Milestone in magnetic cooling

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The first milestone in magnetic cooling has been achieved. Between 5 and 10 degrees of cooling – this was the success criteria for the first milestone in a project involving magnetic cooling at Risø National Laboratory – Technical University of Denmark (DTU).

And the figure is currently at 8.7°C – this means that a refrigerator at room temperature (20°C) can be cooled to almost 11°C. Of course, this is not quite enough to keep the milk cold, but the project's test setup also has only the one objective of conducting research in different materials, varying operating conditions and the strength of the magnetic field.

"The setup is not the largest of its type, but the most important thing is that it 's easy to exchange parts in the machine. With the knowledge that we gain along the way, we will ultimately be able to build the very best magnetic cooling system," explains Christian Bahl, a postdoctoral student attached to the project for one year.

How is a magnetic field used for cooling?

Magnetic cooling technology exploits the fact that when a magnetic material, in this case the element gadolinium, is magnetised, heat is produced as a by-product of entropy. The principle of entropy is that there will always be a constant amount of order/disorder in a substance. When the magnet puts the substance in "order", it has to get rid of the excess disorder – and this becomes heat. Conversely, when the magnetic field is again removed, the substance becomes cold.

The heat is transferred to a fluid that is pumped back and forth past the substance inside a cylinder. The end that becomes cold will be located inside the refrigerator and the warm end will be outside.

Why magnetic cooling?

It is natural to wonder: Why magnetic cooling? After all, there are decent and also relatively energy-efficient refrigerators on the market. But there are three good reasons why this type of cooling has a future.

First, the technology is potentially more energy-efficient than the alternatives. It only really uses energy to move the magnetic field to and from the magnetic material. The model currently under development produces the magnetic field through a system of powerful blocks of magnets similar to those we use on our refrigerator doors, only stronger. These do not get worn out, and thus do not need replacing, which is very good for the environment.

This leads to the second major benefit, namely the fluid, which could turn out to be just plain water. Consequently, there would not be the same environmental impact as with today's compressor-based refrigerators. The third great potential difference is the noise level. Bahl expects their demonstration model, which should be ready in 2010, to be practically silent. The opportunities are obvious.

"It is probably not realistic to think that magnetic cooling technology will be used in consumers' homes right away. Manufacturers have spent too many years streamlining the prices of the existing refrigerators. Initially, it will be about implementation in various types of niche applications – large-scale refrigerating plants, soda machines or places where a noise-free environment is important," says Bahl, adding, however, that he believes it will ultimately spread to the rest of society.

On a global scale, there are at least ten other teams working on similar projects involving magnetic cooling, but the field has not yet become a major focus area. The concept of magnetic cooling has been known for many years, but using the technology at room temperature is something relatively new.

At Risø's Department of Fuel Cells and Solid State Chemistry, Senior Scientist Nini Pryds has received a grant of approximately DKK* 14 million from the Danish Council for Strategic Research Programme Commission on Energy and Environment. Along with the DKK 7 million that Risø and the three partners – DTU's Department of Manufacturing and Engineering Management, Sintex and Danfoss – are investing in the MagCool project, it will be possible to develop a prototype.

Sintex has the expertise in permanent magnetic fields, and the company is currently developing the model of magnets that will produce the powerful magnetic field for Risø's test model. Another objective of the project is to determine whether this technology can pave the way for the super-efficient and environmentally friendly refrigeration machine of the future.

*1 Danish krone = 0.182 U.S. dollars

Source: RISO