Chambers and Instrumentation

CHAMBERS

STORA: 22 m^3 chamber

The chamber is made of electropolished stainless steel with inner dimensions 3.2 x 2.9 x 2.4 meters (breadth x length x height). The volume of the chamber is 22.4 m^3. The effective internal surface is 48.01m^2 giving the surface-to-volume ratio S/V = 2.14 m^{-1}. The chamber is equipped with several inlets/outlets for introduction of reactants and for connection of sampling devices. A circulation fan for internal mixing is placed at the floor of the chamber. This chamber is suitable to be operated at both static and dynamic mode.

Inlet air
Inlet air to the chamber is cleaned with charcoal filters and the air exchange in the chamber is adjustable. An anemometer and a PLC controlled fan are used to control the air exchange. The range for the air exchange is 0.25-2.5 air exchange / hour and the uncertainty for the anemometer is ±2% of reading. The chamber operates at ambient air pressure. Air and gaseous components are supplied to the chamber through a mass-flow controlled system (model 5850S, Brooks Instruments) and Teflon® lines.

Air velocity
Air velocity in the chamber is adjustable (0.1-0.3 m/s) and it is made by the three fans which are placed on the chamber floor. Adjustment of the air velocity is made via a potentiometer at the operator panel.

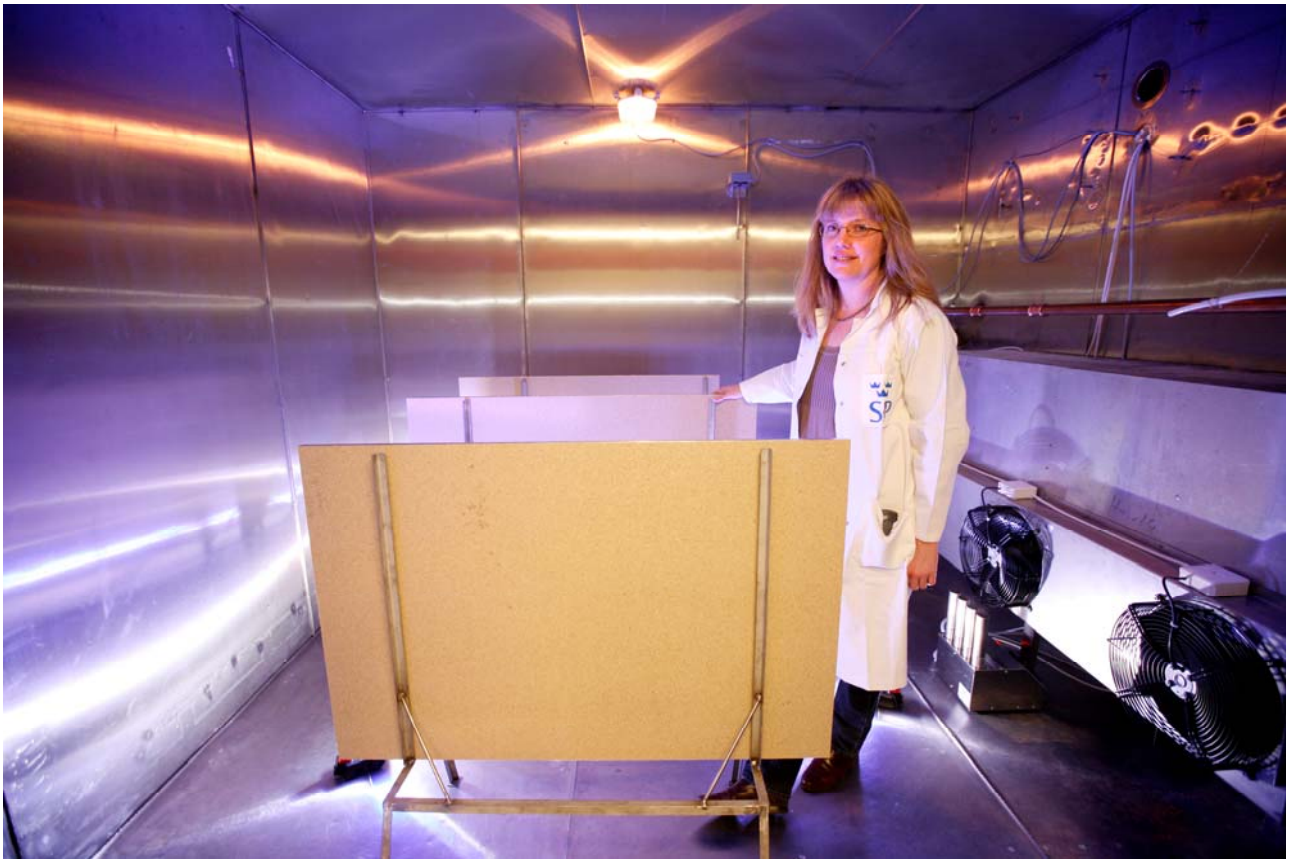
Temperature control
Temperature control in the chamber is made by a water circulation system (heat exchanger). A temperature sensor (PT-100) and a temperature controller control the water temperature to the heat exchanger. Uncertainty for the temperature sensor is ±0.5°C and the temperature range in the chamber is 20-45 °C.

