### Hydronic Radiant Cooling

#### By: Dean T. Newberry



Talbott Solar & Radiant Homes Inc.

(C) Talbott Solar & Radiant Homes

Inc.

### Heat Transfer

#### Heat moves 3 ways

- Convection
  - Moving heat with air
    - Warm air rises
    - Mostly done with fans
- Conduction
  - Heat transfer through an object
- Radiation
  - Energy transmitted by waves (infrared)

# Exchanging heat in Buildings

- Convection based systems
  - Baseboard and valance "copper fin tube"
  - Gravity furnace
  - Forced air furnace
  - Air conditioning
- Radiant based systems
  - Hydronic or steam radiators
  - Hydronic radiant floors
  - Hydronic or electric ceilings

#### What is cooling "comfort" in buildings?

- Comfort Equation:
  - Evaporation 20%
  - Convection 30%
  - Radiation 50%



#### Radiation 50%

Radiation = Temperature, 74° Farenheit Evaporation = Moisture, 50% Relative Humidity Convection = Air Speed 0 Feet/Second

# Hydronic Radiant Energy

- Specific heat of water higher than air
- □ Low temperature heating ~110°F
  - Heater is more efficient
- □ <u>High temperature cooling</u> ~55°F
  - Chiller is more efficient
- Zero duct losses
- Small radiant panel back losses
- Less circulation energy
  - Fan 1/4HP, 600 Watts
  - Circulator 1/25HP, 100 Watts

### Energy

#### Recent T24 run for 3 small houses

- QVM9, 90% condensing heater / DHW
- York Affinity Chiller 15 SEER
- Radiant Ceiling heating / cooling
- Energy is T24 pass 30%
- A typically homeowner will operate the house for comfort not efficiency, and will realize a portion of possible savings.

### Operating energy comparison

# LBL estimate 1994, Helmut Feustel 42.3% Less Energy!



# **Historical Perspectives**

- Cave dwelling
- Skytherm House
- Whitecap systems
- Culvert Wall
- KaRo System
- Runtal Radiators
- Wirsbo two trac
- Wirsbo two trac on rc-channel
- Talbott Radiant Panel

### **Historical Perspectives**

# Cave dwelling in Cappadocia Turkey Earth coupled space conditioning





#### Harold Hay Roof Pond

#### Skytherm House Atascadero CA 1973

Roof Pond
 Movable
 Insulation



# Whitecap systems

#### Bourne residence 1986

- Roof pond
  - Floating foam insulation
  - Nighttime sprinkler evaporative cooling.
  - Passive heating



# Culvert Thermal Mass Wall

- Office building
- Winters CA 1975
- High Mass Passive
  - Nighttime ventilation cooling
  - Passive solar heating
- □ Very low energy
- Used in few buildings



### How about Radiant Floor Coolng?

- Widely used in innovative buildings
  - Bangkok Airport
  - Hunter Museum of Art, Chattanooga TN
  - Akron Art Museum, Akron OH
- Not so useful in conventional residential buildings
  - Less solar heat gain
  - More floor coverings

#### Residential radiant floor cooling?

#### Difficulty getting the loads





### Karo Systems

- Capillary Tube Polypropylene Mat
- Interesting Concept
  - Doesn't fit well into American construction practices.



### **Runtal Radiator**

- Ceiling radiator
- Conventional hydronic unit
- Requires a lot of units to cool.

				1			
							CIFICATIONS
d rolled st owdercoat	old rolle powder	SA from con a gloss (	l in the US finished in	ufactured anels are	are man ad. The pa	RC panel radiators and ceiling mounte	and the second
nal colors.	onal col	r 100 optio	s and over	ard colors	any stand	are available in ma	6 10
d widths fr	nd widt	29'-6", at	m 2'-0" to	engths fro	nade in le	These panels are r	1
let and ou	inlet an	NPT for i	s are 1/2"	onnection	I piping or	3" to 70". Standard	1 1
ore avail ions, pleas	ations. a	and oute specifica	RC pane	complete	For more	by special order). F	
				pages.	technical	refer to the Runtal	RC-2
				a			
							FT RATINGS
AT	EAT	s @ 65°F	ft Rating	BTUH/			
180°F   1	180°F	215°F	DEPTH	HEIGHT	MODEL	aving,	fficient as well as space s
400	400	270	inches	inchos	000	panels. These	radiators are true radiant
200	190	400	1.0	8.6	RG-2	werroom	ovide more comfort at a lo
380	380	530	1.6	11.5	RC-4	rs. vallous	ure man convective heate water temperatures (AMT
470	470	660	1.6	14.4	RC-5	specific conditions	sonvenience, but for more
560	560	800	1.6	17.3	RC-6	or with the 215°F	ppropriate correction facto
660	660	940	1.6	20.2	RC-7	ges for the	ease see the technical pa
760	760	1070	1.6	23.1	RC-8		n tactor ad to the design conditions
847	847	1203	1.6	26.0	RC-9 RC-10	10	va to elle aceign conditioni
-10	040	1010		60.0			
							TING SYSTEMS
							INC CHOILEMS
							and the second second
eaded roo	hreaded	ted with th	ling moun	ls are ceil	RC pane		
pplied by	supplier	hich are a	pports, w	ceiling su	nuts and	1	6
iges for m	pages f	echnical p	the RC t	lease see	others. P	~	
			y uetans.	mounting	comprete	RC-4	C. Star
							(A)

