

Reflecting to keep cool

Surfaces that throw out heat would reduce the energy it takes to cool things down

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Air conditioning and refrigeration are among the largest consumers of electricity. Although we need to reduce the use of electricity to contain global warming, with rising temperatures, the demands for cooling will increase, for comfort, productivity and conserving food.

Shanhui Fan and his group at Stanford University, US, have shown that "radiative cooling" can keep things cooler than the surroundings and they work on ways to convert this effect into positive power savings. In 2014, Shanhui Fan, Aswath Raman and others had written in the journal, *Nature*, about a material that promoted emission of heat at wavelengths that pass out of the atmosphere and into outer space. In a more recent paper, Fan, Raman and Eli A Goldstein implement a method where radiation from a reflective surface, even while the sun is shining, helps air-conditioning work more efficiently, with a 21 per cent saving of electricity.

The problem with Earth and warming is that the atmosphere captures and conserves heat. It is the rise in this capacity, with CO₂ buildup, that leads to rising temperatures. Because of this property, the radiation from a warm object is stored and does not allow cooling beyond a point.

The Stanford group, in 2014, had noted that there was a feature of the atmosphere which could be exploited to get finally rid of some of the heat. This is radiation in the 8 to 13 micrometre band of wavelength, where the atmosphere is transparent to Infra Red radiation. While the bulk of the heat that an object radiates is absorbed by the atmosphere in its vicinity, the heat that is emitted in this frequency window goes through the atmosphere and out into space — there is positive cooling.

The arrangement that was tried out on the rooftops of Stanford in 2014 used a sheet of the material that radiated in this frequency band and it was found to get four to five °C cooler than the surroundings. The applications envisaged were for cooling at remote places, where electricity could not reach, or as the roof material in storage of food or medical supplies. It was an "unexplored opportunity of using the cold darkness of the Universe as a fundamental renewable thermodynamic resource for improving energy efficiency here on Earth", the authors of the paper had said. In the more

recent paper, the team examines a technology where radiation by surfaces helps bring down the radiator temperature of air-conditioning equipment and hence increase their efficiency. While radiative cooling does not have the capacity to take the place of air-conditioning or refrigeration, it can make a sizeable difference to the power needs of cooling systems. The Stanford paper starts by saying that 15 per cent of the electricity produced globally, accounting for 10 per cent of global greenhouse gas emissions, is consumed by cooling systems. The demand for cooling is likely to increase ten-fold by the year 2050, they say. Hence, "improving the efficiency of cooling systems is a critical part of the twenty-first century energy challenge", the paper says. The usual way in which cooling systems work is by using the drop in temperature that takes place when a volatile liquid is allowed to evaporate. Once evaporated, the vapour needs to be condensed for evaporation again. This is done by compressing the vapour. But compression causes warming, and then, before use as an evaporative coolant, the vapour needs to be cooled. This takes place by the condenser, acting as a radiator, which loses heat by warming the surrounding air or any water that is allowed to run over it. Now, the laws of thermodynamics are such that the best efficiency possible for a refrigerating machine depends specifically on the temperature at the condenser, at which the arrangement sends heat out to the environment — the lower this temperature, the higher the efficiency. "As a rule of thumb, the electricity input into a cooling system is reduced by 3 to 5% for every one °C reduc-



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tion of the condenser temperature", the paper says. As the temperature rises quite a lot during compression, the vapour cannot be completely cooled down but it comes down to between five to 10°C above the temperature of surroundings. If the condenser is also bathed in running water, there would be evaporation of water and the vapour would get a little cooler. Doing this, however, can get complex, as the water needs to be treated, so that it does not deposit salts on the condenser, and then, the water needs to be cooled before it is used again. Arrangements like cooling towers are not practical for smaller applications. There is also significant water loss, by evaporation, the paper says. This is a serious negative, as water itself, in the regions of the Earth where economical cooling is most required, is scarce.

Radiative cooling, with application to cooling the condenser of refrigeration plants, then becomes an attractive possibility. The Stanford group made use of aluminum plates, some three-fourths of a cm thick and just two x two feet in dimension, with a winding copper tube embedded inside them. The radiative cooling surface, which combined high reflectivity with the capacity to radiate at the most advantageous wavelengths, was attached to the metal sheet with

an adhesive that conducted heat. The cooling surface was hence closely in contact with the copper tubing, through which a stream of water was passed. Sunshades were also placed so that the casing of the arrangement did not heat directly under the Sun.

