### Insulation Materials

There is a large range of different insulation materials from natural fibres like wood or hemp, mineral fibres like rockwool and synthetic based materials like polystyrene. These materials have a low thermal conductivity. This is represented by the \( \lambda \) value. A high value indicates that more heat can be transferred to the outside – poor insulating behaviour. Besides the insulating behaviour it is also important to consider the energy that is needed for production and the waste disposal in the end of its lifecycle.

<table>
<thead>
<tr>
<th>Wood fibre (^1)</th>
<th>Rockwool (^2)</th>
<th>Hemp (^3)</th>
<th>Expanded Polystyrene (EPS) (^4)</th>
</tr>
</thead>
<tbody>
<tr>
<td>![Wood fibre image]</td>
<td>![Rockwool image]</td>
<td>![Hemp image]</td>
<td>![Expanded Polystyrene image]</td>
</tr>
</tbody>
</table>

Thermal conductivity \( \lambda \) [W/mK]
- 0.040 – 0.060
- 0.035 – 0.050
- 0.040 – 0.080
- 0.025 – 0.040

### Some Number and Facts

**U Value:** A U value is a measure of heat loss in a building element such as a wall, a floor or a roof. It measures how much heat is transferred through parts of a building. In general it can be said that the smaller the U value, the better the thermal performance of the building envelope. \(^5\)

**A Value:** The \( \lambda \) value represents the thermal conductivity. High values show that more heat can be transferred. The smaller the thermal conductivity the better the insulation behaviour. Besides the \( \lambda \) value the **specific heat capacity** is also an important indicator. It presents the amount of heat that has to be brought through 1 kg material in order to raise its temperature by 1°C.

### Golden Rules of Insulation

**Insulation Material:** Usage of suitable insulation materials are important to prevent the conduction of heat. \(^6\)

**Thermal Bridges:** Reduce thermal bridges - places where more energy escapes. Sensible locations are building edges and building seams. If the surface temperature lowers, water condensates and mildew formation may proceed.

**Air-Tightness:** Good air tightness is indispensable for an efficient insulation system.

**Controlled Ventilation:** The purpose of ventilation is to evacuate humidity, steam and pollution linked to the occupation of buildings this to guarantee hygienic premises and healthy occupiers. Losses linked to air renewal can represent between 15 and 20 % of a home’s total energy losses.

**Quality Fitting:** Good fitting of insulation systems (including insulation material, accessories, breather membranes, joints) is essential to guarantee perfect draught proofing. Apart from the insulation performance of a material the overall sustainability, including the production and recycling, has to be considered.

### Crop Residues as Insulation

Besides well known insulation materials, crop residues can be used for insulation purposes. At present, part of these leftover products is used as food and bedding for animals or as fuel, but nevertheless some resources go to waste without the creation of any additional value.

In order to find applications for these materials in the panel production, a team from the Material and Wood Technology Institute and the School of Agriculture, Forest and Food Sciences of Bern University of Applied Sciences developed methods and processes for treating and bonding such raw materials, as well as for manufacturing panels for a number of uses, like producing insulation boards. \(^7\)

### Insulation Examples

To show the insulation effect, two different walls systems are presented, a solid brick wall (B) and a solid timber wall (T). In order to compare the insulating performance, the energy loss per m² are determined (U-value).

<table>
<thead>
<tr>
<th>wall</th>
<th>B1</th>
<th>B2</th>
<th>T1</th>
<th>T2</th>
</tr>
</thead>
<tbody>
<tr>
<td>U-value</td>
<td>2.08</td>
<td>0.24</td>
<td>0.65</td>
<td>0.19</td>
</tr>
<tr>
<td>Heating power [W]</td>
<td>2800 Factor 9 Reduced energy consumption</td>
<td>320</td>
<td>880 Factor 3.5 Reduced energy consumption</td>
<td></td>
</tr>
</tbody>
</table>

To keep a room (4 x 5 x 2.5 m) at an interior temperature (exterior temperature -10°C) of 20°C for 12 hours a certain heating power (see values above) is needed. The difference between the energy consumption of an insulated and an uninsulated room are displayed on the right side.

Insulated wall ≈ 0.8 kg wood

uninsulated wall ≈ 7.0 kg wood

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Sources:
5. Kaiser Patrik, Bern University of Applied Sciences