

Vacuum insulation panels (VIP) in refrigerator room, freezing room & fridge

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Abstract:

With respect to the continuous trend of reduction in energy consumption vacuum insulation panels (VIP) find an increasing application in freezing and cold storage rooms of supermarkets as well as in refrigerators. This implies the investigation of VIP behaviour subject to conditions different from those encountered in building application.

The present contribution deals with the evolution of the internal pressure of VIPs subjected to low and freezing temperature for a period of 5 years confirming the prediction made earlier on its linear increase 0.6 mbar/year in the refrigerator room and 0.10 to 0.26 mbar/year in freezer room depending on the VIP type.

This is a clear indication that the aging process decelerates compared to the standard test condition of VIP due to the low temperature condition.

Further, a refrigerator with different VIP configuration was analysed with respect to their energy performance by means of thermal bridge analysis and possibilities to reduce them.

Keywords:

vacuum insulation panel, pressure increase, aging, floor insulation, low and freezing temperature

1. Introduction

Since the introduction of VIP into the building market at the turn of the millennium, the question of aging and relevant parameter hereof have been addressed by different authors [1-3]. An elaborate report was published by Heinemann on a large number of VIP containing buildings [4] regarding the question of early degradation and showed, that there are no changes of the failure rate values in almost all cases for a period of three years.

Studies on the deterioration on the laminate had been carried out by the authors for the high temperature and high moisture load [5,6]. Assumptions of slow degradation processes in the core material needing long term monitoring (several years) have also been reported [3].

An increasing application of VIP in freezing and cold storage rooms in supermarkets, enabling a more flexible sizing, placing and rearrangement illustrate the need for information on the influence of cooler temperatures on aging relevant parameters. A similar lack of information (in open literature) has been detected regarding energy consumption of VIP containing refrigerators.

2. Experimental

A project for the instrumentation of a cooling / freezing rooms was established on the Empa campus, in the basement of a new office building. Construction plans

for a combined cooling / freezing chamber with partition wall could be changed to include a full VIP floor insulation of both the cold (5 °C) and the freezing (-20 °C) section of the double chamber (figure 5). The thickness of the VIP layers was 25 mm in the cooling and 2 x 20 mm (double layer) in the freezing section, and the area about 9 m² each. Further details including first year results had already been presented at IVIS2007 including vertical section through the floor [7]

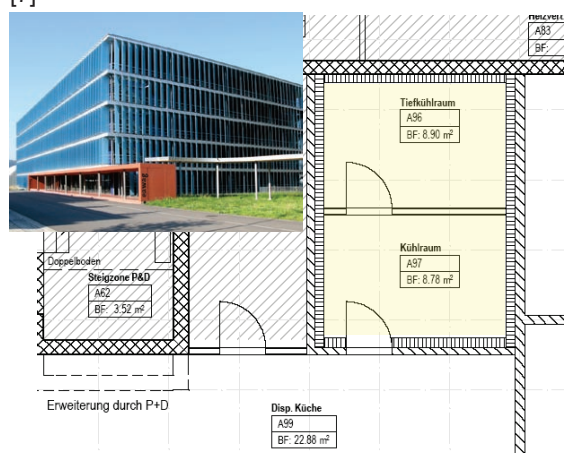


Fig 1: Front view of the near zero energy office building (upper left), the highlighted position of fridge and freezing room in the basement adjacent to the restaurant kitchen (right)

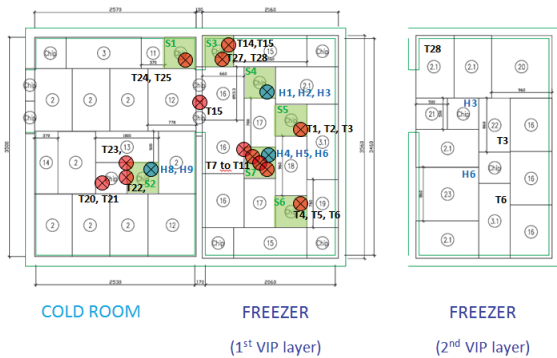


Fig 2: Layout of the VIP's in the refrigerating (single layer) and in the freezing room (double layer). Temperature and humidity sensor are labeled with T and H. Panels with integrated pressure sensor are highlighted in green (or light gray in b&w). Numbers in circle had been from the dimensional planning. Cold storage room CR, Freezer room FR.

