Why use inferior insulation materials when there are better alternatives?

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Summary

This text highlights the many advantages of using bio-based insulation materials over conventional options like mineral wool and fiberglass. Here's a synthesis of the key points:

1. **Environmental Benefits:** Bio-based insulation materials are eco-friendly, acting as carbon sinks because they absorb more greenhouse gases during their growth than are emitted during production. This results in a lower ecological footprint compared to conventional insulation materials.
2. **Hygroscopic Properties:** These materials can absorb and release moisture from the surrounding air and materials, which helps regulate humidity and improves the indoor climate. This makes them suitable for vapor-permeable building constructions.
3. **Local Production and Renewability:** Many bio-based insulations are locally produced, reducing transportation emissions. They are also renewable and compostable, contributing to sustainability.
4. **Ease of Handling:** Bio-based insulations are more user-friendly during installation as they do not cause skin irritation like traditional insulation materials such as mineral wool and fiberglass.
5. **Types of Bio-based Insulations:**
    - Wood Fiber Insulation: Made from sawmill by-products, available in boards and loose-fill, with good soundproofing properties.
    - Cellulose Insulation: Manufactured from recycled paper or virgin pulp, affordable and widely available in Sweden.
    - Hemp and Flax: Both have natural pest- and mold-resistant properties. Hemp is fast-growing and absorbs a lot of carbon dioxide, while flax has a long history as insulation material in Sweden.
    - Straw and Wool: Straw is a low-cost, environmentally friendly material, while wool has excellent insulating properties but requires treatment to prevent pest damage.
6. **Technical Specifications:** The text explains that insulation materials are evaluated based on their thermal conductivity (lambda value), specific heat capacity, and density. A lower lambda value indicates better insulation performance.

Conclusion: Bio-based insulation materials offer multiple benefits, including lower environmental impact, practical advantages, and technical performance. They are a suitable choice for both heritage buildings and new constructions, helping manage moisture and create a healthier indoor environment while being sustainable.

Full article

There are many advantages to using bio-based insulation materials. In Sweden, the availability of alternative insulation materials has grown significantly over the past decades, and we see an industry that continues to surge forward. However, a large part of the conventional construction industry still needs to make this transition. A good role model can be found to the east, in Finland, where bio-based insulation materials are so established that they hold a significant share of the market.

Bio-based insulation materials have so many beneficial properties that they are an obvious choice over more conventional materials like mineral/stone wool and fiberglass. Not least, the manufacturing process of mineral and fiberglass insulation is so energy-intensive that they should be dismissed outright.

In general, bio-based insulation materials act as carbon sinks because they capture more greenhouse gases during the growth phase than are released during production. As a result, they have a low ecological footprint and generally have a significantly lower climate impact in production compared to other conventional insulation materials.

They are also hygroscopic, meaning they can absorb and buffer moisture from the surrounding air and materials and then gradually dry out again. This hygroscopic property allows them to be used in vapor-permeable constructions. Bio-based insulations have a high energy-buffering capacity, which means they help stabilize indoor climate over the day by storing heat during the day and releasing it at night. The insulation is typically locally produced, reducing the need for long-distance transport. It is also renewable and compostable. Finally, a practical aspect is that they are much more pleasant to handle during installation since they do not cause itching compared to other conventional insulations.

Facts: The best property of an insulation material is its poor thermal conductivity. This thermal conductivity is measured by the lambda value (λ-value). The worse the thermal conductivity, the better the insulation ability (W/mK). The lower the number, the better! Dry insulation retains heat better than wet insulation, so make sure it stays as dry as possible. Insulation with a high density, i.e., heavy insulation, has better sound-dampening properties.

Facts: To compare the technical properties of different insulation materials, we look at thermal conductivity λ [W/(m K)], thermal storage capacity *k* [10-6 m2 /s], specific heat capacity (the amount of heat required to raise the temperature of one kilogram of material by one degree) *c* [J/(kg K)], and density *ρ* [kg/m3]. It's also interesting to consider the type of fire classification and which fire retardants have been added to the insulation. Common fire retardants include ammonium polyphosphate, sodium hydroxide (soda), borate, and boric acid. Borate is listed on the European Commission's priority list of materials to avoid. Ammonium polyphosphate is a fertilizer, and sodium hydroxide is soda. Board-form insulation usually contains fibers to stiffen them. These could be BIKO fibers, which are synthetic polymer fibers, or polyester fibers.

Some of the earliest insulation materials include sawdust and wood shavings. These have been used as insulation since the start of the industrial era in the 19th century when sawmills produced a large supply of shavings. Since it is a by-product, it is a cheap material. It is important to ensure the shavings are thoroughly dry to avoid trapping moisture from the beginning. One disadvantage is that shavings easily settle, resulting in lower insulation value compared to other wood fiber products. Sawdust particles are shorter than wood shavings, which means they settle even more and therefore insulate slightly worse. Sometimes 5% lime is added to reduce the risk of pests. From a climate perspective, wood shavings are good because they are a by-product, sequester carbon dioxide, and do not require extra energy to produce. They can also be classified as locally produced and are among the cheapest options. The lambda value is approximately 0.06-0.08 W/mK.