Humidity control
Humidification in the chamber is made by an ultra sonic humidifier and the control of the humidity is made by a humidity sensor, which has an uncertainty of ±2%. The range for the humidity in the chamber is < 2 – 80 %RH.

The chamber can be used for emission measurements of organic compounds from materials, as well as a reaction chamber or an exposure chamber. In the present condition it is a dark chamber but in case of need photolytic lamps can be easily installed.

The chamber is compatible with ASTM E1333 - 96(2002): Standard Test Method for Determining Formaldehyde Concentrations in Air and Emission Rates from Wood Products Using a Large Chamber.

The internal view of STORA



LILLA: 1 m^3 chamber

The chamber is originally developed and designed for measurements of emission of volatile organic compounds (VOC) and formaldehyde from materials. The chamber is made of electropolished stainless steel with inner dimensions 65 x 102 x 150 cm (breadth x length x height). The volume of the chamber is 0.9945 m^3. It was also checked by measurement with a tracer gas (N_2O) with a result of 0.99 m^3. The internal surface is 6.337 m^2 thus giving the surface to volume ratio S/V = 6.37 m^{-1}. The chamber is equipped with several inlets/outlets for introduction of gaseous reactants and for connection of sampling devices. A circulation (squirrel cage) fan for internal mixing is placed in the bottom part of the chamber.

The chamber can be operated either in static or a dynamic mode. Dried and filtered air is supplied through a separate line; the flow is controlled by a flowmeter and measured by a volume meter. Air change rate (ACR) can be regulated between 0.1 – 4 h^{-1}. The chamber is basically operated at room temperature of 23 ºC and ambient pressure; it can be thermostatted between 18 – 30 ºC. Relative humidity can be varied between < 2 – 80 %. Distilled water is used for humidification. The temperature and relative humidity are controlled by sensors. Air and gaseous components are supplied to the chamber through a mass-flow controlled system (model 5850S, Brooks Instruments) and Teflon® lines.

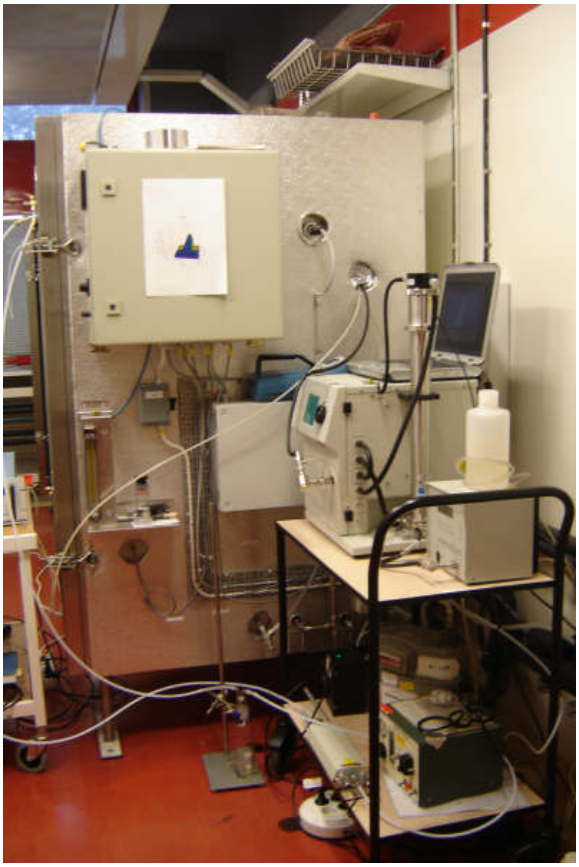
The chamber can be used for emission measurements of organic compounds from materials, as well as a reaction chamber or an exposure chamber.