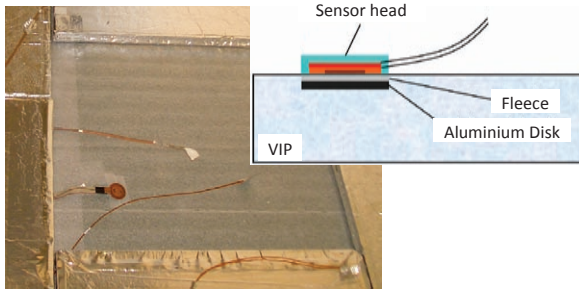


Fig. 3: Principle of the in-situ measurement of the internal pressure (technique va-q-perm, developed by VIP producer va-Q-tec, Würzburg, Germany [8,9]).

3. Results

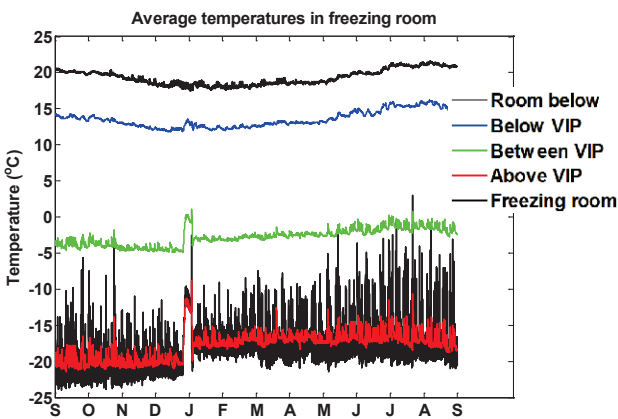


Fig. 4: Average temperature in the freezing room and cold storage room respectively during the period 1 September, 2007 to 31 August, 2008

The every 12 minutes logged data in Fig.4 showed late Dec. 2007 a jump up, that did not occur a year later on next X-mas.

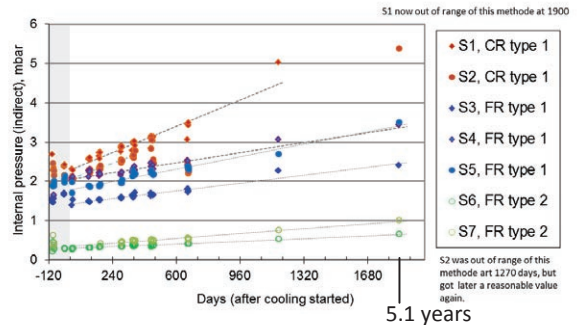


Fig. 5: In-situ measured internal pressure of VIP floor insulation in the cooling / freezing room. The dotted lines indicate the respective linear trends.

According to [9] a measurement range between 0.02 and 10 mbar can be covered with this fleece type. Here the data between 0.2 and 4 mbar well on the linear trend. Values above are less well on the line, and artifacts from the method and not real internal pressure is likely the causation for this.

4. Fridge – house hold sized Refrigerator/Freezer

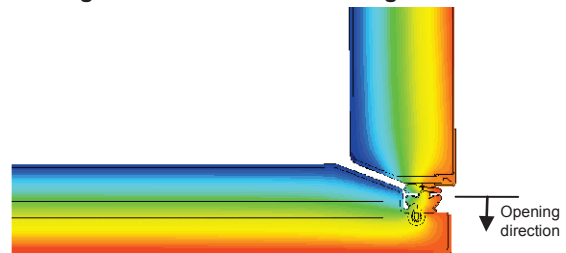


Fig. 6: 2D-Thermal simulation of VIP in a freezer door.

5. Discussions

Conclusions from former IVIS2007 with 25-year-extrapolation in such cold and dry environment: $\Delta\lambda < 0.5 \cdot 10^{-3} \text{ W/(m K)}$ will have to be checked in a future project in respect the first result of several years in a real roof applications [3] where the 8 year value of $6.6 \cdot 10^{-3} \text{ W/(m K)}$ is a hint to a moisture influence doubling of $\Delta\lambda$. The hypothesis, that in dry and one side only cold condition this effect could be small should to be investigated in (a) future project(s).

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