Wood fiber insulation is made from pine and spruce and is a by-product from sawmills. The insulation is available as porous boards in various thicknesses and as loose-fill insulation. In board form, it is very user-friendly and easy to handle, making it convenient for smaller areas to be insulated. It is also relatively easy to find as many retailers offer it. It has good sound-dampening properties due to its weight, about 50 kg/m3. The boards are dimensionally stable and do not settle. The lambda value is around 0.038 W/mK. The insulation is fireproofed, usually with ammonium polyphosphate or ammonium phosphate, and sometimes with borate.

Cellulose insulation is sold as both loose-fill and boards. It can be made from new paper pulp or recycled paper. Boards are easy to handle, but for larger jobs, loose-fill insulation is more economical. Loose-fill is blown in with a pump, and the setup cost for the pump should be factored in but is usually a minor expense. As with all insulation work, it's important to ensure there are no air pockets around window frames and similar areas. Loose-fill has the advantage of being able to fill small cavities. Boards must be cut with high precision to avoid gaps between them to achieve equally good results. Boards are made with a small amount of

plastic to make them dimensionally stable, which may include BIKO fiber. Both loose-fill and boards are fireproofed. A common fire retardant is ammonium polyphosphate, which releases water upon heating, smothering the fire. Aluminum hydroxide and borate are also used as fire retardants. Cellulose insulation made from recycled paper pulp is naturally more climate-friendly since it repurposes an already manufactured product instead of using virgin paper pulp. Cellulose insulation is affordable, relatively easy to find, and manufactured in Sweden. The lambda value is around 0.036-0.039 W/mK.

Hemp is a fiber that was once widely cultivated and used in Sweden. The long and very strong fibers were used in textiles and ropes. Between 1970 and 2000, industrial hemp cultivation was banned in Sweden, but it is becoming more common again. As an insulation material, hemp is relatively new. It thrives in Sweden, but unfortunately, there are few hemp growers, limiting the availability of Swedish hemp. However, hemp is cultivated elsewhere in Europe. It is available as both loose-fill and boards. Its lambda value is similar to other bio-based insulations. In board form, it is fireproofed with soda, and the boards are made with BIKO fibers to help maintain their shape. Hemp can also be used as loose-fill insulation, but as far as I know, there is currently no technology to blow it in, so it must be installed manually. A benefit of hemp is that pests avoid it, and it has natural anti-fungal and anti-bacterial properties. Hemp is grown without pesticides, and no chemicals are used in the processing. Hemp is a fast-growing plant and sequesters so much carbon dioxide that even after industrial processing, it remains a significant carbon sink. The lambda value is approximately 0.04 W/m.

Straw is a by-product of agriculture and a suitable fiber for insulation due to its ability to trap air in the straw. Straw bales don't have a long tradition as insulation in Sweden, but they have been used for wall insulation in the U.S. for much longer. The advantages of straw are that it is cheap and the construction process is relatively quick because it is packed into bales. In Sweden, it is most common to use traditional small bales, but in France and the Baltics, the construction process has become more industrialized, using large prefabricated straw bale elements that are lifted into place with a crane. Although straw has a relatively high lambda value, insulation is still sufficient when building with bales because the wall is thicker than in other wooden houses. The bales are typically plastered with clay—one layer on the inside and one on the outside—to keep mice out and to trap still air inside the wall. Straw is an environmentally friendly option depending on how far it needs to be transported and how it was grown. It is important that the straw is dry when built into the wall. Straw is very difficult to ignite. The lambda value is approximately 0.07-0.085 W/mK.

Linen as insulation has long been used in Sweden, especially as caulking between timber logs and around window and door frames. For several years now, linen insulation boards have been manufactured in Finland. They have good insulation

properties and sound-dampening capabilities. Moreover, handling linen insulation avoids hazardous dust and irritation. Many allergy sufferers find linen insulation comfortable to work with. The fibers are formed into mats and stiffened with a small amount of polyester fibers. A small amount of relatively harmless soda is added to achieve fireproof classification, even though linen is naturally difficult to ignite. Linen is naturally resistant to pests, rot, and mold. Sweden has a climate well-suited for linen cultivation, as do Finland and Germany, from where we import it. The lambda value is approximately 0.038 W/mK.

Sheep wool is an odd inclusion in this context of plant-based insulations, but wool shares similar properties. Wool is also a by-product that we should definitely make better use of. Production exists in countries like Austria and the UK, and attempts have been made in Sweden. Wool insulation has excellent insulating properties compared to the other materials discussed in this article. The problem with wool is that it is easily attacked by moths, so it must be washed and treated before being built into a wall. The Austrian producer Isolena has developed a method to avoid chemical biocides, claiming instead to alter the molecular protein structure using a plasma ion treatment process. Wool has natural water-repellent properties and is very difficult to ignite. Currently, wool insulation has to travel further than domestically produced wood-based insulations. Wool insulation is still relatively expensive. The lambda value is approximately 0.035-0.038 W/mK.

In conclusion, there are several relatively equivalent insulation materials to choose from, so the location and the house's conditions should influence the choice. However, bio-based insulations have so many advantages that there’s no reason not to choose one! Climate impact, sustainability, and the material properties all favor bio-based insulations. Whether for old wooden houses or new construction—where the only sensible option is to build wooden houses—it makes sense to use materials with hygroscopic properties that can absorb, distribute, and vent moisture, just like the wooden house itself.

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