Ancient Construction Techniques

Thermal Mass

Ancient building techniques incorporated thermal mass.

Yet today’s building techniques rarely make use of thermal mass...
Our Buildings Today are Like A Drink Cooler... WITHOUT THE ICE!

The Drink Cooler

- Air tightness stops heat from entering/leaving
- Insulation slows transfer of heat through the cooler
- Wait long enough and drinks will be the same as ambient temperature – ie. 80F on a hot day

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What makes the Drink Cooler Perform So Well?

Phase Change Material
(aka – ICE)
Infinite-R™ Phase Change Material

A Thermal Energy Storage technology that works like ice inside a cooler.

- **Absorbs** Heat when Melting
- **Releases** Heat when Freezing

Phase Change Material (aka – ICE)
Infinite-R™ Phase Change Material

**STORE** Energy

Using FREE Ventilation or Efficient Cooling in the morning  

**SAVE** when it's most expensive in the afternoon

![Graph showing energy savings with Infinite-R™ technology]
Infinite-R™ Phase Change Material

PCM Mats

- 16” wide x 48” long
- 24” wide x 48” long
- Class A Fire Rated
- Salt Hydrate
- 25 Year Longevity Warranty
- Standard Melt/Freeze Temps

| 66°F | 71°F | 73°F | 78°F | 84°F |
Commercial Bldgs: Core Applications
Application: **ROOFING**

Public Housing Building (High Rise) - Tarrytown, NY

**Densdeck Covered with New PVC Membrane**

**INSOLCORP PCM Mats**

**Separator Mat**

**Old Roof**

*One Way Vortex Valves*

These “One Way Vortex Valves” only allow air OUT of the roof. When installed at the perimeter of the roof, it takes advantage of the suction effect from wind uplift and effectively vacuum sucks the roof membrane down to the building in high winds! NO MORE SCREWS, NO MORE GLUES!!

[Image showing workers on a rooftop with materials being installed]

[Image of a one-way vortex valve]

[Website: www.insolcorp.com]
Application: **ROOFING – Wind Vent System**

**Wind Vent System Components**

5. Loose Laid Waterproofing Membrane 
   - Elvaloy KEE, PVC, TPO, EPDM, Modified Bitumen
4. Loose Laid Cover Board 
   - Gypsum, Densdeck, Securock, Concrete Board
3. One Way Vortex Valves 
   - Strategically place valves in the wind vortex position as wind tunnel tested
2. Loose Laid Insulation 
   - Infinite R & Polyisocyanurate, EPS
1. Air Barrier Deck 
   - Added Barrier, Steel, LWIC, Structural Concrete, Wood

**One Way Vortex Valves**

- One way rugged spun aluminum 
- 11” height, 5” diameter
- No moving parts
- Transfer uplift pressure (suction) from above the roof membrane to the underside of the membrane and to the structural air barrier substrate
- Strategically place valves in the wind vortex position as wind tunnel tested
Building Envelopes are designed to reduce Heat Flux (the flow of heat thru the building the wall or roof)

Heat Flux can be calculate by this simple Equation:

$$Heat\ flux = \frac{\Delta Temperature}{R value}$$

**Insulation** is used to reduce the Heat Flux thru the Building Envelope by making the **R-value bigger**

**PCM Mat** is used to reduce the Heat Flux thru the Building Envelope by making the **$\Delta Temperature$ smaller**.
Take for example a Conventional Flat Roof:

- Roof surface temperature = 135°F,
- Interior Temperature is 75°F
- Insulation R-Value = 10

\[
Heat flux = \frac{135°F - 75°F}{R\text{value} = 10} = 6 \text{ BTU's per Hour per ft}^2
\]
If We install a layer of 78° InfiniteR™ the Heat flux becomes:

\[ \text{Heat flux} = \frac{78^\circ F - 75^\circ F}{Rvalue = 10} = 0.3 \text{ BTU's per Hour per ft}^2 \]
We would have to add R-190 of insulation to the Roof to = an INSOLCORP PCM Roof

\[
\text{Heatflux} = \frac{135^\circ \text{F} - 75^\circ \text{F}}{\text{Rvalue} = 200} = 0.3 \text{ BTU's per Hour per ft}^2
\]

How Does this Effect the Building?

