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OVERVIEW

Superinsulating Materials: A New Era of Insulation Technologies

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A new generation of insulating materials has emerged on the market during the last decade. The use of superinsulating materials (SIM) begins a new era of insulation technologies.

What are the main differences between SIM and traditional insulating materials?

Except for a few types of cellular foams, all traditional insulating materials rely on still air embedded in cavities, pores or cells which prevent any convection. This is why the thermal conductivity of such materials reaches a minimum value of about 29 $mW.m^{-1}.K^{-1}$.

To go beyond this limit and achieve superinsulation, three main principles can be applied to reduce thermal conductivity:

- **removing the gas** - this technique is used for Vacuum Insulation Panels (VIP)
- **changing the gas** - this technique is similar to the one use for double glazing filled with argon or krypton
- **trapping the gas in tiny pores** with a size lower than the mean free path of the entrapped gas in order to limit energy transfer between molecules. This technique is used for Aerogel or other nano-porous materials.

VACUUM INSULATION PANEL (VIP)
COURTESY: POREXTHERM

AEROGEL
COURTESY: ASPEN AEROGEL

Using one of these three options, the thermal conductivity of SIM is generally below 15 $m.W.m^{-1}.K^{-1}$ and can reach very low values (close to 5 $mW.m^{-1}.K^{-1}$). VIP and nanostructured materials such aerogel are available on the market and integrated in building products such as polycarbonate boards. **SIM remain much more expensive [20-40 (€/m²) per 1 $m^2.K.W^{-1}$] than traditional materials [2-10 (€/m²) per 1 $m^2.K.W^{-1}$]** but they are often economically the most attractive solution if the cost of reduced floor area is taken into account.

What can SIM do for energy performance in buildings?

In residential buildings, **space heating, domestic hot water and refrigeration represent about 80 % of the total energy consumption**. The **most efficient way to curb energy consumption in buildings is reducing heat loss** by improving the thermal insulation of the building envelope (roof, wall & floor). Going beyond current thermal performance is essential to achieve EU2020 targets. For example, in Europe, it appears that the optimum U-values lie between 0.15 W/m².K to 0.3 W/m².K, with an average value close to 0.2 W/m².K. Using traditional insulating materials such as mineral wool or cellular foams implies insulating layer thickness of 15 to 20 cm. For retrofitting, the thickness becomes a major issue of concern and SIM with a lower thickness (2 to 5 cm) are effective here.

European research projects

The European Commission supports research via substantial investments in the EU 7th framework programme. The AEROCOINS project aims to **develop a brand new composite/hybrid organic-inorganic aerogel material.** The objective of the HIPIN project is the **development of sustainable, cost-effective production of a nanostructured aerogel-based coating**. A third project NANOINSULATE is working on **durable, robust, cost-effective, opaque and transparent VIP** by incorporating new nanotechnology-based core materials such as nano-foams, aerogel composites and high barrier films. A new project, **FOAMBUILD**, has recently started to develop thermoplastic particle foam using newly developed raw materials, additives and process set-ups to produce neon-cellular foam.

International initiatives to promote SIM

Since the beginning of the new millennium, **there is growing interest in SIM around the world**. An international symposium about VIP (IVIS) is organised every two years since 2001.The IEA Annex 39 investigated VIP's application in the building sector. The new IEA Annex 65 Long-Term Performance of SIM in Building Components and Systems will be operational from mid-2014. The main objectives are to provide reliable data (properties & durability) and secure implementation techniques.

Technical assessment & standardisation

In Europe, **few VIP and aerogel products are covered by technical assessments. At time of writing** CEN & ISO working groups are preparing proposals for VIP standards. In the USA, an ASTM standard covers the general requirement for VIP.

Playback video recordings of the BUILD UP Web Seminar on Superinsulating materials (05/11/2013) at www.buildup.eu/news/38814.

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