University of West Hungary

Ph. D. degree thesis

Developing opportunity of heat insulation for light construction buildings

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Abstract:
Nowadays one of the most important research areas is the energy efficiency technologies like heat insulation systems. fair frame of present research have prepared insulation panels, with significant insulation influence by using low emission foils and vacuum. Successful done to approximate the heat insulation coefficient fair by using parallel stretched aluminum foils. Better insulation effect than the air can be achieved by the removal fair from the insulation field or changing to other gas. The second main stream of the research was to use vacuum as an insulation material. It developed a vacuum insulation panel which is usable in construction areas.

Preliminaries:
The increasing demand for energy in the world and the limited available energy sources forced the consumers use energy with higher efficiency. High percent of energy used for heating and cooling both in Hungary and the other part of the world. The insulation efficiency partly depend on how long can we use the same energy, e.g. how long can we keep it inside the buildings. To achieve this aim usually apply heat insulation materials. In the developed countries has prescriptions related to the insulation parameters of buildings. In the course of time this prescriptions become more strict. New Directive (2002/91/ EK) come into force concerning energy efficiency of buildings in the EU countries and mean more strict criterions for the buildings. According to rules most building need auxiliary heat insulation layer that mean thicker insulation layer. It would be better increase the insulation efficiency rather than insulation thickness.
Not only rules forced the owners, but also the prices of energy. It has more importance the coefficient of heat transmission by the purchasing residential homes or windows. The U value become an everyday concept, 10-15 years ago less people knew what does it mean.

Description:
The aim of research was to develop an insulation systems having better heat insulation coefficient as the today generally used glass wool, mineral wool or polystyrene foam. The aimed application area was the field between construction elements of light construction houses.

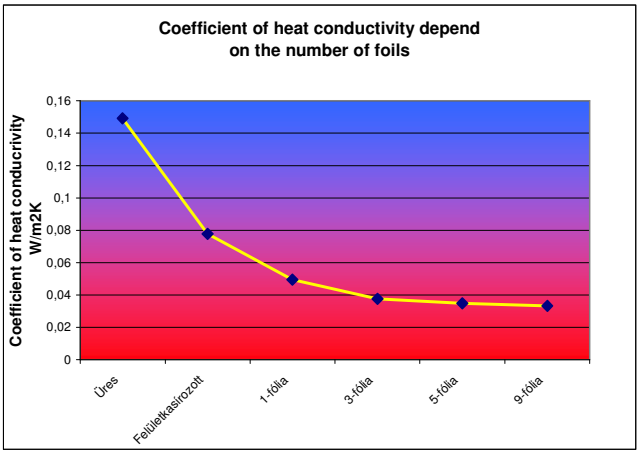
The research had two main direction:

- Using parallel stretched low emission foils: Mirror panel;
- Using vacuum as a heat insulation material: Vacuum panel;

Before starting experiments I made a scientific analyses concerning heat spreading methods.
I made theoretical findings, how would be possible to prevent heat energy spreading by the three different way.

In the case of Mirror panel I used aluminum foils having low emission surface property. The experiment had 6 steps, from using zero foil to use 11 layer. The starting level was a simple wood panel made 4 mm thick beech plywood covering decks and pine frame elements.

The size of the panel fitted to the measuring equipment, surface 300*300 mm, thickness 38 mm. The sum air field in the panel was in all case 30 mm. The inside of the panel filled with atmospheric air and the internal surface of the panel was naturally wood.
Surface of inside covering decks was covered with aluminum foil in the second step. In the further steps the air field was cut with 1, 3, 5, and 9 aluminum foils. The foils decided the air field 15, 7.5, 5, and 3 mm thick layers. I measured the coefficient of heat conductivity in all steps. The result show the 1. Picture below.



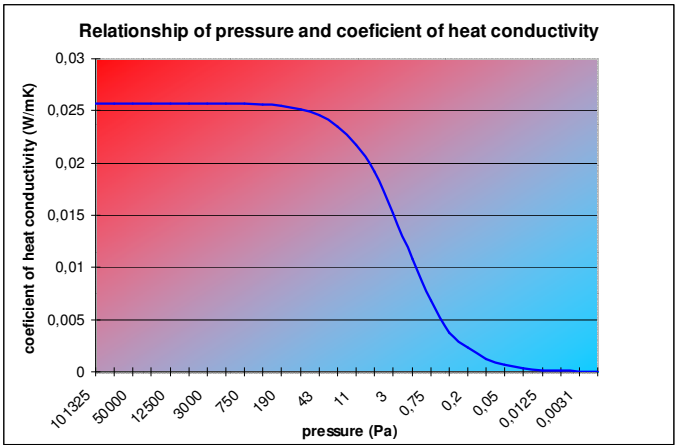
1. picture

In the second research direction I tried to use vacuum as an insulation "material". I developed a rigid panel made 6 mm thick beech plywood, the inside wall was covered with 200 μm thick aluminum foil, the frame made aluminum profile. The size of vacuum insulation panel was 800*800 mm and the whole thickness 27 mm, that mean 15 mm air filed in the middle. The panel was able to keep the fine vacuum (0,1 mbar) and the outside pressure of 1athmosphere. Due to the 6 mm beech plywood the panel is strong enough to be usable in the building construction area.

Results:

In the case of 9 foil layer mirror panel it was succeed come 11% close to the heat conductivity of air. This coefficient of heat conductivity is 30% better than the traditionally insulation materials like mineral wool, glass wool and polystyrene foam. In the middle part of mirror panel has not heat bridge, only the pine frame work as heat bridge. In the 3 mm air layers has very few chance for formation of convection. The 9 aluminum foil surface make sure to keeping close to zero the heat transport by radiation. The measured equivalent coefficient heat conductivity for the inside part of the 9 layer panel was 0,02778 W/mK.

It was proved by the measuring of the vacuum panel that the significant change in heat conductivity happen only under 1 mbar. This findings is harmony with the theory. According to the experience I have to deny the view by state there are marked improvement of heat insulation effect in the pressure 50-100 mbar. We can calculate significant change in heat conductivity under 1 mbar. Despite of this results the measured equivalent coefficient of heat conductivity was not better than 0,04 W/mK, because off the heat bridges.
The picture 2 show the connection between the air pressure and the coefficient of heat conductivity.



2. picture

Propositions:

1, In the 6 steps experiment series I proved the effect of built in low emission layer foils number to the coefficient of heat conductivity. The foils were stretched inside of measuring wood panel developed for this purpose. The number of the foils in the panel were 0, 2, 3, 5, 7, 11. With the increasing number of foils in the same air field the equivalent coefficient of heat conductivity is going to the coefficient of heat conductivity of air.

2, I developed a heat insulation panel which insulation value (0,02778 W/mK) is significant closer to insulation value of air than the traditionally wool and polystyrene type insulation materials. The air field in the panel is divided to 3 mm layers by low surface emission foils. The 9 stretched low surface emission foil reduced the heat transport by radiation and the thin (3 mm) air layers keep the effect of convection in the minimum.

3, I put a proposal for form a new insulation material, using low emission surface layers and polystyrene pearls. The glued polystyrene pearl can keep the suitable 3-5 mm distance between the foils. So developed insulation material has about 40% higher heat resistance in 10 cm thickness than the mineral wool with coefficient of heat conductivity 0,04W/mK.

4, I developed a rigid vacuum panel by using aluminum covered 6 mm beech plywood construction that is able to hold vacuum under 1 mbar. The panel is suitable for using in industrial circumstances.

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