The coolness of tiny things

A new way of stopping machines overheating is being developed.

NANO-THIS. Nano-that. Nano-the-other. A nanometre is the name given by the scientific-measurement system to a billionth of a metre, and the idea that making things so small you measure their dimensions in nanometres will unlock advantages denied to larger objects has been around for well over a decade. Long enough, in other words, for sceptics to wonder when something useful will actually come of it.

It looks possible, though, that something useful is indeed about to happen. The evidence suggests that adding a sprinkle of nanoparticles to water can improve its thermal conductivity, and thus its ability to remove heat from something that is in contact with it, by as much as 60%. In a world where the cost of coolth is a significant economic drain (industrial cooling consumes 7% of the electricity generated within the European Union) that offers a worthwhile gain. It would, for instance, allow the huge computer-filled warehouses that drive the internet to fit in more servers per square metre of floor space.

Nanofluid cooling, as the phenomenon is known, was discovered almost two decades ago, but is only now coming out of the laboratory. According to Mamoun Muhammed of Sweden's Royal Institute of Technology, one of the field's leading researchers, three problems have stood in its way.

The first was stopping the particles sticking together and thus ceasing to be nano. That has been overcome by adding emulsifying agents such as cetrimonium bromide (originally developed as an antiseptic) to the mix.

The second problem is which particles to use. At the moment oxides of metals such as zinc and copper seem to be the favourites, but tiny tubes made of carbon are also being explored. This, in turn, raises the question of how the phenomenon actually works.

It is not simply a matter of the added ingredient (6-8% of the total volume seems to be the optimum mix) being a good conductor in its own right, though this helps. Nanofluids are better conductors than the sum of their parts. That suggests the particles are changing the structure of the water itself in ways that improve its conductivity. Water, despite its protean appearance, has a lot of internal structure, particularly when it is cool. The molecules are organised, albeit more loosely, in ways that resemble the material's solid form, ice. Nanoparticles inevitably alter this arrangement, and that may make the mix better able to transmit heat. If the changes involved were understood, picking the right size and composition of nanoparticle would be less a matter of guesswork.

The biggest problem about moving from laboratory to industry, though, is the question of scale. As the quantities increase, the way things mix and react alters a lot. That makes it hard to predict from small-scale experiments what will happen in a commercial setting.

If these problems can be overcome, though, a bright future beckons, and some of the nanohype that has been swirling around might actually get translated into a useful product.

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