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Sparkling Water

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Our final look (for now) at water as a refrigerant looks to the future and a technology currently under development that could rewrite the textbooks and rules of thumb for the entire chiller market. One of the phrases I hate to hear is "everybody knows…," which usually precedes some piece of spurious nonsense that is only perceived to be true because it is repeated so often by people who start their sentences with "Everybody knows…."

Everybody knows JFK said "I am a jelly doughnut" when he visited Berlin in 1963. His grasp of German grammar was better than that and his use of the term "ein Berliner" was correct. He was identifying with the citizens of Berlin metaphorically.

Everybody knows Rick's famous line in Casablanca, "Play it again, Sam," although the closest that Bogie comes to this in the film is the rather less slick "You played it for her, you can play it for me…if she can stand it, I can. Play it!"

I came to Casablanca for the waters... I was misinformed.

Everybody knows that WD in the spray lubricant WD-40 stands for "War Department." Everybody except the inventer, Norm Larsen of San Diego, who confirms that it was his 40th attempt to formulate a Water Displacement compound and the shorthand he entered in the lab register, WD-40, stuck (unlike everything he sprayed with his new miracle concoction).

Everybody knows that chillers using water as the refrigerant in a vapor compression cycle need to be huge because of the very low volumetric capacity of the refrigerant. Volumetric capacity is the latent heat times the gas density and while water's latent heat is huge—more than 15 times higher than R-134a—its gas density is incredibly low. Typical "water chillers" are therefore made using turbo compressors with a very large diameter impeller and in the hundreds of tons of cooling capacity range. One reason for the low gas density is that the whole refrigeration cycle operates under a fairly hard vacuum. In a system for chilled water in a commercial building, where the water is chilled from 55°F to 43°F (13°C to 6°C) the refrigerant would evaporate at 0.3 in. mercury (1 kPa) (or a vacuum of 29.7 in. [100 kPa] if you prefer). This is only 1% of atmospheric pressure. Even in the condenser in such a system the water vapor will only be at about 7.5% of atmospheric pressure.

A recent development in Munich is looking to transform our perception of water as a refrigerant. Small-sized turbo compressors running at very high speed offer the prospect of a system combining compressor, evaporator, condenser and motor in a device about the size of a 15 gallon (55 liters) bucket. This module would be piped into a chilled water circuit and a cooling water loop to deliver about 15 tons (53 kW) of cooling, with multiple modules in an array to deliver larger capacities.

The secret to this phenomenal performance is the combination of a permanent magnet motor running at 100,000 rpm with a molded plastic turbine impeller, about 4 in. (100 mm) diameter, capable of withstanding the exceptionally high forces created by such high-speed operation. The operating shaft is maintained in position by magnetic bearings and the variable speed drive provides stepless capacity control over a wide range. Energy consumption is claimed to be less than 70% of the best of class conventional chillers so the seasonal energy efficiency ratio (SEER) can be 35 Btu/Wh (10 kJ) or even higher. For those of us struggling to cope with the recent jump from SEER 13 to SEER 14 this will come as a shock of seismic proportions, with a tsunami of highly efficient air-conditioning units to follow. For the rest of the world, desperately in need of a step-change improvement in energy efficiency, it will be a welcome relief. ■

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