

# **HEMP – THERMAL INSULATION FOR SUSTAINABLE BUILDING**

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## **Summary**

Hemp – one of the oldest cultivated plants – has been used more and more widely in modern buildings. It has better properties than commonly used thermal insulating materials, plus it meets the requirements for environmentally friendly production. The modern manufacture of Canabest thermal insulation mats made from hemp fibres allows a wide range of applications in the demanding conditions of today's housing and communal construction.

**Keywords:** Hemp, thermal insulation, ecological footprint, healthy living

## **1 Hemp – traditional material for modern buildings**

### **1.1 Return to the advantages of natural materials**

Ever since the beginning of the Industrial Revolution, with the advancement of transportation, development of new materials and huge increase in the amount of construction projects, development in the housing industry has been accompanied by a departure from the traditional, localized building trade, replaced with almost total construction industrialization. In connection with the diminishing raw material resources and in connection with climatic threats, however, views on the extensive development of society in general have been changing in recent decades, and gradual changes can be seen in the building industry too. The necessity for a thrifty approach to the consumption of energy and natural resources presents a challenge in the use of traditional technology and, in particular, renewable resources.

Another major impetus for the utilization of natural materials in construction has been an increase in diseases of civilization. Scientific research on the health impacts of buildings has even specialized into three areas already, namely “Indoor Air Pollution” (adverse effects of pollutants from the physical, chemical or biological point of view), “Building Related Syndrome” (diseases demonstrably caused by a building) and “Sick Building Syndrome” (adverse effect on humans in buildings with no proven connection yet).

This makes the building industry develop not only towards as much operational energy savings as possible but also towards an increased utilization of natural materials with low energy demands during production and towards the use of materials that make the human environment as healthy as possible.

## 1.2 Hemp

Hemp is one of the oldest materials, used already in the ancient times but almost forgotten during the Industrial Revolution. Hemp is the best example of a renewable, quickly growing material. The efficiency of hemp growing (cellulose yield per sown area) is up to 4 times higher than that of commercial forestry. One hectare produces 12-13 tons of dry raw material for the production of approx. 8 tons of building materials in just 120 days. The quick growth of hemp prevents invasion by weeds, so there is no need for pesticides. Since the plant also contains substances that repel insects, there is no need for herbicides either.

As a building material, hemp is an advantageous raw material with properties that surpass the properties of wood in many aspects. Hemp has high strength, stability, tear resistance and, in particular, totally exclusive moisture and water resistance.

## 2 Thermal insulation mats made from hemp fibre

Insulations made from hemp fibre feature excellent thermal insulating and acoustic properties, fully equalling conventional insulations that are commonly available on the market. On the other hand, they offer unique properties only found in natural materials, which make them completely different from conventional insulation materials and put them at a much higher level.

### 2.1 Ecological footprint

In connection with climate change, the evaluation of building materials will have to take their energy balance into much greater account. The environmental impacts of the production of building materials can be best compared using the amount of greenhouse gases released. Global warming potential (GWP) is the value of the effective equivalent emission of CO<sub>2</sub>, i.e. the amount of CO<sub>2</sub> released in the production of a material.

**Tab. 1** Examples of the energy balance of building materials

Type of material	$\rho$ kg/m <sup>3</sup>	$\lambda$ W/(mK)	GWP kgCO <sub>2</sub> eq/kg
Air bricks	800	0.1-0.2	1.76
EPS 20 polystyrene	20	0.04	3.35
Mineral wool	70-100	0.04	1.70-2.20
Hemp mats	30	0.04	<b>-0.377</b>
Building timber	500-600		<b>-1.40 to -1.5</b>

The negative GWP balance is achieved by CO<sub>2</sub> consumption during the growth of hemp plants; the absorption is greater than emissions from the consumption of energy needed for the manufacture of boards.

