A low-energy Building under Arctic Conditions

Experiences After Five years of Operation

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A low-energy Building under Arctic Conditions

Experiences After Five years of Operation

Agenda

• Introduction
• Construction of the house
• Results
• Problems
• Conclusions
Low Energy House Sisimiut

– Built in 2005 in Sisimiut, Greenland  
  (42km north of polar circle)

– Semi detached house  
  (197 m² total floor area)

– Objectives
  • Low energy consumption  
    $80 \text{ kWh/(m}^2\cdot\text{yr)}$
  • Good IAQ
  • Advanced technologies
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- Well insulated envelope
- Air tight
  - $n_{50}=1$
- Minimal thermal bridges
- Three types of windows
  - 1+2 pane
  - 2+1 pane
  - 2+vacuum
- Hydronic floor heating
- Oil furnace
- Solar collectors for DHW
  - 8m²
  - 57%
- Ventilation with heat recovery
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**Double wall construction**

![Diagram of double wall construction](image)

<table>
<thead>
<tr>
<th>Construction</th>
<th>Insulation thickness [mm]</th>
<th>U-value [W/(m²·K)]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Walls</td>
<td>300</td>
<td>0.15</td>
</tr>
<tr>
<td>Ceiling</td>
<td>350</td>
<td>0.13</td>
</tr>
<tr>
<td>Floor</td>
<td>350</td>
<td>0.14</td>
</tr>
<tr>
<td>Windows</td>
<td></td>
<td>1.0 – 1.1</td>
</tr>
</tbody>
</table>
Unique heat exchanger developed at DTU
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Total heating demand per year

- Year 1
- Year 2
- Year 3
- Year 4

■ Floor heating  ■ Ventilation afterheating
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Total heating demand per year

Year 1  Year 2  Year 3  Year 4

Floor heating  Ventilation afterheating
Experienced problems and solutions

- Higher indoor temperature
  - 23°C instead of 21°C
- Heated entrance
- Air tightness
  - $n_{50} = 1$
  - $n_{50}$ in 2009 = 3.29
  - $n_{50}$ in 2010 = 2.96
  - $n_{50}$ in 2011 = 2.74
  - Explored leakages sealed
- Water leakages around the windows
  - New cladding of the facade, Summer 2010
Experienced problems and solutions

- Excess of the solar heat in the summer
  - Additional heater (cooler) put to the entrance (crawl space)
- Thermosyphoning
  - Electromagnetic valve installed in December 2009
- Incorrect setting of the heating coil in the ventilation system
  - Set point of 20°C from December 2010
- High heat loss from ventilation ducts
  - Additional 120 mm of thermal insulation added in Fall 2009
- Malfunction of the switching damper inside HE
  - Mended in December 2009
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Experiences After Five years of Operation

Total heating demand per year

Energy [kWh]

0 5,000 10,000 15,000 20,000 25,000 30,000 35,000

Year 1 Year 2 Year 3 Year 4 Year 5

Energy [kWh/m²]

0 25 50 75 100 125 150 175

Floor heating

Ventilation afterheating
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Energy per HDD

<table>
<thead>
<tr>
<th>Year</th>
<th>kWh/kWh</th>
</tr>
</thead>
<tbody>
<tr>
<td>TRY</td>
<td></td>
</tr>
<tr>
<td>Year 1</td>
<td></td>
</tr>
<tr>
<td>Year 2</td>
<td></td>
</tr>
<tr>
<td>Year 3</td>
<td></td>
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<tr>
<td>Year 4</td>
<td></td>
</tr>
<tr>
<td>Year 5</td>
<td></td>
</tr>
</tbody>
</table>

20%
Conclusions

• It is possible to build energy efficient buildings in the arctic regions

• Problems uncommon in milder climates might appear

• Technologies used must be simple and easy to repair in case of malfunction
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Thank you for your attention!
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Unique heat exchanger from DTU

- tH, out [°C]
- tH, in [°C]
- tC, out [°C]
- tC, in [°C]
- efficiency [%]