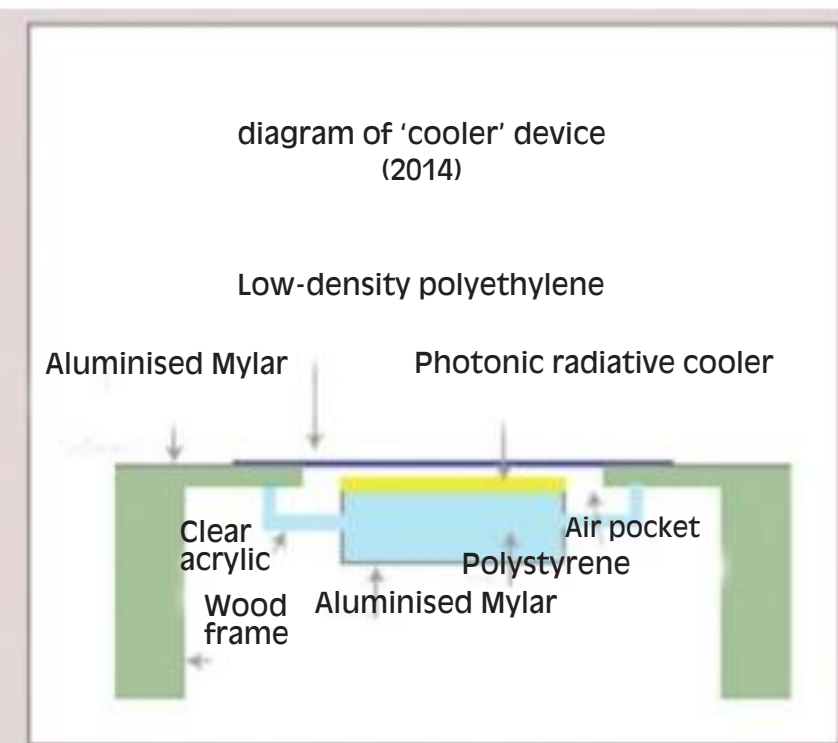
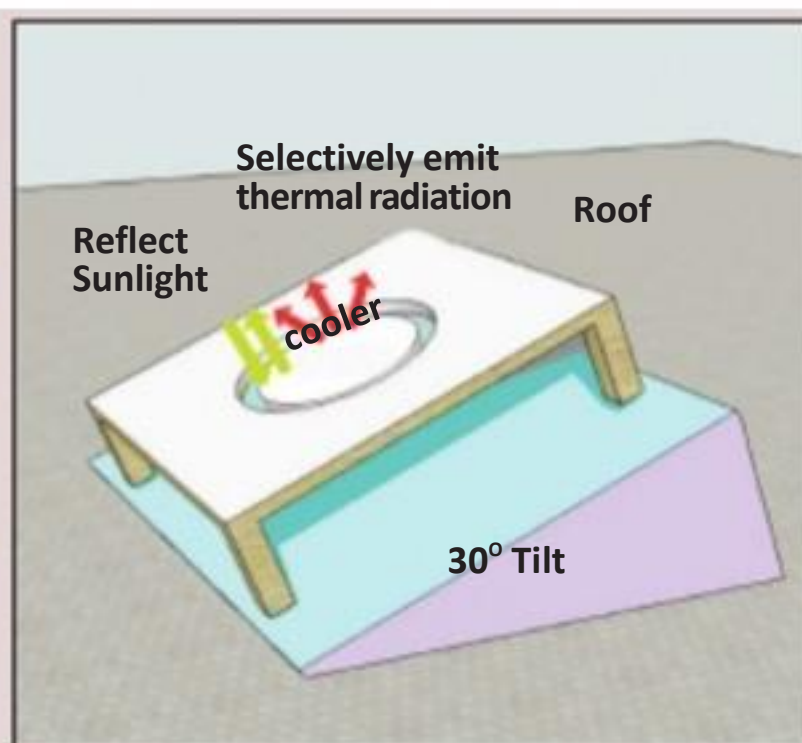
The stream of water was found, during trials, to cool by two and three °C, with flow rates, respectively, of 0.29 litres a minute and 0.12 litres a minute, for a one square metre cooling plate, at the hottest time of the day. Averaging over 72 hours, the arrangement gave cooling of three to five °C at an effective flow rate of 2.67 litres a minute. This corresponds, the paper says, to a rate of discharge of heat of 40W to 70W by each square metre of the cooling plates. The paper goes on to estimate the effect that this rate of extraction of heat would have on the efficiency of an air-conditioning plant if the cooling arrangement was linked to the condenser of the plant. "Over four summer months (May through August of a Typical Meteorological Year) in Las Vegas, Nevada, US, we show that by covering 60 per cent of the roof on a two-storey commercial building, 14.3 MWh of electricity could be saved, corresponding to a 21 per cent reduction in the electricity required for cooling", the paper says. It is not that radiative cooling has



