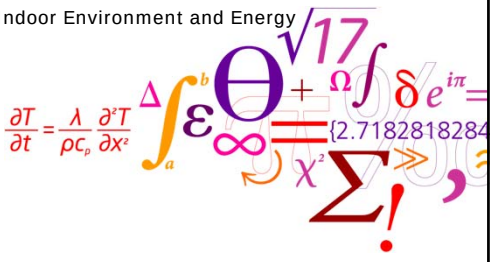
Using (recycled) building materials to improve indoor air quality

A short introduction into research activities under ZeroWaste BYG related to quality of indoor environment

Recirkulering af byggematerialer, Tirsdag d. 3. september 2013
DTU Mødecentret

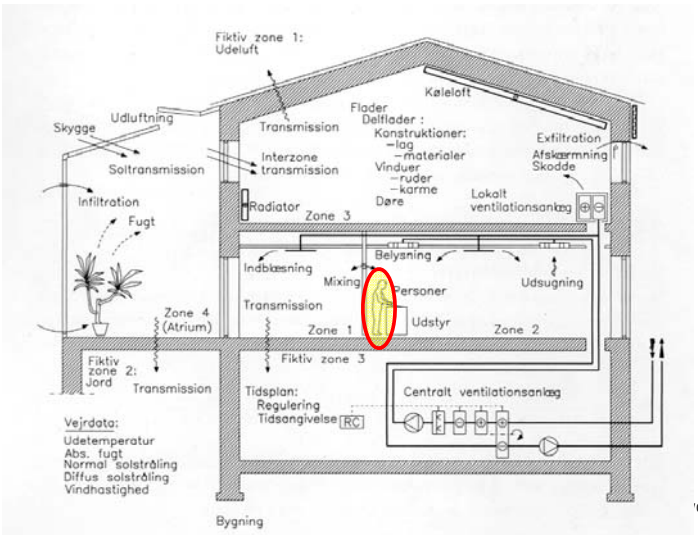
Jakub Kolarik – Section for Building Physics and Installations
Pawel Wargocki – International Center for Indoor Environment and Energy



DTU Civil Engineering
Department of Civil Engineering

Why should we care about indoor air quality?

There are people in the building!



Our indoor environment is not always healthy

Main health effects related to indoor air pollution:
(EnVIE 2009)

- Allergic and asthma symptoms
- Lung cancer
- Chronic obstructive pulmonary disease
- Airborne respiratory infections
- Cardiovascular morbidity and mortality
- Perception of odours and irritation

Building Related Illness (BRI)
Sick Building Syndrome (SBS)

Sick Building Syndrom (SBS)

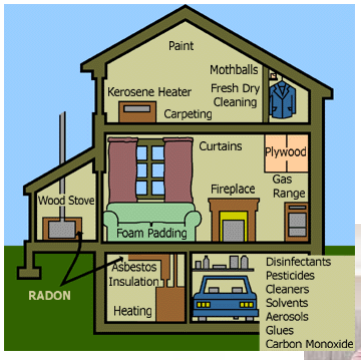
- Irritation of mucous membranes (eyes and nose)
- Headache
- Fatigue
- Dry skin
- Concentration difficulties, … etc.

- SBS can be used as a marker for reduced productivity
  - Overall acceptability
  - Motivation
  - Staff turnover

Figures:
http://www.home-air-purifier-expert.com/images/nifty-sickbuilding.jpg; www.humanresourcesjournal.com

Indoor air pollutants

- **Occupants**
- Pets
- Mould and fungi
- **Chemicals** originating from:
  - Outdoors
  - Cooking
  - Heating
  - Ventilation system
  - Office equipment
  - Smoking
  - Building materials
  - Floor and wall coverings, paints
  - Furniture
  - Cleaning products
  - Pesticides



Figures:
http://www.solcomhouse.com/images/indoorair2.gif
http://preview.canstockphoto.com/canstock5353738.png
http://thumbs.dreamstime.com/thumblarge_409/1245101244D4IIP1.jpg

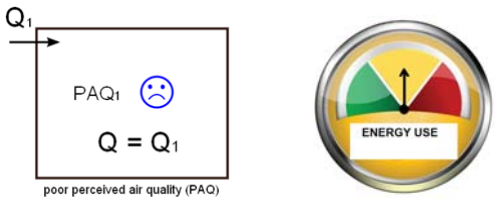
How to eliminate indoor air pollutants?

