Cooling down

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Unlike in most parts of Europe, it was another hot summer in the US. *E&T* looks at the state of air-conditioning engineering in the States and elsewhere in the world.

Summer in the US north-east may bring to mind rugged men sailing through the Cape, tanned cherubs building sandcastles or soft-shell crabs plucked fresh from the sea. But for those of us living here, the images belie a far less glamorous reality – the wretched heat and humidity.

In May, a heatwave hit southeastern Connecticut, causing many to worry that this could be a harbinger of yet another, perhaps even more dreadful, summer. The problem was much more acute for anyone struggling through the season without a proper air conditioner. I was one of those people.

But as temperatures soared above 39°C and the humidity was who-knows-what, the urgency to buy one of these energy-gobblers became increasingly clear. Yet, whether to relent – and thereby further damage the environment (and my electricity bill!) – was still indeterminate, especially since we Americans have a long way to go before our air conditioners become 100 per cent environmentally-friendly.

Carrier to today

The late Willis Carrier, engineer and inventor of the first half of the 20th century, is a sort of ‘patron saint’ of the US coolant business. He started a modest engineering firm with a handful of partners, one which grew into a multi-city international business based out of Connecticut.

At the age of 25, Carrier had the first patent on a type of air conditioner that would presage the modern age of cooling. His design was tailor-made for a stuffy lithography plant in Brooklyn, New York, where the humid conditions ruined the pictures at the site. From there, he gained world renown, in part from his appearance at the 1939 World’s Fair, where his “igloo” drew rapt attention.

A lot has happened since 1939. Today’s machines would shock Carrier and his ilk, whose version of an air conditioner is reminiscent of the early computers that used to occupy a whole room.

No longer the mammoth machines of yore, today’s models are sleeker, more cost- and energy-efficient, and manufactured by companies that have mandates for controlling greenhouse gas emissions.

Vendors tout new – or new versions of old – technologies such as thermal cooling, which operates on a load-reduction premise.

Cooling methods from vendors in the space, such as Ice Energy and Trane, are hoping this changes the way Americans think of their coolers.

Trane has installed numerous “thermal storage” units in financial buildings such as Credit Suisse and Morgan Stanley in Manhattan.

Ice Energy, based in Windsor, Colorado, has monopolised restaurants, fitness centres, manufacturing plants and automobile dealerships. It promotes a hybrid cooling technology that integrates with standard AC units.

Ramachandran Narayanamurthy, director of research and innovation for the company, draws a distinction between what Ice Energy does and standard methods of air conditioning.

Ice storage air conditioning, he says, provides both energy and environmental benefits plus comfort. “The main reason you have air conditioning is to be comfortable, but the downside is that it drives power consumption when we have the least amount of power available on the electric grid.”

His method is to run the compressor and all the power-consuming elements overnight, storing the cooling that would normally be delivered into a building in the form of ice. He claims that this can cut power consumption by 95 per cent.

Todd Colard, manager of the Energy Services division of Trane, says that with thermal storage and its subsequent lessening of energy consumption during the day, there is far less strain on an electric grid.

“If you look at air conditioning as a whole, I think it’s almost 30 per cent of the energy consumption of a building.” In the US, there are three such grids, with the Eastern grid being the oldest, and the one that has repeatedly failed in New York over the past few years.

Energy consultant Adam Hinge, a member of the American Society of Heating, Refrigerating and Air-Conditioning Engineers, Inc. (ASHRA), concurs on thermal storage’s benefits. He says that, in the past decade or two, there has been a decided trend toward the use of thermal storage over traditional cooling methods.

This is, in part, because “as air conditioning loads grow, and the saturation of air conditioning goes into a whole lot more buildings, it’s having a fairly big effect on utility peak summer demands”.

Carbon reduction mandate

But whether new twists, like thermal storage, solve old problems remains to be seen. Clearly, a block of ice won’t reverse the type of strain air conditioners have been putting on the environment since they gained widespread American popularity in the 1950s.

That said, America has been much more keen on protecting the environment than is sometimes given due.

Today, technology is furthering green efforts with a US Environmental Protection Agency mandate that by January 2010, ozone-depleting hydrochlorofluorocarbon-refrigerants will be greatly reduced.

Carrier was one of the leaders in this effort, but the other players are following suit. For example, Emerson Network Power – Liebert is phasing out its refrigerant R22 to the more environmentally-friendly refrigerant R407C in its cooling equipment.

Says Engineer Alan Goerke, a sales manager with Emerson: “R22 will no longer be available on new equipment industry- wide in 2010. We are also promoting more efficient cooling systems to save energy by cooling the heat load closer to the source with a liquid instead of air; since liquid is a more efficient heat transfer medium than air.”

For the past several years, many of the leaders in this area, such as HVAC behemoth Carrier, have shown a steady improvement.

This does not mean, though, that the newfangled air conditioners will reverse the damage already done: they still have an enormous way to go before they become truly energy efficient.

According to Engineer Fred Keller, a former Carrier consultant, there are many reasons why modern air conditioning still contributes to the carbon footprint.

“The new refrigerants we selected to replace the ozone-depleting ones are now a concern because they are global warming compounds,” says Keller.

These would be R-134a chillers and Puron R-410A-based residential products which do not contain chlorine and thus do not contribute to damaging the Ozone Layer, Keller points out.

He adds that “about 5 to 10 per cent of the total carbon emissions for the life of that air conditioner are due to the refrigerant. The other 90 to 95 per cent are due to the energy that the refrigerant will consume”.

Where the problems lie

Bruce Wollenberg, an engineering professor at the University of Minnesota, says a niggling problem is that designers have yet to manufacture a truly efficient air conditioner.

Over the past 20 years, there has been a push for more energy-efficient refrigerators, furnaces and air conditioners, Wollenberg points out. And yet, “We really have not begun to attack motors. Motors consume the largest part of the electrical use simply because every household has so many and they are what’s driving the industry”.

Consistent research has been done to make air conditioners more efficient, but it has not been concentrated enough. “The motors are rather inefficient; and the trouble is that making them efficient runs the cost up,” Wollenberg says.

By efficiency, he means that a fan, for example, will at best only use about 60 per cent of its cooling capacity – the rest is lost through the inefficiency of its motor. That is obvious, when one simply touches the back of the unit, Wollenberg points out. A similar problem is still occurring with other appliances, including air conditioners.

In the summer, this is particularly perplexing for air conditioning engineers.

Wollenberg’s students are most interested in what they can do to curb carbon emissions through their future designs.

Yet, carbon emissions are an entirely different matter from increasing the air conditioner’s efficiency.

As Keller put it: “There’s a lot of uncertainty as we look forward 15 to 20 years as to exactly what technologies we will be using in our air conditioners.”

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