PREMISSES

- few (not primary little) materials
- reusable, dismantable, recyclable
- natural, less processed
- low primary energy demand
- local, low transportation

> *http://www.waermedaemmstoffe.com/*

mi wo

components:
- ...

properties:
- σ: 20-153 kg/m^3
- λ: 0,035-0,045 W/m·K
- c: 840-1.000 J/kg·K
- primary energy: 250-500 kWh/m^3

use:
- ...

☺:
- ...

☹:
- ...

soft wood fibre

components:
- wood fibres from waste wood + ammonium sulfate (against mould)

properties:
- σ: 150-190 kg/m³
- λ: 0,040-0,055 W/m·K
- c: 2.000-2.100 J/kg·K
- primary energy: 600-1.500 kWh/m³
- water-, rot-, fire-proof

use:
- as stiff and flexible panels
- insulation extern, intern

☺:
- made of waste material
- natural raw material
- reusable, depositable

☹:
- high primary energy for production
- not compostable, health-unfriendly impregnated panels

gutex, unger diffutherm

sheep wool

components:
- wool (mainly from New Zealand)
- 3-5% borate salts
- poss. polypropylene grids for support

properties:
- σ: 30-138 kg/m^3
- λ: 0,040 W/m·K
- c: 960-1.300 J/kg·K
- primary energy: 40-80 kWh/m^3

use:
- as fleece, mat, panel, cramming
- substitute for PUR-foam for sealing

☺:
- renewable natural material
- reusable, depositable

☹:
- transportation costs (NZ)
- chemical moth protection

cellulose insulation

components:
- 80-88% waste paper (newspaper)
- 12-20% borate salts (impregnated against rotting and vermin

properties:
- σ: 30-80 kg/m^3
- λ: 0,04...0,045 W/m·K
- c: 1.700-2.150 J/kg·K
- primary energy: 50 kWh/m^3
- not loadable, rot-proof

use:
- loose fill in framing

☺:
- recycled raw material
- reusable

☹:
- fine dust pollution
- no composting possible
- fill does not necessarily reach every corner

isofloc

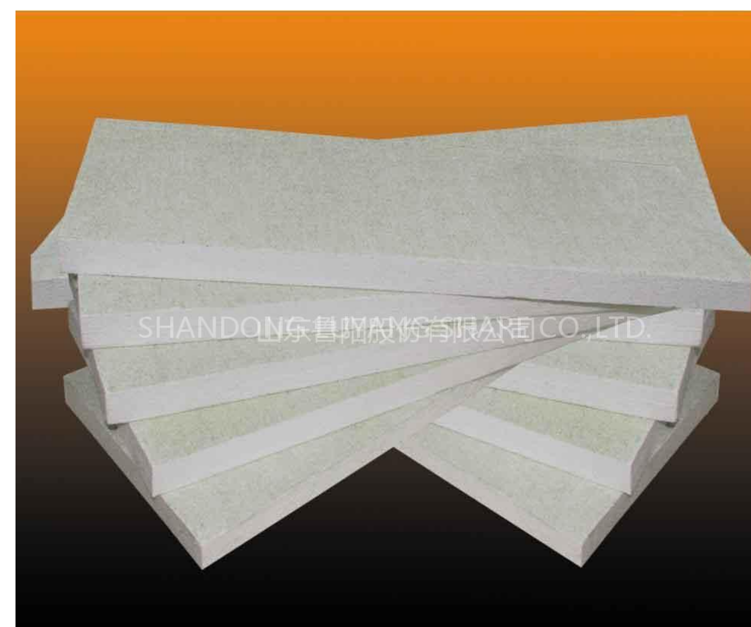
perlite

components:
- powdered volcanic glass + carbon dioxide

properties:
- σ: 40-90 kg/m^3
- λ: 0,050-0,070 W/m·K
- c: 1.000 J/kg·K
- primary energy: 90-160 kWh/m^3
- water-, rot-, fire-proof

use:
- loose fill (pour) in framing
- additive to plaster, screed
- *new! as panels*