The embedded, winding copper tube that carries water.

not been used before. There are arrangements where a water tank connected to a roof-top heat exchanger can generate cool drinking water during the night, in arid areas. The paper cites work by Fernandez, Wang, Alvine and Katipamula where the same surface materials used here were employed with a heat storage system to achieve higher energy savings, 45 per cent in Las Vegas. The system used by the Stanford group, which needs no arrangements for heat storage, however, is more suited for use with building cooling systems, the paper says.

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You are what you eat



More than body weight, a much better indicator of internal well-being is diet

DOMINIC TRAN

According to the Australian Institute of Health and Welfare, 63 per cent of Australian adults are overweight or obese.

But it's much harder to estimate how many are within a healthy weight range but have poor diets or sedentary lifestyles. These can cause significant health problems that will often

be missed because the person appears to look "healthy".

How do we judge the health of weight?

Obesity statistics often take estimates of body fat using body mass index. Although BMI isn't perfectly correlated with body fat percentage, it's a quick and easy method for collecting data using just the person's

height and weight. If the BMI is higher than 25, a person is considered "overweight". If it's above 30, they're considered "obese". But BMI doesn't tell us how healthy someone is on the inside.

Using additional lifestyle measures, such as diet and exercise frequency over the last year, a recent report from the Queensland Health department estimated 23 per cent of

those who are not currently overweight or obese are at risk of being so in the future. These figures indicate that the percentage of unhealthy-weight individuals does not accurately capture the percentage of unhealthy-lifestyle individuals, with the latter number likely to be much higher.

If you're not overweight, does a healthy lifestyle matter?

Many people think if they're able to stay lean while eating poorly and not exercising, then that's okay. But though you might appear healthy on the outside, you could have the same health concerns as overweight and obese individuals on the inside.

When considering risk factors associated with heart disease and stroke or cancer, we often think about health indicators such as smoking, cholesterol, blood pressure, and body weight. But poor diet and physical inactivity also each increase the risk for heart disease and have a role to play in the development of some cancers.

So even if you don't smoke and you're not overweight, being inactive and eating badly increases your risk of developing heart disease.

Little research has been done to compare the risk, diet and exercise contributes to the development of heart disease in overweight versus skinny but unhealthy individuals. However, one study measured the risk of different lifestyle factors associated with complications following acute coronary syndrome — a sudden reduction in blood flow to the heart.

It found adherence to a healthy diet and exercise regime halved the risk of having a major complication (such as stroke or death) in the six months following the initial incident compared with non-adherence.

Unhealthy diets are bad for your body, but what about your brain?

Recent research has also shown overconsumption of high-fat and high-sugar foods may have negative effects on your brain, causing learning and memory deficits. Studies have found obesity is associated with impairments in cognitive functioning, as assessed by a range of learning and memory tests, such as the ability to remember a list of words previously presented some minutes or hours ear-

lier. Notably, this relationship between body weight and cognitive functioning was present even after controlling for a range of factors including education level and existing medical conditions.

Of particular relevance to this discussion is the growing body of evidence that diet-induced cognitive impairments can emerge rapidly — within weeks or even days. For example, a study conducted at Oxford University found healthy adults assigned to a high-fat diet (75 per cent of energy intake) for five days showed impaired attention, memory, and mood compared to a low-fat diet control group.

