight according to the tolerance specified in the relevant standard method (**ASTM 7143-05; ISO 16000-10**). This is achieved by recording the total flow entering the cell and comparing with the total flow exiting the cell. The difference between flows must be within 10% for most standards. Please note that a suitable flow meter will be required to do this (e.g. **C-FLMTR**).

4. Sample Preparation

Test samples are generally prepared, stored transported etc. according to the relevant method, i.e. either **ASTM 7143-05; ISO 16000-11**.

4.1 Paint & Coatings

Paint or coating materials can be prepared using:

- i) Application roller for paints and coatings (part number **FL-0160**)
- ii) Test plate for paints and coatings (part number **FL0161**)

A picture of a roller and test plate are depicted in figure 2. Please note the paint or coating should be allowed to dry/cure before the emissions are sampled using FLEC.



Figure 2. Application roller and test plate for paints and coatings

4.2. Carpets and flooring

The carpet test plate adaptors (**FL-0150** for 1 or **FL-0151** for pk5) allow the FLEC to sample emissions from carpets, fabrics, etc. of varying thickness (up to 10 mm). These plates are constructed of aluminium and are insulated to provide protection from temperature fluctuations.

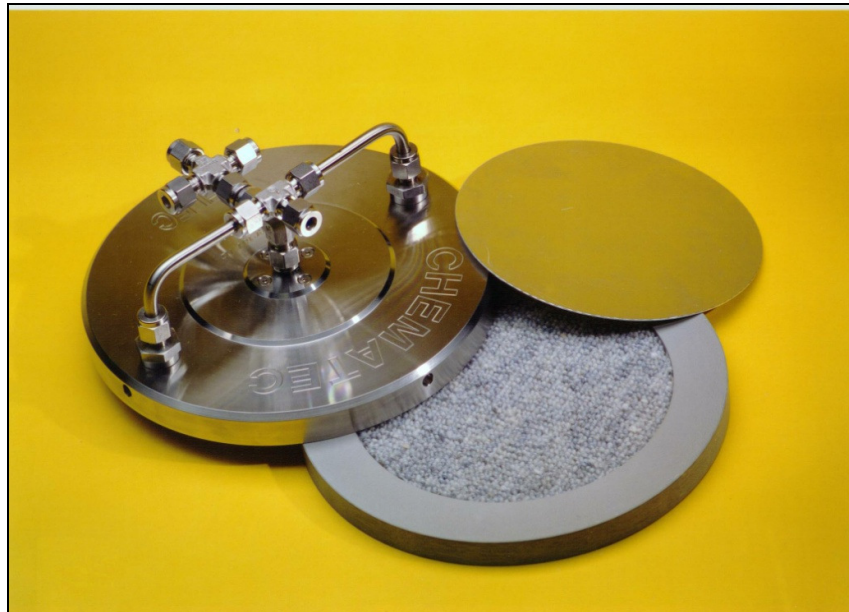


Figure 3. Carpet and fabric sampling accessory (up to 10mm thickness)

4.3. Subunits for non-planar surfaces and general applications

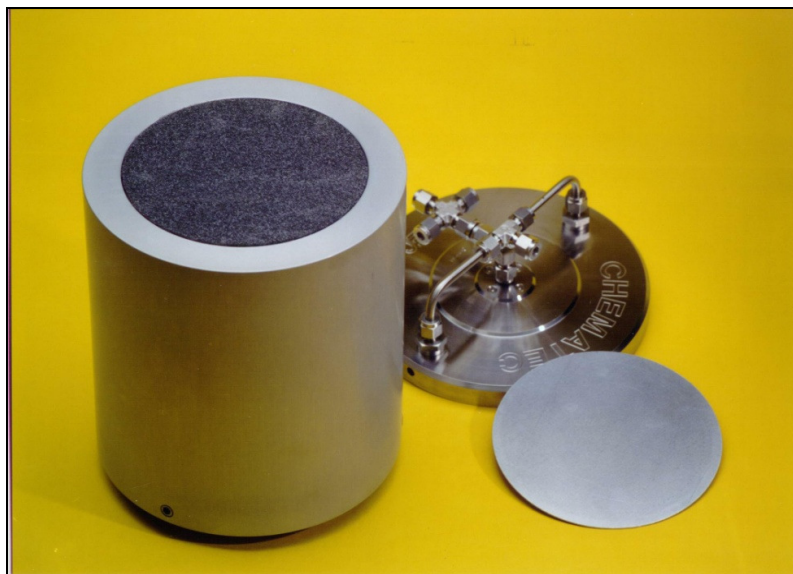


Figure 4. Sub-unit for thick pile carpets, porous material and liquids
Two subunits, measuring 150 mm I.D. (part number **FL-2001**) and 152 mm I.D (part number **FL-2002**) are constructed of solid aluminium with a cylindrical chamber.