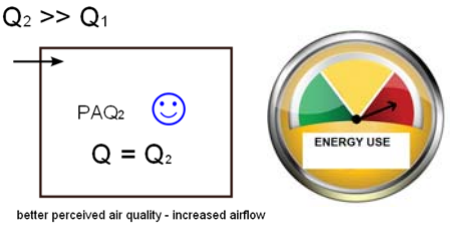
- Ventilation – Costs ENERGY !
- Filtration – Costs ENERGY !
- Air Cleaning/Air Purification – Costs ENERGY !

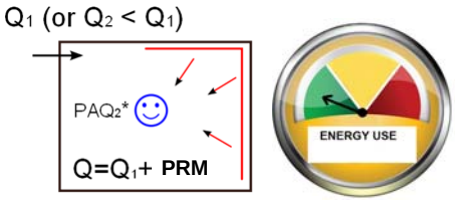
- Source control
- Surface removal and chemical transformations

Where can building materials help?

Substitute of Ventilation with PRM?



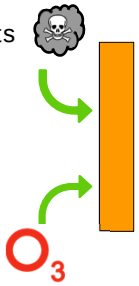




Better perceived air quality – the same or lower air flow + PRM

Surface removal & chemical transformations

- **Passive Removal Materials (PRM):**
  - Used inside buildings to remove air pollutants
  - negligible energy expense
  - without emitting either primary or secondary pollutants
- PRMs can inhibit ozone reaction by-products
  - By removing ozone from indoor air
  - By removing (adsorbing) reaction by-products
- Can PRMs improve air quality as perceived by people?



Figures: Darling, E. (2011); Kaczmarczyk, J. (2009)

Clay-Based Wall Plaster

- A research study conducted by University of Texas at Austin and Missouri University of Science & Technology in cooperation with

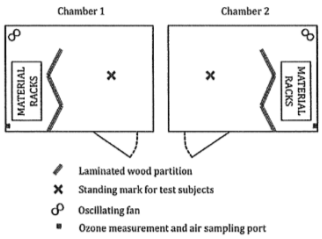
  International Center for Indoor Environment and Energy, DTU:

- Clay as been used architecturally for 1000s of years
- Can be locally-sourced
- Recycled composition (72% by weight)
  - Recycled clays, sands, marble, etc.
- Low-embodied energy
  - Manufacture & transport
- Humidity buffer…….
- Large-area applications

Figure: Darling, E. (2011)

Recirkulering a

Objectives and approach



- Objectives:

  Explore if clay improves:
  - Human perceptions of Indoor Air Quality
  - Ozone & by-product concentration levels

- Experimental approach:
  - Clay plaster on gyp. board / new carpet / ozone combinations (Carpet = 14 m2, Clay = 10.6 m2)
  - Twin stainless steel chambers (30 m3 each, 1.5 air change/h)
  - Human perception assessments (12 males and 12 females)
  - Air sampling of saturated aldehydes (C5 – C10)

Figure: Darling, E. (2011)

Rec

Results

- Clay added to chamber with carpet & ozone =>
  - Decreased total aldehyde concentration:
    day3: -72%
    day4: -29%)
  - More positive air quality
    p = 0.017 (combined p-value for both replicates)

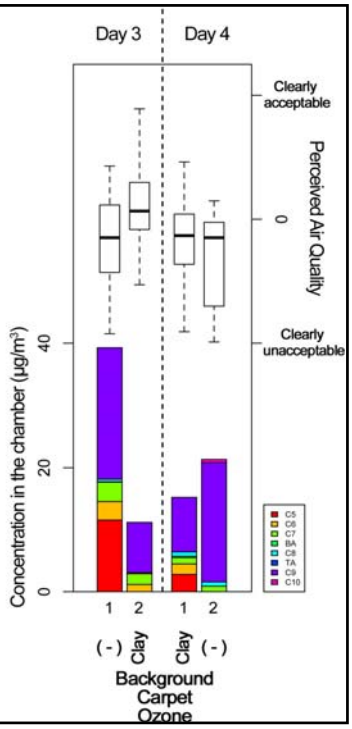


Figure: Darling, E. (2012)

Summary and outlook

- Clay-based wall plaster …
  - Is a recycled product
  - Improved human perceptions of air quality
  - Reduced ozone & VOC concentrations
  - Had low emissions with & without ozone
- Tasks for research under ZeroWaste project:
  - "There is no compromise on environmental impact" – testing of materials developed under ZeroWaste BYG
  - Can some of our new materials contribute to reduction of indoor air pollution?
  - If yes, what are the concepts of using such materials in buildings?

Figure: www.hdwallpapers.in