Another study conducted at Macquarie University also found eating a high-fat and high-sugar breakfast each day for as little as four days resulted in learning and memory deficits similar to those observed in overweight and obese individuals.

These findings confirm the results of rodent studies showing specific forms of memories can be impaired after only a few days on a diet containing sugar water and human "junk" foods such as cakes and biscuits.

Body weight was not hugely different between the groups eating a healthy diet and those on high fat and sugar diets. So this shows negative consequences of poor dietary intake can occur even when body weight has not noticeably changed. These studies show body weight is not always the best predictor of internal health.

We still don't know much about the mechanism(s) through which these high-fat and high-sugar foods impair cognitive functioning over such short periods. One possible mechanism is the changes to blood glucose levels from eating high-fat and high-sugar foods. Fluctuations in blood glucose levels may impair glucose metabolism and insulin signalling in the brain.

Many people use low body weight to excuse unhealthy eating and physical inactivity. But body weight is not the best indicator of internal well-being. A much better indicator is your diet. When it comes to your health, it's what's on the inside that counts and you really are what you eat.

The writer is a postdoctoral research associate, University of Sydney, Australia. This article was originally published on www.theconversation.com

PLUS POINTS

Asteroid clicks



The Japanese space agency has released stunning new pictures taken by a rover standing on top an asteroid. The images, sent down from the surface of the asteroid Ryugu, show the rock in amazing and eerie detail. They were sent back over a distance of around 180 million miles.

They come after the space agency successfully landed two rovers on the asteroid, dropping them from a spacecraft floating just above the surface. The rovers dropped down onto the asteroid by the Hayabusa-2 spacecraft are the first mobile exploration robots ever to land on an asteroid's surface. The images they are sending back are the first time that anything has ever autonomously moved and taken pictures themselves on asteroid, too.

One of the pictures includes the shadow of the antenna and pin of the rover itself. The pin — which is the long line that can be seen sticking out of the rover — helps increase friction when they engage in the hops that they use to jump around the surface, among other purposes.

Jaxa, the Japanese space agency, says that both of the rovers are "in good condition and are transmitting images and data". The pictures they are sending back have confirmed that they are moving themselves around the asteroid's surface.

The rovers will spend their time exploring the surface by being joined by yet another visitor, called Mascot, built by scientists in Germany and France that will further explore the surface.

The new pictures are the second batch to be sent down by the Hayabusa-2 spacecraft. The first were taken as the two rovers tumbled to the surface, and show their whirling motion as they fall.

The independent

'Biggest bird' ever



After more than a century of conflicting evidence, Anglo-French animosity and an HG Wells novella involving murder most fowl, scientists said last week they have finally solved the riddle of the world's largest bird.

For 60 million years the colossal, flightless elephant bird — *Aepyornis maximus* — stalked the savannah and rainforests of Madagascar until it was hunted to extinction around 1,000 years ago. In the 19th century, a new breed of buccaneering European zoologists obsessed over the creature, pillaging skeletons and fossilised eggs to prove they had discovered the biggest bird on Earth. But the study released last week by British scientists suggests that one species of elephant bird was even larger than previously thought, with a specimen weighing an estimated 860kg — about the same as a fully grown giraffe.

"They would have towered over people," James Hansford, lead author at the Zoological Society of London, told AFP. "They definitely couldn't fly as they couldn't have supported anywhere near their weight."

In the study, published in the journal, *Royal Society Open Science*, Hansford examined elephant bird bones found around the world, feeding their dimensions into a machine-learned algorithm to create a spread of expected animal sizes.

Named *Vorombe titan* — Malagasy for "big bird" — the creature would have stood at least three metre tall and had an average weight of 650kg, making it the largest bird genus yet uncovered.

Despite having one of the longest existences of any animal in Madagascar — whose isolation from the rest of Africa led to the development of several entirely unique species — the elephant bird died out after a new wave of human settlers arrived around a millennium ago.

Far from being an ancient curiosity, Hansford believes the elephant bird could hold vital clues in how to manage Madagascar's future ecosystem despite being extinct for 1,000 years.

The straits times/ann