These can be adapted for purpose by adjusting the bottom of the chamber according to the thickness of the material to be tested.

The 150 mm I.D. unit is suitable for testing dry materials with rough or porous surfaces, *e.g.* deep-pile carpets, wood, insulation, polyurethane foams, *etc.* The test materials must be cut to a radius of 150 mm so that they seal up to the edges of the subunit.

The 152 mm I.D. unit is suitable for testing wet or liquid materials. The material under test is placed in a glass Petri dish with an outer diameter of 152 mm and I.D. of ~150 mm.

4.4 Test kit for recovery measurements

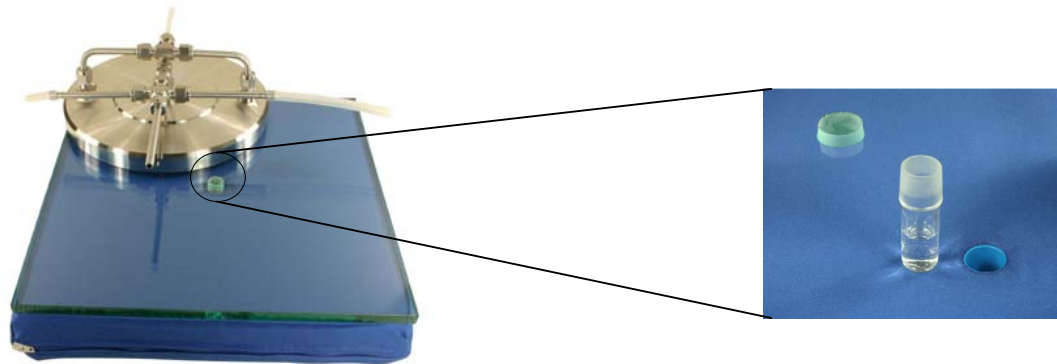


Figure 5. Test kit for recovery measurements

The test kit (part number **FL-0100**) facilitates testing for sink effects as required by standard emission cell test methods. The kit shown in figure 5 comprises of a glass plate that is suitable for holding a small vial and an insulating pad. Sink effects for the FLEC are evaluated by placing a vial (containing the compound of interest) into the glass plate vial holder, positioning the cell over the glass plate and supplying the desired gas input flow. The test compound is released from the vial is collected onto sorbent tubes attached to the cell over a defined period of time. The sink effects of the cell are determined by comparing the mass differences between the observed compound quantities retained by the sorbent tubes with that of the actual mass of the test compound based on the weight loss of the test compound from the vial.

4.5 FLEC Telescope accessory for field measurement

A range of extension arms are available to allow the FLEC to be used directly on a ceiling or wall *in situ* within a room. The FLEC telescope accessory (**FL-0200**) extends from 2 to 3.5 m and the telescope extension (**FL-0201**) is a further 1 m long. Clamps are available which allow the FLEC to be positioned directly against a wall (**FL-0202**), against the ceiling (**FL-0204**) and for holding the FLEC pump (**FL-0203**).



Figure 6. Wall clamp, ceiling clamp and pump clamp

5. FLEC Air controller

As FLEC is typically used to measure low level VOC emissions, it is important that the supply of air is stringently clean with respect to organic impurities. It is essential that both the flow rate and humidity of air entering the FLEC are controlled and kept constant throughout an emission test. Such factors are critical if test data are ever to be reliably compared. The FLEC air control unit (**FL-1000**) is designed to control the flow, humidity (humidifier for FLEC Air Controller **FL-1000-02**, fittings for humidifier **FL-1000-02-01** & replacement humidifier insert **200190**) and purity of the air supplied to the FLEC in one easy-to-use unit. Clean, dry, compressed air is supplied to the controller and passed through a high capacity interchangeable charcoal filter (**FL-1000-01**) which removes trace-level organic contaminants. A portion of the air is then humidified to 100%. The two air flows (dry air and 100% humidified) are then mixed together to provide the required % RH. User access points facilitate independent measurement of air humidity and flow rate.