The chamber complies with ISO 16000-9:2006: Indoor air -- Part 9: Determination of the emission of volatile organic compounds from building products and furnishing -- Emission test chamber method. Information about the 1 m3 chamber can also be found at SP's home page.
http://www.sp.se/en/index/services/emissionchamber/Sidor/default.aspx

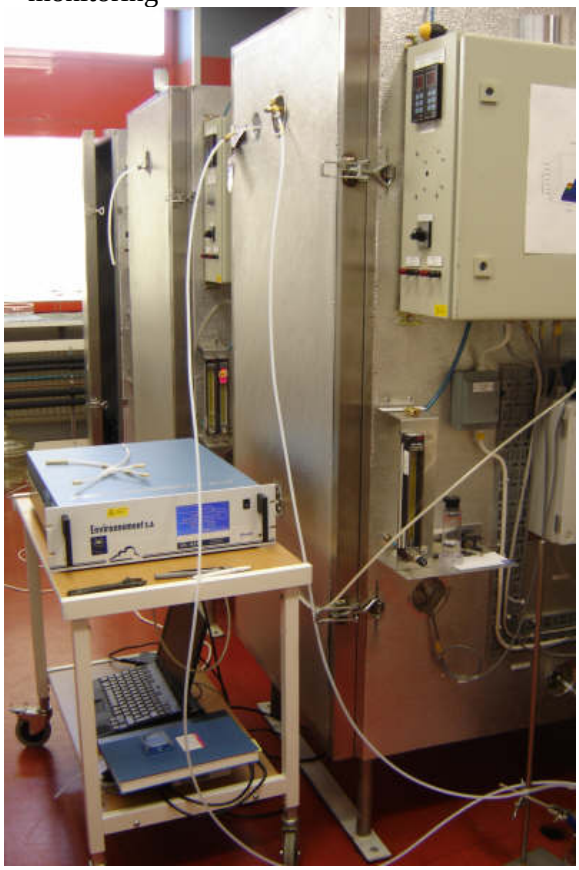
Standard test conditions in the LILLA chamber according to ISO 16000-9. Area of sample and area specific air flow rate can vary.

Test chamber volume:	1.0 m^3
Area of sample:	1.4 m^2
Air change rate:	0.5 h^{-1}
Area specific air flow rate:	0.4 m^3/m^2h
Temperature:	23 ± 1 ^oC
Relative Humidity:	50 ± 3 % RH

Experimental set-up for particle measurements.



Inlet/outlet lines for ozone introduction and monitoring



Open and closed chamber with the steering unit for temperature and humidity.

Microchamber: FLEC

The FLEC (Field and Laboratory Emission Cell) chamber has been developed in a joint project between SP Swedish National Testing and Research Institute, Danish National Institute of Occupational Health and Danish Building Research Institute. It is today commercially available from CHEMATEC; for details see http://www.flec.com/. FLEC complies with ISO 16000-10:2006: Indoor air -- Part 10: Determination of the emission of volatile organic compounds from building products and furnishing -- Emission test cell method.

FLEC is currently used for measurements of emissions of various compounds from flat surfaces (flooring materials, building material, flooring constructions) as well as from small objects. Purified and dried air is circulated above the surface and the emitted compounds are sampled. The cell is operated according to various standards at a flow of 100 or 300 mL/minutes but flows as high as 1 000 ml/minute can be used.

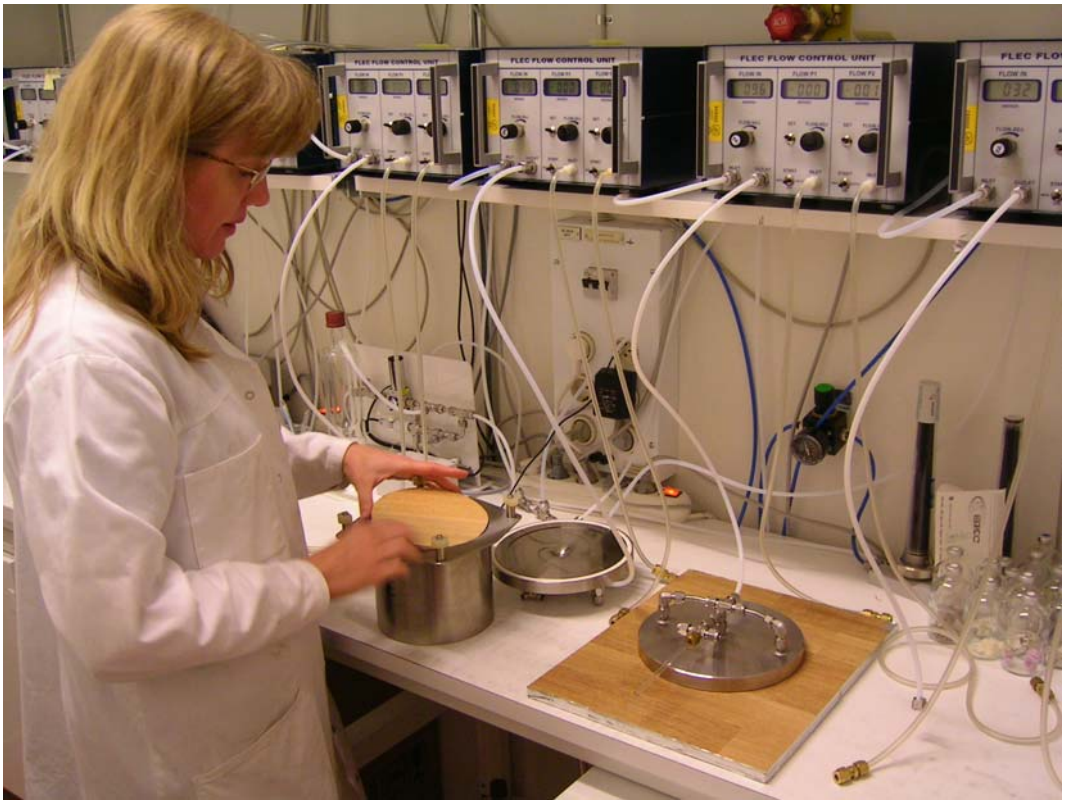
Conditions of the test in the FLEC cell according to ISO 16000-10:

