Keep your cool with new technology

Thermal storage and under floor systems provide advanced climate control for large sanctuaries.

A major cost in both the construction and operation of a large church facility is the environmental control system. As worship spaces become larger, so does the air conditioning load, and the equipment required to cool the space. As ceiling heights increase, noise and drafts associated with pushing air from the ceiling to the occupied zone becomes an issue.

There are several ways to minimize the size, first costs, and operating costs of air conditioning systems while eliminating drafts and air-induced noise. These concepts are best applied for worship centers of more than 1,000 seats and that operate during the week in addition to Sundays. The cooling load is assumed to be in excess of 200 tons.

A new-old idea — cooling using thermal storage — may provide the means to achieve reduced first costs and continued operating cost savings. In the 1920s, churches and movie theaters were some of the first applications of thermal storage. These projects share a similar condition, a short duration peak cooling load with an extended down time period with no cooling requirement.

The greatest challenge to designing a quiet, draft-free air distribution system for a large sanctuary is the high ceiling.

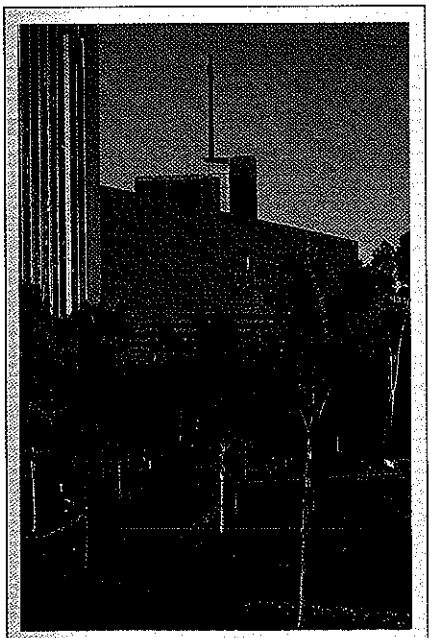
The cooling load

Churches experienced about a two-hour cooling load on Sunday morning that may have been needed as well as for Sunday night and Wednesday night services. Together, the cooling load took place in less than three percent of the week. Assuming a 50-ton cooling load, spreading the cooling work over the entire week by forming ice, the church could get by with a one and a half or two-ton water chiller instead of a 50-ton machine. Today the concept remains the same but the ice is formed at night, when power costs are low.

Conventional air conditioning refrigeration equipment is sized for the maximum expected cooling load on the hottest day of the summer. At this capacity (200 tons or more), chilled water instead of direct expansion is generally the most economical cooling medium.

Installed refrigeration capacity is significantly reduced in a thermal storage based cooling system. This size reduction is achieved by producing ice at night, using low temperature brine to freeze water when the systems are normally shut down. During the >>

By Russell M. Keeler



Heat, not stones, concern parishioners of this all-glass sanctuary

People who sit in glass houses of worship for an hour or two are more concerned about the heat and humidity of the room than anything else, and the all-glass sanctuary of the Crystal Cathedral, Garden Grove, CA, brought its own challenges when it was conceived prior to its opening in 1980.

Architect Philip Johnson told Dr. Robert H. Schuller that building an all-glass sanctuary in Southern California would dictate the ultimate shape of the building, because "with the sun coming through all of that glass, people are going to bake. Air conditioning will bankrupt you, so we'll have to cool it naturally."

Hence the building incorporates unique cooling louvers that begin at slightly above ground level and continue in staggered rows to the full height of the structure. The louvers open thermostatically to allow cooler air in on warm days.

Louvers at the 120-foot-high crown of the structure allow the rapidly rising hot air following the upward sloped ceiling to exit into the atmosphere.

This movement actually creates a gentle breeze inside, and only on rare 100 degree days does the Cathedral seem too warm. Otherwise, Johnson's cooling system is perfectly suited to Orange County's comfortable climate.

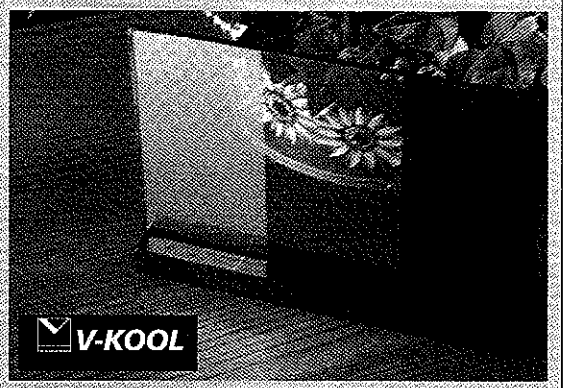
Moreover, the 10,000 mirrored panes reflect much of the sun's rays (about 90 percent) creating a clear, yet somewhat "tinted" effect inside.