6. Emissions Testing

Please note that this section aims to provide a very brief description about how the FLEC hardware and associated auxiliary equipment are operated during testing. Detailed descriptions about typical air flows, leak testing, air sampling, recovery and sink effects, cleaning requirements, test conditions etc. can be found in the relevant standard method and Markes Thermal Desorption Technical Support Note TDTS 55.

The time of application of the test material is known is $T=0$. Most test protocols specify the time at which emissions should be tested from $T=0$. For example; **ISO/EN 16000** series standards specify emissions testing at 72 hours and 28 days for product certification. Much shorter periods can be used for in house product quality control, but as described above, the product should be allowed to dry / cure before emissions are measured

Testing generally involves placing a FLEC cell over a test material, letting pure humidified air flow into the FLEC and pass over the sample surface for a period of equilibration. Equilibration periods range from 1-2 hours for in-house quality control emissions tests to 24 hours for product certification by standard methods (e.g. **ISO/EN 16000-10**). After equilibration, organic vapours in the air exhausting from the FLEC cell are collected (pumped) onto two sorbent tubes for ~15 to 20 minutes. The start of vapour collection marks the start of the test time from $T=0$. In other words if a 72-hour emissions test is to be carried out, the equilibration period should be started earlier to allow vapour collection to begin at 72-hours after $T=0$. The samples sorbent tubes are subsequently analysed by TD-GC/MS(FID). Sorbent tubes are not attached to the FLEC until the point of vapour collection. During the equilibration period, the FLEC cell vent cap remains loosely in place (figure 7) resulting in air being swept through the cell and vented out through the FLEC vent and air-outlets / tube connection points (labelled a and b in figure 1). After equilibration the sorbent tubes, each with an individual pump attached, are connected to the FLEC with the pumps initially switched off as described below.

6.1 Collecting and analysing emissions

1. Determine the total inlet flow and what specific sampling flows are required.

Note: the sum of the two sampling flows is usually selected to be 75 to 80% of the total air inlet flow. For example a total air inlet flow of 250 ml/min could be combined with a 100 ml/min sampling flow rate through each tube.

Note: FLEC pumps are 'constant flow type' pumps and can therefore be set to the desired flow rate and checked without a sorbent tube attached. (See FLEC Air Pump Manual QUI-1030 for further information).

2. Ensure the FLEC Air Pumps are switched off. Remove the brass storage caps from the ends of two conditioned sorbent tubes (using the CapLok tool) and attach the non-sampling end of each tube (non-grooved end) to each pump using the flexible tubing supplied. Retain the brass storage caps in a clean environment for use after sampling

Note: for further information on tube conditioning and capping see TDTS 05. Insert the sampling (grooved) ends of each tube into the two FLEC air outlets until they touch the 'tube spacer' projecting from the FLEC vent cap.

Note: the distance between the ends of the two sorbent tubes is ~2 mm and is designed to optimise turbulence and mixing. The tube connections should only be tightened finger-tight at this point

Note: tubes are secured to the air outlet orifices by a ¼" fitting which is part of the FLEC cell. Sorbent tubes with outer diameter dimensions other than ¼" will require a suitable adaptor.

3. Once each of the two sorbent tubes are in place, the vent cap is removed and the connections to each of the sorbent tubes are tightened gently with a wrench to make them leak tight (figure 8)

4. Turn the FLEC pumps ON to begin sampling. (Refer to FLEC Air Pump Manual QUI-1030 for pump operating details)

5. At the end of the selected sampling period, turn the FLEC pumps off, loosen the tube connections and disconnect the sorbent tubes. Recap the ends of both sorbent tubes immediately with the brass Swagelok type storage caps removed earlier. Tighten the caps using the CapLok tool.

6. Analyse sorbent tubes according to standard thermal desorption methods (for example **ASTM D6193-03, ISO 16000-6** etc)

7. Calculate concentration, Area Specific Emissions Rates etc. according to the relevant standard method and Markes TDTS 55.

