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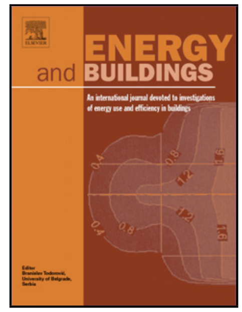

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Experimental study on the effects of humidity and temperature on aerogel composite and foam insulations[1]

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Highlights

- Examination of the degradation mechanisms of polystyrene foam, polyurethane foam and aerogel composite insulations.
- Polystyrene foams are stable, while polyurethane foams see significant changes.
- Aerogel composites exhibit sensitivity to moisture and temperature, but this varies depending on the type of manufacturing process used.

Abstract

Building insulation materials have been subjected to various temperature and humidity conditions and their thermal performance during several weeks of controlled environmental exposure. Several commercially available insulation materials (three aerogel composite blankets, two extruded polystyrene foams (XPS) and one blown polyurethane foam (PUR)) were evaluated. The purpose is to compare performance of newer types (aerogel composites) with established types (foams). Thermal conductivity was measured with a heat flow metering apparatus at one week intervals for five weeks. Insulations were exposed to conditions of 65.6°C and 90% RH, 65.6°C and 60% RH, 65.6°C and 30% RH, and 32.2°C and 90% RH. Results indicate that humidity levels play a significant role in PUR performance, but not a significant role in XPS performance. The three aerogel composites have mixed results: one has little relationship between moisture content and thermal performance, one is strongly affected by moisture and the remaining is moderately affected by moisture. Fourier infrared spectrometry was performed on some of the materials to observe chemical stability. Results indicate that factors other than moisture content, such as hygroscopy and volume expansion, significantly contribute to thermal performance.

Keywords:

Aerogel, polymer foam, insulation, thermal conductivity, accelerated aging

1. Introduction

1.1. Background

Energy consumption has heightened significantly over the past few decades, and with the push for energy conservation research has strengthened. Commercial and residential buildings are a large source of energy consumption. In 2012, an estimated 18.9 quadrillion Btu ($19.9x10^{15}$ kJ) were consumed in the residential and commercial sectors of the United States, representing about 1/5 of energy used [1]. Climate control is a major portion of this consumption. Data from 2009 suggests that 48% of home energy use was for heating and cooling [2], and 2003 data shows that 44% of energy used in commercial buildings was used for heating and cooling [3]. By using a combination of thermal insulation and air