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Competitive high performance Aerogel-Based Composite material for the European insulation market

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Abstract

A new advanced Aerogel-Based Composite (AABC) material is presented in this work. The thermal conductivity, the water vapour permeability, the compressive stress and the tensile strength have been determined depending on the matrix material used. This study shows that the AABC material is particularly effective with a thermal conductivity lower than 0.016W/(m.K). This insulation material is currently being tested as internal and external insulation system in the FACT experimental platform of the CEA in France. As this new material is manufactured with a low cost process, it should be quite competitive in the superinsulation European market.

Keywords: Superinsulation; Advanced Aerogel-Based Composite material; cost-effective; indoor and outdoor testing

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1. Introduction

The world energy consumption for building space heating is rising. The need of new materials to decrease the thermal losses is therefore essential. The Advanced Aerogel-Based Composite (AABC) material shows a great potential as a new efficient insulation system solution [1-3]. In an experimental study E. Cuce et al. [4] shows that aerogel insulation system can provide slimmer constructions in buildings with higher mitigation in greenhouse gas emissions compared to the conventional insulation materials.

In the frame of the Horizon 2020 European research program [5], the HomeSkin project [6] aims to develop and introduce on the European market a new silica AABC material with competitive performances compared to current insulations. In order to control the production costs, the new process is fulfilled without the need of the supercritical drying production step. Many efforts were necessary to reach properties that were targeted in the project: ultra-low thermal conductivity and excellent moisture regulation with high water vapour permeability.

This article describes the main steps to produce the new aerogel insulation material and presents its current properties. Thermal conductivity is compared using different kind of matrix materials. The microstructure of the material is analyzed with SEM (Scanning Electron Microscopy) technique. The mechanical properties are tested as well as the vapour permeability of the aerogel material. In order to prove the practical use of this new aerogel insulation, two different systems are actually applied in the FACT [7] facilities of the CEA in France and described in this article.

2. Material and method

2.1. Production process

An innovative process methods used for manufacturing xerogel and insulating composite materials is developed in the frame of the project. The main steps of this production process are represented in the Figure 1. A silica sol obtained by hydrolysing alkoxysilane in the presence of hydrochloric acid and then adding ammonia, is poured on sheets of melamine foam, Polyethylene terephthalate (PET) fiber, Glass fiber or Needle glass fiber (NGF) introduced in a tailor made reactor. The thickness of these matrix materials can vary from 7 mm to 30 mm. After gelation, the reinforced alcogel is aged. Hydrophobization agent is then introduced into the chamber. The reaction mixture was then separated from the hydrophobic silica alcogel composite. Finally, the condensed alcogel reinforced by the melamine foam, the PET fiber or the glass fiber is dried in a pilot scale dryer.

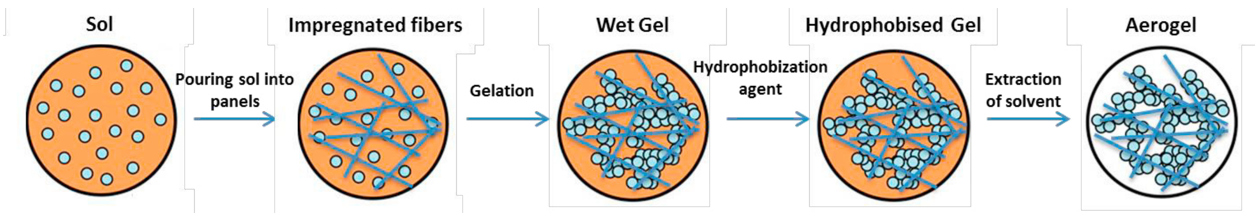

Fig. 1. Description of the process steps to produce silica aerogel panels (inspired form [8]).

2.2. Structural and thermal characterization techniques

The thermal conductivity values were measured on the samples obtained using the guarded hot plate method according to ISO 8301:1991 standard [9] at 23°C, 50% relative humidity and atmospheric pressure. The specimens dimensions were 300mm by 300mm and thickness of samples were included between 10mm to 30mm.