Under these conditions, adding INSOLCORP PCM Mat to a 25,000 ft² roof would reduce load by 132,500 BTU's per Hour

This is equivalent to saving 11 TONS of HVAC running at FULL Capacity
Metal Roofs

- Developed by The Department of Energy ORNL
- 80% Nighttime heat loss reduction
- 30% reduction in Heating Load
- 50% reduction in Cooling Load
- Heat Flux reductions up to 95%
- Can be installed over existing roof without tear off minimizing landfill debris

INSOLCORP PCM Mat between hat channel above sheathing

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Low Slope Roofs

Fastened Roofs

- Uses narrow 4” to 6” insulation strips between each mat of PCM to act as fastener location & guides.
- Infinite-R™ laid loose between strips
- Mech fastened roofs with 16” to 24” spacing between screws, and approx 3ft2 per screw or less.

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Roofing Case Study: City of Baltimore

Client: City of Baltimore – HEBCAC
Project: Wind Vent Roof w/PCM
Amount of PCM: 6,000 Ft²
Project Features: Used PCM within roof system to achieve energy savings coupled with lower cost roof replacement

![Graphs showing average daily therms and kWh before and after PCM roof installation.]

![Image of City of Baltimore building with cars parked in front.]

![Insolcorp logo.]
Roofing Case Study

Public Housing Building (High Rise) - Tarrytown, NY

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Roofing Case Study
Public Housing Building (High Rise) - Tarrytown, NY

Heat Loss BTU's ft²/Hour

CTRL Heatflux
InfiniteR™ Heatflux

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Roofing Case Study

Public Housing Building (High Rise) - Tarrytown, NY

Tarrytown Roof Heatflux
PCM vs. w/o PCM


CTRL Heatflux Infiniti™ Heatflux

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Roofing Case Study

Public Housing Building (High Rise) - Tarrytown, NY

Heat Flux
Tarrytown NY - Week of July 15th 2017

Ctrl  PCM Heatflux
Infinite-R™ laid loose on top of ceiling tiles, usually laid 48” long across two tiles to use grid/T’s for distribution of weight.

• Class A Plenum Fire Rated
• Plenum return systems provide the ability for PCM to introduce storage/thermal mass into the actual HVAC air system.
• Ideal for peak load shifting. Cool PCM at night, reduce or eliminate A/C in day.
Commercial Retro Fit - Educational Case Study

Middle School - Newton, New Hampshire

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Commercial Retro Fit - Educational Case Study
New Hampshire Middle School

Winter - Feb 2017

FEBRUARY 2017 - 60% Reduction in Heating Runtime (Minutes)
Commercial Retro Fit - Educational Case Study
New Hampshire Middle School

Summer - July 2017

Vacant Classrooms - Identical Testing
JULY 2017 - 58% Reduction in Cooling Runtime (Minutes)
Commercial Retro Fit – Retail Case Study

Retail Location - Phoenix, AZ

PLACEMENT OF INFINITE-R™:
QUANTITY OF INFINITE-R™:
INFINITE-R™ PCM MELT TEMPERATURE:
LABOR HOURS TO INSTALL:
EXISTING HVAC SYSTEM:

PRE-INSTALL MONITORING:
POST-INSTALL MONITORING TO DATE:

OVER SUSPENDED CEILING TILES
1,200sf
78°F
APPROX 2 MEN X 6 HRS
(x1) OLD AHU - 3 TONS
(x1) NEW AHU - 3 TONS
JULY 24 - AUG 17 2016
AUG 18 - SEPT 1 2016

Measurement & Verification Equipment Installed to monitor POWER & TEMPERATURE before & after install.

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Commercial Retro Fit – Retail Case Study

Retail Location - Phoenix, AZ

Installing Infinite-R™ with NO OTHER CHANGES to building.

Installing Infinite-R™ AND then Optimizing for controls setbacks & off-peak energy storage.
Commercial Retro Fit – Retail Case Study

Retail Location - Phoenix, AZ

Total AC Cooling Energy [kWh]

Temperatures Before vs After (Above Ceil Tile - F°)
Commercial Retro Fit - Retail Case Study

Retail Location - Phoenix, AZ

What's the Impact on JUST PEAK DEMAND?

Result - Estimated 36% Reduction
APPLICATION: ABOVE CEILING TILES
Savings Performance - CALIFORNIA Climate Zones 6 & 7

TOTAL ENERGY [Electric]

Avg 18% Total Energy Reduction
Avg 19% Heating Energy Reduction
APPLICATION: ABOVE CEILING TILES
Savings Performance - CALIFORNIA Climate Zones 6 & 7

TOTAL ENERGY [Electric]

Avg 19% Total Energy Reduction
Avg 61% Heating Energy Reduction
APPLICATION - ABOVE CEILING TILES
Savings Performance - CALIFORNIA Climate Zones 8 & 9

TOTAL ENERGY [Electric]

Avg 12% Total Energy Reduction
Avg 39% Heating Energy Reduction
APPLICATION: ABOVE CEILING TILES
Savings Performance - CALIFORNIA Climate Zones 10 & 15

