Thermal Comfort

Patxi Hernandez
TECNALIA, patxi.hernande@tecnalia.com

Abstract

Thermal comfort for an indoor environment can be defined as the satisfaction with the hydro thermal condition. Current practice on thermal comfort evaluation mostly relies on the analysis of the thermal balance of a human body, and therefore is related to environmental parameters such as temperature, humidity or air velocity, but also to physical activity and transpiration, or indeed clothing. Typical indicators are directly based on these parameters, or indirectly using them to mathematically calculate people satisfaction (eg. PPD , PMV). However, there is currently an international discussion regarding how the heat balance theory can be strictly applied to the evaluation of thermal comfort. The adaptive comfort theory suggests that humans consciously or unconsciously modify constantly our behaviour to adapt to hygro-thermal conditions, therefore not responding to a static heat balance theory. Recent studies using detailed Human Thermal Models (HTM), also suggest that heat balance methods are too static and do not account for the full thermoregulatory responses of a human body. There are also researchers that argue that there are cultural and symbolic thermal sensibilities, which cannot be homogenised by standard levels and equations.

Besides discussion of comfort assessment and beyond its analysis as a social subject of concern that impacts quality of life, we have to consider that is also related to economic and environmental dimensions. It can be related to the “costs” as subject of concern, as maintaining tight levels of thermal comfort (according to “traditional” vision of thermal comfort) would generally require an increased control and management of the space, with higher costs on equipment and/or energy costs. On the other hand, occupants who feel comfortable could increase the productivity, thus high levels of thermal comfort representing an economic benefit. Regarding the environment as subject of concern, comfort requirements in buildings generally have a direct relationship with the energy use and associated environmental impacts.

Taking into account that the evaluation of thermal comfort as indicator of satisfaction is still under discussion, and that there is little guidance on its interaction with economic and environmental issues, a first approach towards “sustainable thermal comfort” is to recommend flexibility in comfort bands, and to give special attention to inhabitant interaction and local factors. Detailed comfort methods such as adaptive comfort or HTM, which can allow a clearer representation of human adaptation, are generally more appropriate for use in the context of sustainable buildings when detailed analysis is needed.

SuPerBuildings

PRESENTATION TITLE

Patxi Hernandez

TECNALIA

Thermal Comfort

Indicator name / short description

- Hygro-thermal comfort in indoor environments

Indication of satisfaction with the indoor environment

Sub-indicators / short description *(if any)*

- Operative temperature / Air Temperature
- PMV (Predicted Mean Vote)
- PPD (Percentage of People Dissatisfied)
- Relative Humidity
- Air Velocity

Introduction

The thermal sensation is related to the thermal balance of the human body, and is influenced by physical activity and clothing, as well as the surrounding environmental conditions.

Prediction of thermal sensation is commonly calculated from function of activity (metabolic rate), clothing insulation, and four main environmental parameters:

- air temperature,
- mean radiant temperature,
- air velocity and
- air humidity.

Thermal Comfort

Validity

- SOCIAL
  - Satisfaction with the environment.
  - Health related issues (exposure to high or low temperatures)
    - Heat/cold waves ; Fuel poverty
- ENVIRONMENTAL
  - Impacts and resource use related to maintaining comfort
    - Installation & Equipment ; Operation & Maintenance
- ECONOMIC
  - Cost of maintaining comfort
    - Installation & Equipment ; Operation & Maintenance
  - Productivity

Thermal Comfort

Assessment method (design phase)

- Qualitative Criteria
- Basic indicators (temperature, humidity, air velocity)
- Fanger PMV & PPD method (ISO 7730)
- Adaptive comfort (ISO 15251, ASHRAE 55:2010)
- Human Thermal Models (HTM)

Applicability

- Design Calculations (early stage or detailed)
- Building / Room simulation
- Dynamic building performance simulation
- CFD

Discussion / conclusions

- Thermal comfort assessment in current practice is generally oversimplified.
- Resulting comfort guidelines are not applicable from a sustainable building perspective.
- 'Comfort Categories' as currently defined are not appropriate to be used on the context of sustainable buildings.
- A **"sustainable thermal comfort"** approach would recommend flexibility in comfort bands, and would give special attention to inhabitant interaction and local factors.
- Interaction of comfort values with other subjects of concern (economic, environmental), should be included in the analysis.
- Detailed comfort methods such as adaptive comfort or HTM allow a clearer representation of human adaptation, and are more appropriate for use in the context of sustainable buildings.

Thermal Comfort

Comparability

Most thermal comfort assessment methods are very simplified.

- Rely on reduced set of indicators or qualitative assessments
- Attempted classification on "comfort categories"
- Local conditions and inhabitant interaction are not considered

More complex methods (eg. adaptive comfort, HTM) allow for a more flexible approach to thermal comfort.

Comparability of assessment results would require further study on conflicting issues between social, environmental , and economic implications of comfort.

SuPerBuildings

Thank you for attention

patxi.hernandez@tecnalia.com