Test chamber volume	0.000035 m^3
Area of sample	0.0177 m^2
Air change rate	171 h^{-1}
Area specific air change rate	0.34 m^3/m^2h
Temperature	23 ± 1 ^oC
Relative Humidity	50 ± 5 % RH

Various sampling and analytical devices may be connected to the chamber, e.g. adsorbent tubes for volatile organic compounds or cartridges for sampling of aldehydes or organic acids. Results are emission factors in units of µg/(m^2*hour). FLEC can be used in field (portable version).

FLEC can be successfully used for studies of on surfaces such as chemical reactions, exposure, deposition and adsorption/desorption processes. A reacting gas or exposing gas is introduced in the circulating air and the emitting compounds are sampled and analyzed by suitable techniques.

The shape and size of FLEC with mass flow regulators for inlet air and pumping unit.



INSTRUMENTATION

The chambers are equipped with sampling ports and a set of instruments which are regularly operated. Additionally, there are some other instruments in close collaboration (marked green; Evert Ljungström, Department of Atmospheric Sciences, University of Gothenburg) which are used for measurements at the chambers.

Instrumentation/methods	**Monitored parameter**
Gas chromatograph with liquid sample injection GC-Agilent 6890N MS-Agilent 5975 inert XL + FID GC/MS/FID	Organic compounds in solvent extracts in pg/µL - ng/µL
Gas chromatograph with liquid sample injection Perkin Elmer Clarus 5000 GC/MS/FID	Organic compounds in solvent extracts in pg/µL - ng/µL
Gas chromatograph with Head Space injection Perkin Elmer Clarus 5000 HS-GC/MS/FID	C_2-C_{10} hydrocarbons µg/sample in 22 mL vials HS tempetarure < 200 ^{o}C
Gas chromatograph with gas sample injection GC-Agilent 6890N + ECD detector	Halogenated hydrocarbons

GC/ECD	
Gas chromatograph with gas sample injection Varian 3400 Cx with FID and TCD GC/FID/TCD	Hydrogen to hexane in gas phase (ppm level)
Gas chromatography with gas sample injection Varian 450-GC with FID and TCD GC/FID/TCD	Hydrogen to hexane in gas phase (ppm level)
Gas chromatography with thermal desorption injection (air/material) Unity/Ultra/Air Server Markes, GC-Agilent 7890A MS-Agilent 5975C + FID ATD/GC/MS-FID	Mainly C_6-C_{30} at ppb levels Possible C_2-C_6 at ppb levels
Gas chromatography with thermal desorption injection (air/material) Perkin Elmer Turbo Matrix 650, GC-Agilent 6890N MS-Agilent 5975C + FID ATD/GC/MS-FID	mainly C_6-C_{30} at ppb levels
Liquid chromatography Varian pump 9012 +Autosampler 410 + UV-VIS detector 9050 + RI detector Star 9040 LC/UV	Aldehydes at ppb levels
Liquid chromatography HPLC pump with autosampler + Quattro Ultima triple Quadrupole MS LC/MS/MS	Organic compounds
SMPS (TSI 3081 Differential Mobility Analyzer and TSI 3775 Condensation Particle Counter)	Number weighted particle size distribution 14 – 750 nm
TSI model 8525 optical counter (P-Trak)	Total particle number concentration > 20 nm
Grimm portable aerosol spectrometer (PAS) 1.108 0.3–20 µm in 15 channels	Particle number concentration 0.3–20 µm in 15 channels
Ozone generator HydroAir Bath and Spa Ozonator 20-5133	20 – 280 ppm
Ozone generator UltraViolet Products SOG-3	20 – 3 000 ppb
O_3 monitor Environment O_3 42M (UV absorption)	Ozone 2 – 10 000 ppb
NOx monitor AC32M Chemiluminescent Nitrogen Oxide Analyzer	NO, NO_2, NO_x 2 – 20 000 ppb
PAN analyzer automated sampler GC/ECD	ppt – ppb of peroxyacetyl nitrate