Low Energy Cooling, Ventilation and Heat Recovery Systems

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1. The opportunity
2. Introduction of Cool Phase
3. Application of phase change materials (PCM)
4. Development of a steady state model
5. Dynamic modelling
6. Verification and case study
1. The opportunity

1) Cost

2) Environment

3) Practical
Reduce energy bills by up to 90%
2. Introduction to Cool Phase

» Low service & maintenance cost
» Meets Building Regs. & BREAM
» Improves indoor air quality
» No requirement for external units
» Modular, scalable & adaptable
» Uses no toxic coolants, e.g. R22

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3. Application of PCMs

PARAFFIN:

**Advantages:**
- Stable
- Encapsulation
- Super cooling

**Disadvantages:**
- Expensive
- Flammable
- Thermal conductivity

SALT HYDRATES:

**Advantages:**
- Cost
- Energy density
- Sustainable

**Disadvantages:**
- Corrosive (plastic & metals)
- Thermal conductivity
- Segregation
3. Application of PCMs

- Easy to retrofit, intelligent thermal mass
- 1kg of Phase Change Material (PCM) ~ 200kg of Concrete
- Actively dissipates heat built up during the day
4. Development of a steady state model

1. Creation of a Design Tool
   - Model of basic heat exchangers
   - Simple environmental model
   - Simple phase change temperature
4. Development of a steady state model

1. Creation of a Design Tool
   - Model of basic heat exchangers
   - Simple environmental model
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2. Creation of a Specification Tool
   - Incorporation into Navensys
   - Improved PCM model
   - Improved HE model
   - Comparison to CFD
4. Development of a steady state model

![Temperature vs Time Graph]

- **Temperature (°C)** vs **Time (hr:min)**

- **Red Line**: Air in (model & measured)
- **Blue Dotted Line**: Air out (model)
- **Blue Dash Line**: PCM (previous model)
- **Blue Solid Line**: PCM (measured)
4. Development of a steady state model

Thermal Battery Cooling Power (W)

Flow Rate (m³/h)

- Current HE (Old Model)
- Current HE (Improved Model)
- Enhanced HE (Improved Model)
4. Development of a steady state model

Thermal Battery Pressure Loss (Pa) vs Flow Rate (m$^3$/h)

- **Current HE (Measured)**
- **Current HE (CFD)**
- **Current HE (Theory)**
- **Enhanced HE (Theory)**
4. Development of a steady state model

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5. Dynamic modelling

- Detailed modelling using analytical and numerical techniques
- Based on proven results and testing in the lab and on site

Allows creation of ‘macro performance parameters’
5. Dynamic modelling

Therefore you can model the system more easily…

… and complex models are not needed every time a room simulation is run
5. Dynamic modelling

Macro performance parameters:

• Relationships of system performance to variables, e.g. external temperature, CO2…

• These variables can be used to control the performance of the system

• Simple physical and engineering relationships allow any system to be simulated

• System performance abstracted and reduced to ‘formula profiles’ in IES or control functions in TAS
5. Dynamic modelling

For example:

- On a very basic level we can use ‘building heat gain’ to charge and provide cooling
- Complexity can be added through the effects of internal temp, CO2, fan speed…
- By combining simple rules an accurate model and control strategy can be built up for a complex system.

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<th>Cum. Cooling</th>
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<td>279.3</td>
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6. Verification and case study

Verification

- Data logging
- Lab tests
- Comparison to other systems
6. Workspace case study

Workspace PLC:

- ~ 125 properties within M25
- ~ 700,000 m² rentable floor space
- Serviced offices and light industrial units
- ‘Secondary’ locations
- £70m turnover (2009)
6. Workspace case study

Number of working hours where the temperature exceed 25°C, 26°C and 28°C for the room with Cool Phase and an identical control room.

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</table>
The peak summer temperatures were reduced by an average of 5°C.

Energy usage was reduced by 86% over 6 months.

Air quality was noticeably improved.
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