☺:
- natural raw material
- reusable, depositable
- safe for health



☹:
- long transport, limited resources
- sometimes mixed with bitumen for hydrophobic

foamglas

components:
- powdered glass + carbon dioxide

properties:
- σ: 100-165 [110-200] kg/m³
- λ: 0,040-0,060 [0,060-0,70] W/m·K
- c: 840-1.100 [1.000] J/kg·K
- primary energy: 750-1.600 [350-1.000] kWh/m³
- pressure resistant, water-, frost-, rot-, fire-proof

use:
- substitute for eps and xps
- board (basement insulation)
- granulate (under basement)

☺:
- unlimited raw material, short transport
- reusable, depositable, down-recyclable

☹:
- high primary energy for production
- in panels glued with bitumen

expanded clay

components:
- clay

properties:
- σ: 300-700 kg/m³
- λ: 0,10-0,16 W/m·K
- c: 1.000 J/kg·K
- primary energy: 300-450 kWh/m³
- good as heat storage and acoustic insulation
- water-, frost-, rot-, fire-proof

use:
- loose fill
- additive to bricks, concrete, mortar

☺:
- unlimited raw material
- reusable, depositable
- little transportation costs

☹:
- high primary energy for production

leca

ceramic foam

components:

- ?

properties:

- σ: ? kg/m³
- λ: ? W/m·K
- c: ? J/kg·K
- primary energy: ? kWh/m³
- ?

use:

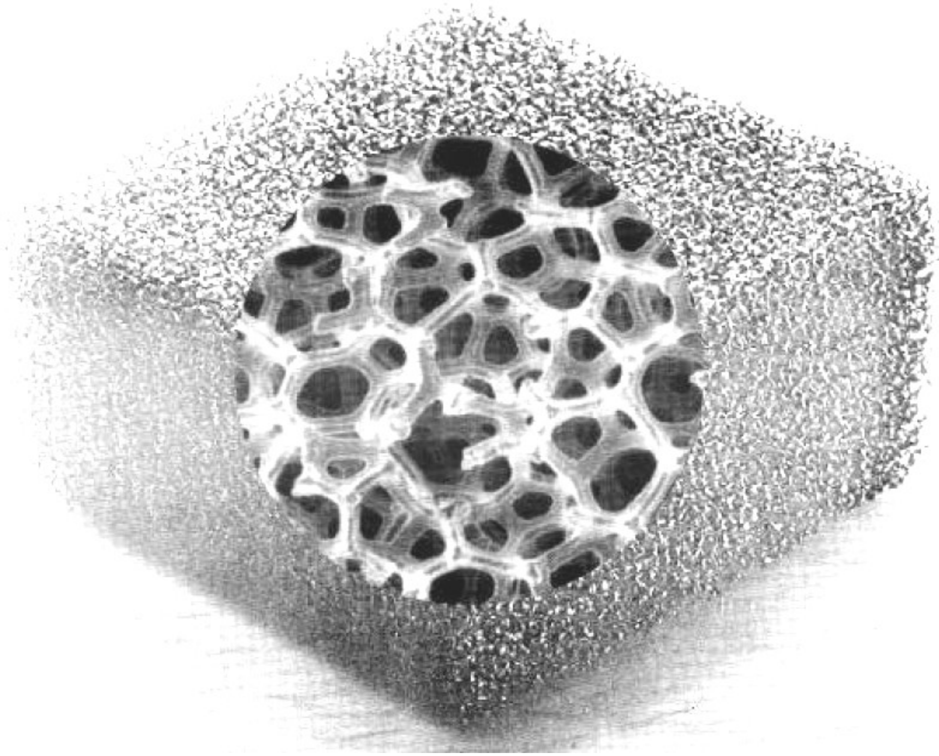
- *?*

☺:

- ?

☹:

- ?



Beyond Vacuum Insulation Panels - How May It Be Achieved?

Bjørn Petter Jelle[ab], Arild Gustavsen[c] and Ruben Baetens[d]

[a]Department of Building Materials and Structures,
SINTEF Building and Infrastructure, NO-7465 Trondheim, Norway,

[b]Department of Civil and Transport Engineering,
Norwegian University of Science and Technology (NTNU), NO-7491 Trondheim, Norway,

[c]Department of Architectural Design, History and Technology,
Norwegian University of Science and Technology (NTNU), NO-7491 Trondheim, Norway.

