Thermal comfort in buildings with PV-powered thermoelectric surfaces for radiative cooling
Outline

- Introduction
- Thecla
  concept and hardware
- Case study
  layout and results process
- Results
- Conclusion and outlook
Introduction

• Partial electricity consumption for space cooling in buildings
  • In sub-tropical climates: 60 to 72 %
  • Climate change → Rising steadily ↑

• Standard air-conditioning
  • One single temperature per room
  • Dehumidification
    → Possible uncomfortable indoor conditions
    → Alternative: longwave radiation exchange
Thecla

- THermoElectric CoolIng partition with Active heat storage
user

aluminum sheet

coating $\varepsilon > 0.9$

Peltier element

heat conductor

heat transfer to PCM
Case study

• **Setup**
  
  • Single workplace in office
  
  • 27 – 29 °C ambient temperature
  
  • Thecla approx. 30 – 40 cm from seated subject

• **Structure**
  
  • 80 min total, including acclimatization
  
  • Cooling power set to 0 %, 50 %, 100 %, 0 % for 20 min each
<table>
<thead>
<tr>
<th>period</th>
<th>1</th>
<th>2</th>
<th>3</th>
<th>4</th>
</tr>
</thead>
<tbody>
<tr>
<td>duration</td>
<td>20 min</td>
<td>20 min</td>
<td>20 min</td>
<td>20 min</td>
</tr>
<tr>
<td>cooling power</td>
<td>0 %</td>
<td>50 %</td>
<td>100 %</td>
<td>0 %</td>
</tr>
</tbody>
</table>
Case study
Case study

• **Data recorded**
  
  • Ambient conditions: air temperature, air velocity, rel. humidity, globe temperature, Thecla surface temperature
  
  • Subjects’ voting every 5 min: overall thermal sensation and thermal comfort + local thermal sensation for body parts on 7 / 6 point ASHRAE scale

• Preliminary study: 7 participants
Case study
Results

• **Results summary**
  • Average Thecla surface temperature: 25 / 23 °C at 50 / 100 % cooling power

• **Cooling effects**
  • Overall thermal sensation: - 0.40
  • Overall thermal comfort: + 0.15 to + 0.55
  • Left arm thermal sensation: ± 0.00
  • Right arm thermal sensation: - 0.25 to - 0.66
Conclusion and outlook

• Conclusion
  • Successful conceptual proof
  • Demonstration of cooling effect when using Thecla

• Outlook
  • Extended human subject study
  • Implementation of PCM heat storage
  • Connection to building HVAC systems
  • Determination of influence on building energy efficiency
Thank you for your attention!

Next step...