### 2.2 Constructional and physical properties

Hemp insulations have properties at least comparable to standard thermal insulating materials in virtually all relevant aspects:

Thermal conductivity, accumulation of heat, specific heat

Naturally, the most important parameter of thermal insulation is the thermal conductivity coefficient. The coefficient value of  $\lambda = 0.04 \text{ W/(mK)}$  matches commonly used thermal insulations made of polystyrene or mineral wool.

However, hemp mats are much better than other types of heat insulation in terms of heat accumulation. Its value of specific heat is  $c=1600 \text{ kg/m}^3$ , almost double the value for mineral wool. Thermal insulations made of hemp mats absorb twice as much heat (and release it when the temperature drops), affecting the thermal comfort in interiors twice as efficiently. They highly improve the use value of buildings, especially in light wood-frame buildings.

Vapour resistance, hydrophobicity, moisture redistribution

Hemp insulation boards have quite exceptional properties in terms of moisture effects. While their vapour resistance factor of  $\mu = 1$  to 2 is identical to that of mineral wool, the internal hydrophobicity and moisture redistribution capacity of the material mean that thermal insulation boards do not lose their thermal insulating capacity even at high moisture content levels over 20% vol.

While other types of thermal insulation require protection against volumetric moisture (moisture content as low as 2% may result in a significant degradation of thermal insulation properties and the growth of fungi), hemp mats provide insulation even when “wet” thanks to their internal hydrophobicity and their ability to redistribute moisture prevents local water logging and protects structural elements against damage by increased moisture content.

Thermal insulation boards made from hemp fibres can be regarded as the best material for the construction of structures open to diffusion.

Acoustic properties also correspond to mineral wool in relation to the bulk density of each board type.

### 2.3 Other useful features

Healthy and comfortable living will play an ever bigger role in builders’ decision-making considering today’s increase in diseases of civilization.

Hemp’s natural resistance to fungi and pests minimizes the risk of allergies. When used in wood-frame buildings or for the insulation of attic areas, thermal insulation mats create an ideal microclimate for healthy living. Especially wall constructions open to diffusion, with their ability to absorb increased humidity and, in particular, naturally humidify air in the opposite situation, naturally control and optimize the environment in terms of living comfort.



**Fig. 1** Insulation mats made from hemp



**Fig. 2** Insulation boards used in a floor

### 3 Canabest

Last year, the manufacture of thermal insulation mats made from hemp fibres was started by Canabest in the Czech Republic.

The manufacture of three types of boards have been successfully commenced and certified so far:

Canabest basic – insulation mats with a bulk density of  $24 \text{ kg/m}^3$ , especially suitable as insulation for attics and ceilings.

Canabest plus – insulation mats with a bulk density of  $36 \text{ kg/m}^3$ , additionally usable as insulation for internal and external walls, noise insulation and part of timber or earthen wall panels – construction open to diffusion.

Canabest basic and Canabest plus mats are manufactured in thicknesses of 40-160 mm as standard, board dimensions 600 x 1200 mm.

Canabest panel – insulation boards with a bulk density of  $100 \text{ kg/m}^3$  are used for floor insulation and facade thermal insulation systems and are manufactured in thicknesses of 20-60 mm.

All Canabest products made from hemp fibres have a thermal conductivity coefficient  $\lambda = 0.04 \text{ W/(mK)}$ , vapour resistance factor  $\mu=1.9$  and the DIN B2 fire rating.

Using a state-of-the-art, fully automated line for the manufacture of thermal insulation mats from hemp fibres, Canabest combines the advantages of a traditional, environmentally friendly, natural material and its full usability in the conditions of a modern building. We can ensure constantly high quality of our products and a flexible manufacturing response to customer wishes. Canabest products are an answer to the current demand for “old” recipes for comfortable living combined with customers’ strict requirements for quality, speed and service in the delivery of building materials.



**Fig. 3** Manufacturing line



**Fig. 4** Dispatch area

### References

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