AEROGEL-BASED MATERIALS AND THEIR DEVELOPMENT PARTICULARITIES

AEROGEL-BASIERTE MATERIALIEN UND IHRE ENTWICKLUNGS-BESONDERHEITEN

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SUMMARY

Traditional thermal insulation materials reached their optimisation limit. Nowadays, new types of materials are developed which can offer better thermal performance than products available on market, e.g. vacuum insulation panels (VIP) and aerogel-based materials. This article describes aerogel and possibilities to positively use its thermal performance for new building insulation materials. Aerogel is today possible to use as loose-fill materials as well as embedded in insulation boards, blankets and thermal insulation plasters. Each of these materials brings some particularities in development which are generally dependant of size and amount of aerogel.

ZUSAMMENFASSUNG

Traditionelle Wärmedämmstoffe haben ihre Optimierungspotenziale erreicht. Heute werden neuartige Materialien entwickelt, die eine bessere Wärmeleistung bieten können als die auf dem Markt erhältlichen Produkte, z.B. Vakuumisolierplatten (VIP) und aerogelbasierte Materialien. Dieser Artikel beschreibt Aerogel und Möglichkeiten, um seine thermische Leistungsfähigkeit positiv für die Entwicklung neuer Dämmstoffe zu nutzen. Aerogel kann sowohl als loses Dämmmaterial verwendet werden als auch eingebettet in Dämmplatten, Dämmmatten und Wärmedämmputze. Jedes dieser Materialien bringt einige Entwicklungsbesonderheiten mit sich, die im Allgemeinen von der Größe und Menge des Aerogels abhängig sind.

KEYWORDS: Aerogel, development, characteristics, loose-fill material, board, blanket, plaster

1. INTRODUCTION

Traditional thermal insulation materials have thermal conductivity which is higher than 0.030 w/mK. Further improvement of thermal performance of these materials is not possible anymore because the optimisation limit (thickness, density) is reached. Nowadays, new types of materials are developed which can offer better thermal performance than products available on market, e.g. vacuum insulation panels (VIP) and aerogel-based materials.

2. AEROGEL-BASED MATERIALS

Aerogels are porous, solid materials composed of 80% until 99.8% air by volume. Air is closed in pores which have diameter of approximately 20 nm. Because of such small pore size and minimal contact points in material, thermal conductivity is very low (rd. 0.018 W/mK) and depends of so-called Knudsen Effect. Moreover, heat transfer is reduced by pore size. Contribution of cell gas and convection are reduced compared to traditional insulation materials.

Aerogels are used in civil engineering for insulation purposes as loose-fill materials as well as insulation boards and blankets, thermal insulation plasters and insulating glass system.

Aerogel loose-fill materials are used for infill and cavity applications. This kind of application is suitable for any size of cavity and aerogel granulate can be compacted up to 95 kg/m^3. Thermal conductivity of loose aerogel granulate is usually between 0.018 and 0.021 W/mK. By compaction of aerogel, thermal conductivity reaches lower values than non-compacted aerogel. Moreover, aerogel granulate can split by higher pressure and smaller particles can leak out of cavity. This leads to dust development. On the other hand, this application is possible only for walls without any gap. Moreover, aerogel loose-fill materials are hydrophobic and have good sound-insulating properties. The material is permeable to water vapour ($\mu = 4$) and non-combustible (class B1 according to DIN 4102-1 [1]). Aerogel loose-fill material products are offered from Cabot [2] and Enersens [3].

For production of aerogel based boards (see Fig 1. left) and blankets, fibrous material is used as matrix material in which aerogel is embedded. Blankets are flexible and have smaller thickness than boards. Such materials are provided from Aspen Aerogels (Spaceloft) [4], Cabot (Thermal Wrap) [5], BASF (Slentex) [6] and Sto (Sto-Aevero) [7]. Thermal conductivity is between 0.015 and 0.019 W/mK. It means that a defined U-value is possible to reach with thinner

aerogel-based insulation than using traditional one. It is especially useful for renovation of historical buildings as well as for new buildings where living space is costly (insulation thickness vs. loss of living space and costs Euro/m^2). Moreover, this type on aerogel-based insulation is used as part of external thermal insulation composite system (ETICS) and for special details, e.g. parts with higher loss of heat and uneven surfaces. All aerogel-based boards and blankets are hydrophobic but diffusion-open materials. They can be glued and anchored or only glued to the underground. Anchoring is seen as negative aspect for thermal performance (thermal bridges) and gluing contributes to worse reaction to fire. Challenge in development and use of such products are dust development by cutting as well as high costs of aerogel.

Thermal insulating plaster are used in external and internal thermal insulation composite systems instead of insulation boards. Such plasters are provided from e.g. Hasit (Fixit 222) [8], Interbran Systems AG (Premium Dämmputz 028) [9] and Heck Wall Systems GmbH (Aero iP) [10]. Advantage of thermal insulating plaster is quick and easy application to underground with plastering machine (see Fig 1. right). Thermal conductivity is between 0.028 and 0.036 W/mK. This values are comparable with mineral wool. Main challenge in development of this kind of plaster is reaching of appropriate balance between thermal conductivity and compressive strength. With lowering of density (more aerogel), better thermal conductivity can be reached but this is also connected with lower compressive strength. Aerogel-based plasters mostly reach fire classification A2 according to EN 13501-1 [11].

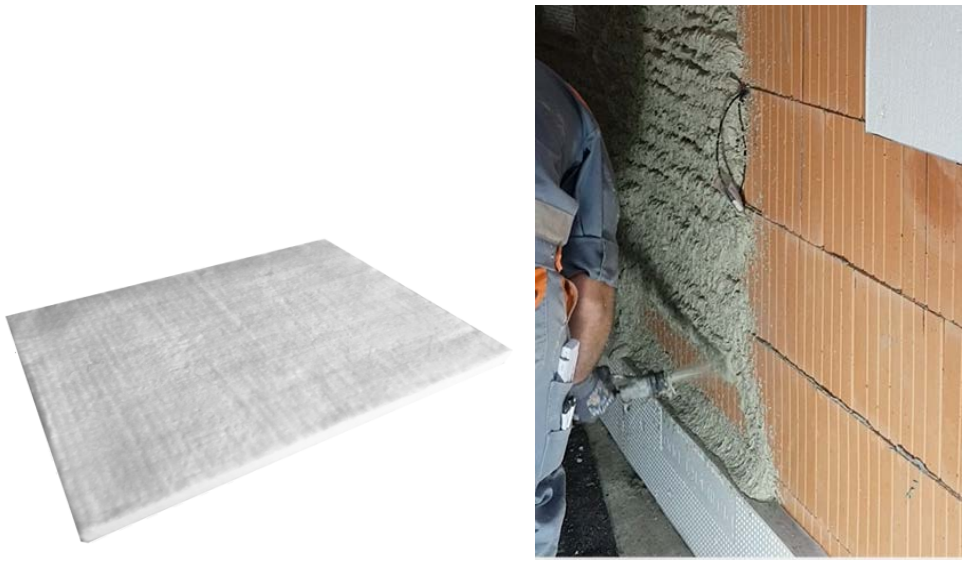

Fig. 1: Aerogel-based thermal insulation board (left) and application of thermal insulating plaster to wall with plastering machine (right)

3. CONCLUSIONS

This article describes aerogel and possibilities to positively use its thermal performance for new building insulation materials. Aerogel is today possible to use as loose-fill materials as well embedded in insulation boards, blankets and thermal insulation plasters. Each of these materials brings some particularities in development which are generally dependant of size and amount of aerogel.

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