[d]Department of Civil Engineering,
Catholic University of Leuven (KUL), B-3001 Heverlee, Belgium.

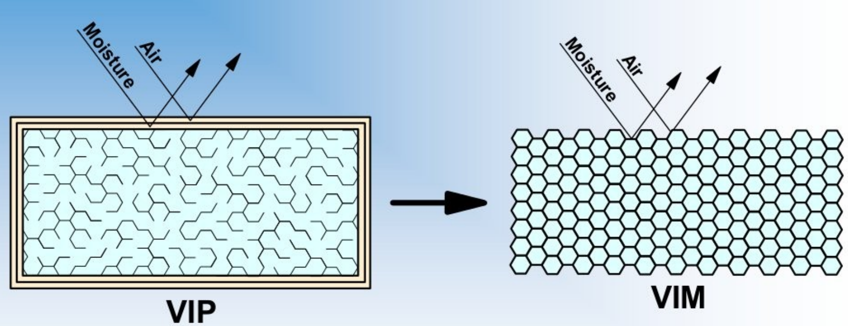
9th International Vacuum Insulation Symposium
London, September 17-18, 2009

IVIS 2009 www.ivisnet.org

Conclusions

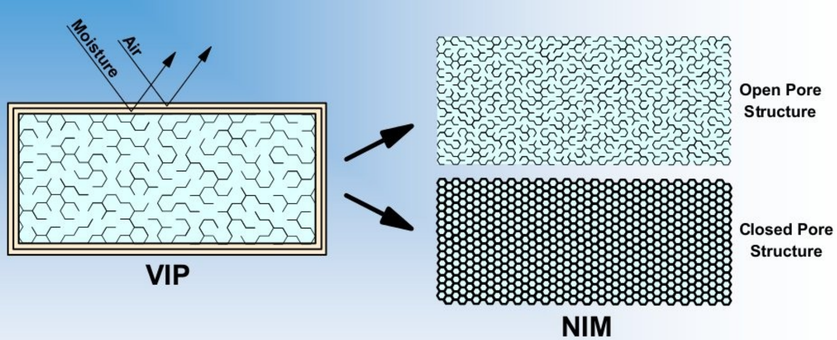
- Beyond the state-of-the-art of today
- New concepts have been introduced
  - Vacuum Insulation Materials (VIM)
  - Gas Insulation Materials (GIM)
  - Nano Insulation Materials (NIM)
  - Dynamic Insulation Materials (DIM)
- Fundamental theoretical studies - basics of thermal conductance
- Requirements of the future high performance thermal insulation materials and solutions have been proposed
- NIMs seem to represent the best high performance low conductivity thermal solution for the foreseeable future
- DIMs have great potential due to their controllable thermal insulating abilities

Vacuum Insulation Material (VIM)



VIM - A basically homogeneous material with a closed small pore structure filled with vacuum with an overall thermal conductivity of less than 4 mW/(mK) in the pristine condition

Nano Insulation Material (NIM)



NIM - A basically homogeneous material with a closed or open small nano pore structure with an overall thermal conductivity of less than 4 mW/(mK) in the pristine condition

The Thermal Insulation Potential

ROBUST

Thermal Insulation Materials and Solutions	Low Pristine Thermal Conductivity	Low Long-Term Thermal Conductivity	Perforation Robustness	Possible Building Site Adaption Cutting	A Thermal Insulation Material and Solution of Tomorrow ?
Traditional					
Mineral Wool and Polystyrene	no	no	yes	yes	no
Todays State-of-the-Art					
Vacuum Insulation Panels (VIP)	yes	maybe	no	no	today and near future
Gas-Filled Panels (GFP)	maybe	maybe	no	no	probably not, near future
Aerogels	maybe	maybe	yes	yes	maybe
Phase Change Materials (PCM)	-	-	-	-	heat storage and release
Beyond State-of-the-Art					
Vacuum Insulation Materials (VIM)	yes	maybe	yes	yes	yes
Gas Insulation Materials (GIM)	yes	maybe	yes	yes	maybe
Nano Insulation Materials (NIM)	yes	yes	yes, excellent	yes, excellent	yes, excellent
Dynamic Insulation Materials (DIM)	maybe	maybe	not known	not known	yes, excellent
Others ?	-	-	-	-	maybe