Emission Testing

- Some principles

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Experience with emission testing

Europe:
- Formaldehyde E1 (wood-based panels)
- DIBt (floor coverings)
- Blue Angel (furniture, floorings, adhesives, sealants, ...)
- M1 (construction products, cleaners)
- GUT (textile floorings)
- EMICODE (adhesives, mortars, sealants, floor coatings)
- France (solid construction products)
- Denmark (construction products, furniture)
- CertiPUR (PUR foam for furniture)

USA:
- Section 1350 / LEED / CHPS (construction products, furniture)
- FloorScore / CRI (textile / resilient floorings, adhesives)
- BIFMA (office furniture)
- Greenguard (construction products, furniture)
Evaluation, e.g. by emissions test, standard schedule:

- after 3 days (early exposure, renovation) and
- after 28 days (long-term exposure)
  (or 3 days, GUT, or 10 days, EMICODE,
  or 7 days, BIFMA, or 14 days, Section 1350 / LEED / CRI)
- Equilibrium concentration: only relevant for urea-formaldehyde binders

![Example of a decay curve VOC](image)
Test chamber and real room

- Adsorption on walls reduces effective emission in real room
- Other sources will contribute to real room air quality

What you get is the emission rate, and the maximum contribution of emitting material to room air concentration

Ageing - how to be considered?
(airing out and oxidation processes during storage, transport, construction process, use life cycle)

Coverage - how to be considered?
(e.g. adhesive by carpet, or wall by paint)
Significance of test result

What you get from chamber testing is:
Chamber air concentration at given time mg/m³,
then calculate from that:

- **Emission rate** hour mg/h
- **Specific emission rate (emission factor)**
  - per area mg/m²h
  - or per mass, per device, per unit
- **Contribution to** air concentration mg/m³
  in reference room or in real room (source strength)
  after a specified time
Reference room - not a test room, but just a model

In Europe:
- Floor area 7 or 12 m², Height 2.5 m
- 1 window, 1 door
- From that calculate wall area, sealant area 0.2 m²
  - From that calculate loading factors (m²/m³)
- 1/2 air exchange per hour
  (1/h in EN 717-1, 0,6/h - 0,9/h in USA),
- 23 °C (Asia: 25°C/28°C; 25°C for CARB regulation)
- 50% relative humidity (45% in EN 717-1)

Testing shall simulate that room more or less

- Some deviation possible, if result is re-calculated to reference conditions
- … as long as air velocity over test specimen surface is sufficient for transfer of emitted VOC into surrounding air
- … and no surface drying occurs during testing
Specific emission rate, e.g. mg/(m² x h):
- is the key parameter as it allows all other calculations
- Instead of area specific emission rate as here, also mass specific, volume specific or unit specific emission rate may be used

Reference room air concentration (mg/m³):
Can be re-calculated from whatever test chamber (within certain limits)
- from emission rate mg/(m² x h), or
- with loading factor m²/m³ and with ventilation rate per h
  - even if these in test chamber differ from reference room

Real or other room air concentration (mg/m³):
Can be re-calculated freely
- from emission rate mg/(m² x h), or
- with reference room air concentration (mg/m³)
- with loading factor m²/m³ and with ventilation rate per h
Test chamber air concentration at given time

- $C_{CH} = \text{mg/m}^3 = \mu\text{g on sampling tube / litres air sampling volume}$

Emission rate

- $ER = \text{mg/h} = C_{CH} \text{ (mg/m}^3\text{) x chamber volume (m}^3\text{) x air exchange (/h)}$

Area specific emission rate or emission factor

- $SER_a = \text{mg/(m}^2\text{xh)} = ER \text{ (mg/h) / emitting surface (m}^2\text{)}$

Reference room air concentration - used as reference

- $C_{MR} \text{ mg/m}^3 = SER_a \text{ mg/(m}^2\text{xh)} \times \text{loading factor } L \text{ (m}^2\text{/m}^3\text{) / air exchange rate (/h)}$

Other room air concentration - different loading factor $L \text{ (m}^2\text{/m}^3\text{)}$ in room

- $C_{OR-L} \text{ mg/m}^3 = SER_a \text{ mg/(m}^2\text{xh)} \times \text{other loading } L_x \text{ (m}^2\text{/m}^3\text{) / air exchange rate (/h)}$

Other room air concentration - different air change rate $n \text{ (1/h)}$ in room

- $C_{OR-V} \text{ mg/m}^3 = SER_a \text{ mg/(m}^2\text{xh)} \times \text{loading factor } L \text{ (m}^2\text{/m}^3\text{) / other air exchange (/h)}$

Instead of area specific emission rate, also mass specific, volume specific or unit specific emission rate may be used.