Experimental Characterization of an Active Thermal Wall based on Thermoelectricity (ATW).

Caracterización Experimental de un Paramento Transparente Activo Termoeléctrico (PTA)

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Active Thermal Wall based on Thermoelectricity (ATW)

• Active Thermal Wall
  – Is a heat pump system that uses Peltier effect
  – TE elements are embedded into the panel
  – If the panel is transparent (glass/Plexiglas) it can replace windows

*US and European Patent
Background

• Thermoelectric material are semiconductors that transfer heat if supplied with DC current.

• Advantages over other conditioning technologies:
  – Simple electronic control
  – Absence of fluids, pipes and pumps (just requires electricity)
  – Small size (cooling system embedded in windows/walls)
Prototype

- Small prototype: 105x120mm
- 4 TE chain comprising 16 pellets each
- Chain 10mm, spaced once every 30mm
Numerical Results

• Analytic solution
  – Based on mathematical equations
  – Problem solved using Matlab

• Numerical simulation
  – Based Finite Element models
  – Solved using Ansys
Numerical Results

- Cooling power as a function con electrical current
- Performance of one single pellet at Tc=20ºC and Th=40ºC
- Maximum power for the whole prototype is 0.09x16x4=5.76W
Numerical Results

• The main problem is how to transfer heat from a flat surface to the air
• Thermoelectric power is higher than the natural convection heat transfer
• Conventional glass conductivity is very low
Experimental Results

• A prototype was built and tested at our laboratory
  – Several sensors were installed
  – An IR camera was used
Experimental Results

- External surface of the cold side
- Experimental conditions: $T_h = 25^\circ C$, $I = 4.5A$
- Main results: Temperature on the glass ranging from $9.4^\circ C$ to $17^\circ C$

Temperature map as obtained with the IR camera.
Conclusion

• A small prototype of ATW has been built.
• Numerical tools have been developed to estimate the behavior of larger elements.
• Experimental tests show that the prototype is working properly (\(\Delta T_{\text{max}} = 15^\circ\text{C at 4.5 A}\)).

• Promising technology mainly where installation of conventional equipment is problematic
  – Historic buildings
  – Technical difficulties
  – Esthetic or size restrictions