— Ben Rhodes, Crystal Cathedral

How windows and fixed glass affect the performance of HVAC systems

As much as 40 percent of a building's cooling requirements is a function of heat entering through existing glass. Solar heat gain through south and west facing windows is a serious problem for glass-intensive church buildings. Even in winter, large facilities may heat the building core while simultaneously cooling the perimeter.

The implication for church managers: Before replacing or enlarging existing HVAC systems or specifying a system for new construction, factor-in the heat reflective performance of the existing or to-be-selected glass, says John Miller of V-Kool Inc., Houston, TX, manufacturer of an applied clear window film.



"Too often the building architect does not understand the relationship between glass and HVAC requirements, usually resulting in the building owner overspending on HVAC," says Miller, "paying higher HVAC operating costs over the life of the building and paying more for glass that is ineffective in terms of heat control. The result may be a facility that is uncomfortable for occupants."

The cost effective solution is applied spectrally selective window film. Spectrally-selective refers to the ability of the film to transmit desirable daylight while blocking undesirable heat. Clear, spectrally-selective film offers the best ratio of visible light transmission to heat rejection. It blocks heat as well as heat-blocking solar control glass and, even in new construction, often the cost of solar control glass exceeds the cost of standard insulating glass to which a spectrally-selective film is later applied.

V-Kool Inc. can be contacted at www.v-kool-usa.com.

day the ice bank is used in parallel with the water chillers. The ice is melted, providing a part of the cooling. The ice acts as a battery — cooling is generated at night at very low cost for use during the peak daytime hours.

A thermal storage system offers advantages for churches:

- Water chillers are reduced in size by as much as 60 percent.
- Chilled water produced by the system is much colder than in conventional systems, allowing for smaller pipes and pumps.
- Colder chilled water allows for a lower conditioned air temperature yielding smaller air handlers, ducts and fan rooms, freeing space for other pressing needs such as storage.

The greatest challenge to designing a quiet, draft-free air distribution system for a large sanctuary is the high ceiling. Generally air outlets are designed to spread air along the ceiling to mix the cool conditioned air with room air. This approach does not work when the outlets are 30 or more feet above the floor. Even with specially designed outlets that direct the air in a downward pattern the presence of drafts is a real possibility.

Under floor air distribution

A relatively new design concept called under floor air distribution solves both the

noise and draft problems. A double floor is created, with the lower floor being fire rated and the upper floor being structural. Cooling air at near room temperature is introduced to the plenum created by the double floor.

The air flows at very low velocity into the sanctuary through specially designed circular outlets. Because the air is near room temperature and hardly moving, there is no sensation of draft, even for bare or stocking feet. As the air warms it rises toward the ceiling where air temperatures can be much warmer than in the lower occupied zone. Heat from lights and equipment is carried out of the building by exhaust fans at the roof. Less cooling is required because heat from stage lighting never mixes with the cooling air in the occupant zone.

This design concept provides several benefits:

- Noise and drafts are virtually eliminated.
- Air handlers are smaller (and cheaper) than in conventional systems.
- Duct runs are generally much shorter, reducing the cost of sheet metal.
- Because air handlers are smaller, mechanical rooms can be smaller, freeing space for other needs.

Besides the reduced first costs of combining a thermal storage system with an under floor air distribution system, long term operating costs are also reduced. Daytime electrical demand is sharply reduced because the smaller chillers, pumps and air handlers come equipped with smaller motors than full sized equipment. Air conditioning system-induced electrical demands form the largest part of the electric bill for many facilities using over 500 kw of power. For a customer in this size range in a major metropolitan area, a kilowatt of power avoided in the summer can yield a saving in excess of $250 per year, or $25,000 for a 350-ton installation.

There is one word of caution: Care should be taken in the selection of both design engineers and contractors for a thermal storage project. In our experience, we have found that engineers designing their first thermal storage project tend to oversize the equipment, in many cases negating the construction cost savings benefits. Similarly, when working in a design/build scenario, contractors tend to overestimate the system costs. To minimize these problems always look for designers who have a track record in the design of ice storage systems.

A combined thermal storage and under floor air distribution system represents the state of the art in large building air conditioning. It offers low first costs with economical operation over the long term. The savings in electrical demand realized from the system may qualify for electric utility rebates. CE

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