TOTAL ENERGY [Electric]

Avg 22% Total Energy Reduction
Avg 42% Heating Energy Reduction
Industrial Case Study - Battery Manufacturing Plant

INSOLCORP PCM Mat used in Ceilings & Roofing to Control Temperature

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Industrial Case Study - Battery Manufacturing Plant

81°F - No PCM

73°F Infinite-R™
Industrial Case Study - Battery Manufacturing Plant

Comparison of temperatures with and without PCM:

- **July 27th, 2015 Day**
  - No PCM

- **June 12, 2017**
  - With PCM

Temperatures:
- **Actual:**
  - Without PCM: 91°F | 76°F
  - With PCM: 93°F | 73°F
- **Average:**
  - Without PCM: 87°F | 67°F
  - With PCM: 84°F | 63°F

Graph showing temperature changes throughout the day for both days with and without PCM.
Industrial Case Study - Battery Manufacturing Plant

Heat Index Temperature

Heat Index Temperature (°C)

Heat Index Temperature (°F)

Jan  Feb  Mar  Apr  May  Jun  Jul  Aug  Sep  Oct  Nov  Dec

0°C  15°C  32°C  48°C

30  60  90  120
Industrial Case Study - Battery Manufacturing Plant

Heat Index Temperature Regression Analysis

No PCM Heat Index

PCM Heat Index

Indoor Temperature [°C] °F

Outdoor Temperature [°C] °F

NoPCM Heat Index (F)
0.928x + 20.9 r^2 = 0.72

PCM Heat Index (F)
0.238x + 65.6 r^2 = 0.489

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Industrial Case Study - Battery Manufacturing Plant

Red Oak, IA PCM Analysis two near identical days selected for comparison TEMPERATURE Before and After PCM Install

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Industrial Case Study - Battery Manufacturing Plant

Red Oak, IA PCM Analysis: two near identical days selected for comparison Relative Humidity Before and After PCM Install.

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PCM Mat I in Ceilings & Roofing to Control Temperature.
Industrial Case Study – RUBB BUILDINGS

Client: RUBB is a global leader in Fabric Tension Buildings
Project: Fabric Building @ RUBB in Sanford ME
Amount of PCM: 16,500sf
Project Features: JV collaboration with RUBB to embed PCM within their “Thermohall” insulated fabric liner system under joint development.
1,200sf Solar Heating System heats bldg, PCM stores heat
Building uses no gas on sunny days in winter, limited gas on cloudy days.
Building holds heat above 55F setpoint overnight without heat.

Sanford Maine – 14,000sf Building
1,200sf Solar Hot Air Wall + 14,000sf PCM

2/27/18 2/28/18 3/1/18 3/2/18
Heat turned up to 65ºF overnight. 3 cycles of heat.
Heat turned OFF overnight. PCM holds at 59F
Cloudy day. No sun. Look at how much slower temp drops after a cycle of heat around the PCM freeze temp.

Heat turned off overnight. PCM holds at 60F

Actual: 50º F | 25º F
0.00 in
Average: 35º F | 17º F
0.76 in

Actual: 60º F | 25º F
0.00 in
Average: 35º F | 17º F
0.13 in

Actual: 55º F | 30º F
0.00 in
Average: 35º F | 18º F
0.13 in

Forecast: 39º F | 32º F
20%
Average: 35º F | 18º F
0.13 in
Industrial Case Study - RUBB BUILDINGS

NEAR NET ZERO HEAT!

Sanford Maine - 14,000sf Building
1,200sf Solar Hot Air Wall + 14,000sf PCM

- Heat turned OFF overnight
- PCM Holds temp at 59°F - No Gas
- Partial Sunny Day
  Solar Heats Space to 65°F
  Overnight Temps stay above 58°F no Gas Heat (50°F Setback)
- Sunny Day
  Solar Heats Space up to 68°F
  Overnight stays above 55°F no gas

Heat turned OFF overnight
PCM Holds temp at 59°F - No Gas
Partial Sunny Day
Solar Heats Space to 65°F
Overnight Temps stay above 58°F no Gas Heat (50°F Setback)
Sunny Day
Solar Heats Space up to 68°F
Overnight stays above 55°F no gas

INSLCORP
Commercial New Construction - **Kiewit Training Center**
Commercial New Construction - University of Washington

Nano Engineering & Sciences Building - Phase II

- ZGF Architects, Inc
- Included PCM for passive energy storage
- Energy design by Affiliated Engineers Seattle, Washington
- InfiniteR™ also selected for Building III & IV

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