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Introducing the Chilled Beam: A Fresh Alternative to HVAC

By Lisa Hiserodt

Mike Spence, senior partner at TMP Consulting Engineers, extended a hand to Bill Rafferty, executive vice president of Mestek, a joint-venture company that began manufacturing energy-efficient chilled beam systems in the United States last summer. "I know about 300 percent more than I did before you walked into the room," he said. "Thank you."

Mike and his team face a difficult challenge: They need to find three equal products, a preferred and two alternates in order to specify the use of chilled beams in a publicly-bid project. This is a sizable dilemma. The chilled-beam market is shifting daily and not all chilled beams are created equal.

Though its name implies otherwise, a chilled beam actually has no relationship to structural elements. It is a cooling system that is exposed or can reside in the ceiling and has the appearance of a structural beam when installed because the units are commonly long and narrow. The reason they are getting attention, however, is that active chilled beams are an energy-efficient alternative to standard air-conditioning systems.

According to the United Nations, buildings account for 30 percent to 40 percent of global energy use. As we shift toward alternative-energy sources, energy-efficiency is becoming a primary challenge for the built environment. Case studies show that chilled-beam systems can offer a significant reduction in energy consumption over standard HVAC (heating, ventilation and air-conditioning) systems. In Mike's case, a preliminary study indicated that chilled beams would generate a 20 percent reduction in energy consumption over an already efficient all-air system. This converts to a significant reduction in CO_2 emissions as well. The project would need to plant 11,438 trees to offset the additional emissions the all-air system would generate.

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Standard all-air HVAC systems condition a space by supplying it with air that has been cooled or heated to a target temperature. Air is returned from the conditioned space, mixed with outside air, and re-circulated in order to manage the temperature differential. The same air also addresses ventilation needs, but the volume of air required to provide temperature control is usually significantly greater, up to six times as much as ventilation requirements alone.

Chilled beams use water rather than air to carry a portion of the cooling. Water has a heat capacity that is 300 times greater than the same volume of air. This means that the same amount of cooling can be delivered in a significantly reduced volume of space, using 1-2 inch piping, as opposed to large sheet-metal ducts.

Chilled beams use 100 percent outside air supply so that the mixing occurs in the space instead of within the system. This translates to the circulation of a significantly reduced volume of air, resulting in a considerable reduction in air handling units and required fan power. System reductions are the primary source of energy savings. But 100 percent outside air also contributes to a significant reduction in duct size, something that has fueled its popularity in Europe, where chilled beams have been commonly used for the past 10 years. Smaller duct sizes can translate to reduced floor to floor heights, something that is of interest to developers who see the reduction in building volume as an increase in profits.

In a standard all-air system, air is cooled by chilled water that runs through centralized cooling coils at the air handling units. This requires a chilled water supply temperature of 42-45 degrees. In the chilled-beam scenario, the chilled water distribution system is more extensive, but the temperature can be 55-60 degrees, which reduces the electricity consumption of the water chiller, further reducing energy consumption. The piping cost premium is more than offset by the sheet metal savings.

All of the energy savings add up to a growing interest in chilled-beam technologies, and in the past year the landscape has shifted significantly. At the outset one product, imported from Germany, pretty much held sway over the U.S. market. There are now about eight or nine competitors, at least half of which are manufactured stateside. This has led the German company to set up a U.S. plant that will start production at some point this summer. Increased availability and competition between suppliers should help bring down the price of chilled beam technology, a welcome consequence for designers and owners of green buildings.

The rapid growth in this industry may also create a situation of "buyer beware," as some rush ahead of product development to grab their share of the evolving market.

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The result is a selection of products that vary widely when it comes to performance measures. And there are other drawbacks as well. While the price is coming down, the units themselves are still relatively expensive, costing roughly $150 per linear foot, or about $2,000 per ton of cooling delivered. Although this is partially offset by savings in plant size, sheet-metal costs and construction coordination, it still requires some measure of life-cycle analysis to justify the increase in upfront costs.

One of the most prominent concerns, however, is condensation. The chilled water coil that serves to cool the air will generate condensation under certain circumstances. The solution in most instances is to control the humidity in the room and to keep the water temperature just above the dew point. Some units offer attached drip pans, just in case. Some engineers have been installing dew point sensors that can regulate water temperature and prevent condensation conditions from occurring.

Because of concern over condensation, chilled beams have been commonly seen as more appropriate for fully sealed environments and considered an option that should be avoided in situations where windows are operable and may be opened by occupants on a warm, humid day. But with proper precautions and training of both occupants and maintenance staff, chilled beams can offer higher quality cooling with less noise and lower energy bills in just about any situation. Current installations include classrooms, offices and laboratories.

So where does this leave Mike? One option would be for him to specify performance criteria instead of naming specific manufacturers. This gives the price advantage of shopping around back to the contractor, and also insures that system performance will not be compromised by a low-cost product. In the future, this should be less of a problem. Conversations regarding performance standards and product certification have already begun in trade associations and a set of standards is sure to be developed soon.

Meanwhile, Mike can be assured that by taking the time to investigate the pluses and minuses of various manufacturers, as well as the technology itself, he may be able to gain an edge over his competitors. There is one thing in all this that is quite clear: Owners and architects are going to be seeking out engineers with chilled-beam experience in the very near future. ■