### Wirsbo two trac panels 2005

# Radiant ceiling heating and cooling Plates not in good contact with drywall

 Too much space between
 Plates



# Talbott Building Integrated Panel

- Integrated panel combines 6 functions:
  - 1. Resilient Channel sound absorbing lath
  - 2. Provides space for tubing
  - 3. Active radiant heating and cooling panel
  - 4. Excellent contact with drywall
  - 5. High emissivity coating optimizes heat transfer
  - 6. Layout on any joist pattern

### Talbott Radiant "xLath" Module

- Modular 16" x 24": fits frame layout
- Self furring, leaves space for tubing in panel void
- Integral emitter plate and resilient (RC) channel
- Hydronic radiant heating / cooling module
- Thermal coating for high performance
- Patent pending



# xLath prototype modules 2006

- Installing tubing in ceiling panels
  - Panels cross joists
  - Spacing optimal
  - No lacing tubing through joists
  - Easy skip for lights
  - Drywall attaches to panel for good heat transfer



### Condition the air

- Some air handling is needed
- In most climates use a Dedicated Outdoor Air System (DOAS)
- Bring in fresh air
- Dehumidify as needed
- Use energy recovery ventilator when possible

# For Multifamily occupancies

- Talbott *xLath* is a component of a Dedicated Outdoor Air Systems (DOAS)
- The Talbott xLath:
  - Replaces the main air conditioner in each residence
  - Unit thermostat control
  - Uses typical hydronic manifolds
  - Is a compact installation
  - Has simple service and maintenance methods
  - Integrates into the sound isolation method commonly used

# Health and Safety Issues

#### □ Talbott *xLath*:

- Operates above the dew point
- Prevents condensation issues
- Minimizes places for fungi growth
- Limits the pathways for fire and smoke distribution throughout the building
- xLath is nonflammable
- Tubing is HDPE or PEX and is commonly used in new buildings.

# **Building Structural Issues**

#### Talbott xLath:

- Takes up less building volume than ducts
- Installs using standard building construction practices
  - Lath installed by drywall contractors
  - Tubing installed by piping contractors
  - Connection to building hydronic system uses the same methods as a fan coil
- Adds negligible mass to the structure

# Risk Management Issues

- Minimizes moldy ducts
- Less pollen in the air
- Fewer pathogens distributed
- Reduces smoke & aerosol diffusion
- Reduces building operating energy
- Reduces operating costs

### **Environmental Benefits**

#### Much less energy usage

- Smaller building volume uses less material
- When used, HDPE Pipe is recyclable
- Coated steel Recyclable

# Building Industry Knowledge

#### □ Talbott *xLath* radiant ceiling modules:

- Have been deployed in 13 residences in the region
- Title 24 methods model the system
- Dedicated Outdoor Air Systems (DOAS) have a strong academic background
- Radiant panel cooling systems are supported by ASHRAE and RPA
- The Western Cooling Efficiency Center (WCEC) at UC Davis is helping deploy these systems into new construction

# Client or Tenant benefits

- □ Talbott *xLath* ceiling modules:
  - Invisible
  - Absolutely quiet
  - Better health than forced air
  - Better comfort than forced air
  - Reacts faster than radiant slabs
  - Cools as well as heats
  - Rapid installation

# Moving Along

- Tubing and Manifolds
- Manifold box
- Circulator box
- Finished Room
- Mechanical Equipment

# Distributing heating and cooling

- Tubing Wall and Manifolds
  - Manifolds inside wall
  - Tubing collects in otherwise unused void



#### Manifold Box

# Manifolds enclosed in closet wall

#### Covered with return air grill



### Circulator center 14"w x 18"h

- Mounted in closet wall
- Covered with return air grill



### Hydronic Radiant Ceiling

Main
 room
 finished
 Note:
 thermostat
 above
 chair



# Mechanical Equipment

- Combined Georadiant
  - Heating, cooling, hot water
- Reversing Chiller
  - Really simple system
- Combined Water Heating
  - Dual purpose water heater and chiller

# Georadiant Combined Hydronic

- Climatemaster Geoexchange Heat Pump
- Hydronic Fan Coil
- Radiant ceiling H/C
- □ Geo DHW □ QVM9
- Solar PV 2.5kW



# Tetco GeoRadiant

- Dual function geoexchange HP
- Radiant floor/ceiling heating and cooling
- Hot water
- D'Mand Circulator



# York Reversing Chiller

Reversing Chiller
15 SEER
R-431A
Efficient
Quiet
Reliable



### **Combined Hot Water Appliance**

Quietside QVM9-90
90% Condensing
PVC Flues
Hydronic Heating
Tankless Hot Water
Modulating to 30%
Microprocessor control



### **Radiant Panel Lessons**

- Wirsbo panel
- Wirsbo on Z-bar
- Z-bar plane finishing
- Avoid drywall zip drive
- Avoid joists

# Wirsbo two trac panels 2005

- Panels cover ~40% of ceiling Just enough coverage for load
- Panel not in close contact with dry wall
- Tubing routs
   through joists
   Work just fine!



#### Wirsbo Panels on RC-channel 2006

- Coverage ~80% of Ceiling
- Tubing routes on surface
- Panel in good
   thermal
   contact with
   drywall



### Ondol module on z-bar

 Ceiling plane finished with z-bar
 Tubing in screw line



#### Applications for Agriculture Cheese cave – Twig Farm Vt



#### Z Specialty Foods – Woodland CA

Proposed to prepare honey for processing and packaging



### Questions?



#### Thank You



Dean T. Newberry

Talbott Solar & Radiant Homes Inc.

http://www.talbottradiant.com/