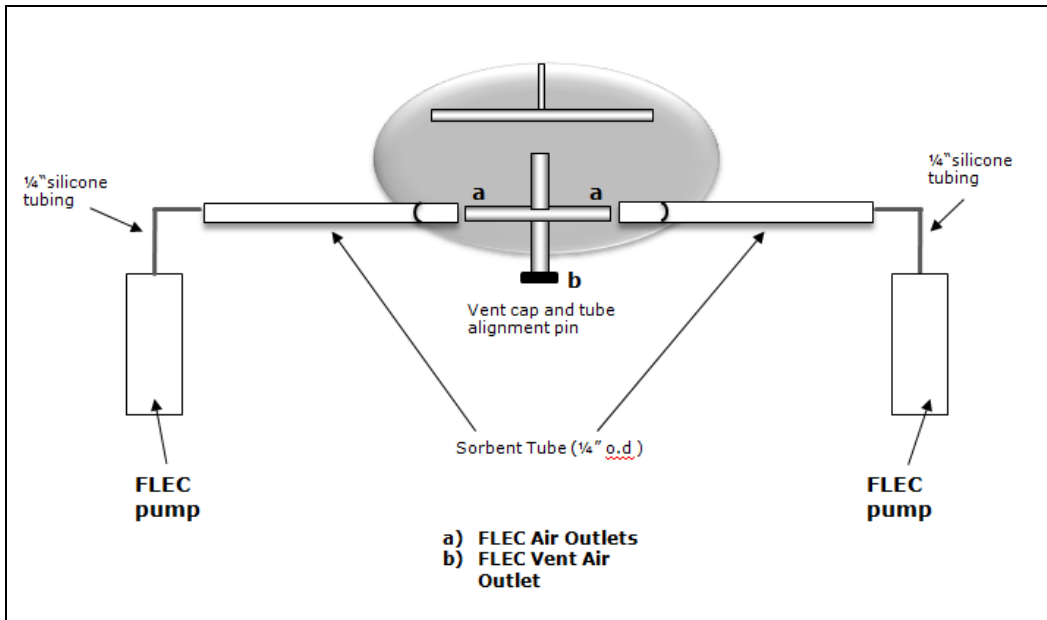


Figure 7. Schematic depiction of FLEC experimental set up prior to connecting sorbent tubes. FLEC pumps are OFF

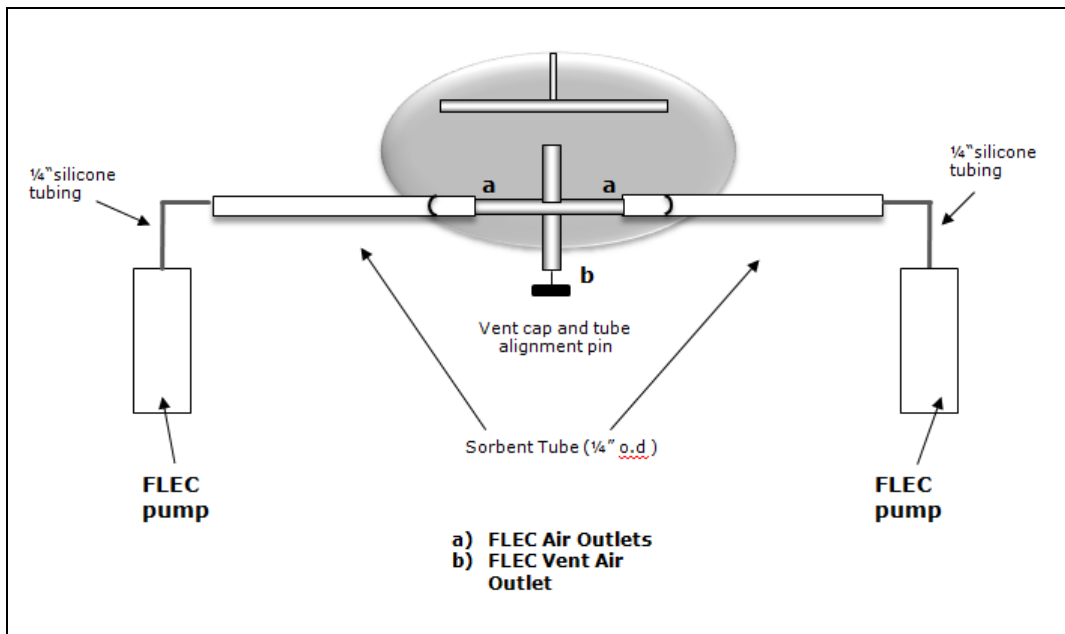


Figure 8. Schematic depiction of FLEC experimental set up with sorbent tubes connected. Sampling commences when FLEC pumps are turned ON