**So, I guess most of us up here in the northern hemisphere all had bouts of pretty-sweltering weather this summer, didn’t we? We even broke some all-time records over here in Europe. And I imagine you folks in southern hemisphere climes like Australia have the word ‘sweltering’ pretty much seared into every one of your summer seasons.**

**Now I’m not going to use this video to get into the whys and wherefores of whether those high temperatures are being affected by climate change…**

**(they are!)**

**No, far be it from me to inculcate such a contentious notion.**

**But I AM going to use this video to consider what could be regarded as a somewhat counterintuitive solution to the problem of increased warming from our sun. And that’s the concept of using the sun’s heat to cool us down.**

**Pretty weird, eh?**

**It’s a technology called solar cooling, and I’m not talking about simply using solar panels to provide electricity to run an air-conditioner, although using renewables for that purpose is a pretty good idea in itself. No, I’m talking about a system that can collect heat directly from sunlight outside and apply some clever physics to it to produce cool air inside.**

**There are some commercial operators already offering various versions of solar cooling in hotter parts of the world, but now a team at the Massachusetts Institute of Technology in the States has published a research paper demonstrating a system that can provide passive cooling to preserve food crops and improve the efficiency of conventional air conditioners, using only the heat of the sun and a very small amount of water and with no need for any additional electrical power.**

**So, as usual, the question has to be, is this yet another piece of academic genius from smart MIT post-doctorates and professors that’ll never actually work in the real world, or is it a radical piece of insight that could dramatically reduce energy requirements for cooling in a future, more sustainable world?**

**Hello and welcome to Just Have a Think.**

**Here’s a couple of stats for you, courtesy of the International Energy Agency…**

**Half of all the air conditioners in use in the world today are in China and the United States. More than half a billion households in those two countries own an AC system. But of the nearly three billion people living in the hottest, mid latitude, parts of the world, only eight percent have access to their own air conditioning. That’s changing fast though, and by twenty fifty, the IEA projects that around two thirds of all homes in the world will have an air conditioning system installed, half of which will be in China, India and Indonesia.**

**Current air conditioning technology is incredibly energy hungry, and if it’s powered by electricity generated by coal or gas power plants then the rapid increase in the number of units will inevitably result in a similar increase in greenhouse gas emissions. Plus, those systems only transfer heat from one place to another. They don’t actually cause heat to leave the overall planetary system, which means local external temperatures, especially in tightly packed urban environments, continue to increase, and more and more cooling power is required.**

**So, anything that can be done to mitigate that effect must surely be welcomed. Obviously moving rapidly away from fossil fuels and towards low carbon alternatives like wind and solar is arguably the most important step, but if we can make the cooling process itself more efficient then all the better, eh?**

**Nature’s way of keeping us cool is the process of evaporation, which is what happens when we sweat. Water droplets on the surface of our skin get heated by the ambient air temperature until they change phase from a liquid into a gas, or vapour. That phase change involves something called the latent heat of evaporation, which requires about six hundred extra calories of energy to liberate the molecules in each gram of water and allow them to escape as vapour. And that loss of energy is what cools our skin down.**

**You can achieve a similar effect by filling a container with water and letting it evaporate as it removes energy from the surrounding warm air. It’s a way of passively cooling your immediate surroundings and if you place a circulating fan next to the bowl then you can direct the cooler air to where you want it. But you need an awful lot of water to make an appreciable difference so you’ll be constantly refilling your container, and all that water vapour will increase the humidity of the air, which in many parts of the world is the last thing you want to do.**

**Nature also uses radiative cooling to keep the entire planet at a liveable temperature. Some of the energy reaching our planet’s surface is radiated back out as infra-red light. That energy then escapes back up into the cold empty vastness of outer space. If the planet couldn’t lose that unwanted energy, then temperatures would quickly reach uninhabitable levels. And by the way, it’s light in the infra-red range that’s being captured in increasing quantity by the greenhouses gases that our modern lifestyles are spewing out into the atmosphere, which is why our scientists are so worried about global warming… BUT I promised I wouldn’t go down that road today, so let’s park that and get back to the main point which, in this case, is that infra-red heat radiation represents another potentially powerful way to achieve passive cooling. It’s a technique that’s been used for centuries in tropical and sub-tropical regions for cooling, and water harvesting during the night-time, when the temperature differential between the earths surface and the skies above is at its greatest, especially on a clear night with no cloud cover. The effect is much less pronounced during the day though, so its not so easy to reap the benefits of infra-red radiation for daytime cooling, which is often when people need it the most.**

**The folks at MIT say they’ve taken both these, somewhat limited thermodynamic principles and combined them with a thermal insulation layer to produce a much more efficient cooling system about the size of a standard solar PV panel.**

**Essentially, you’ve got three layers of material. The top layer is an aerogel, which is an extremely porous sponge-like polyethylene material containing a proportionately large volume of air in the cavities. It’s an inherently very good insulator, but crucially it also allows both water vapour and infra-red light to pass through.**

**Below that is a second layer containing hydrogel. It’s another sponge-like material, but as the name suggests, the pores of this one are filled with water. It’s apparently very similar to materials used in cooling pads and wound dressings. The hydrogel acts as the source of water for the evaporative part of the cooling process.**

**The bottom layer is a mirror-like material that reflects any remaining sunlight that managed to make its way through the top two layers. That heat reflection prevents the entire device from warming up too much, which would otherwise negatively affect its overall performance. The top layer of aerogel is also a very good solar reflector, so it helps to keep the system cool as well, even under strong direct sunlight.**

**The effect of this triple layer sandwich is both evaporative cooling from the hydrogel AND infra-red radiative cooling from the reflective base layer. And unlike traditional air conditioners which simply spew unwanted hot air out into the surrounding external environment, the infra-red radiation from this cooling system goes straight up through the atmosphere and out into space which, according to the MIT team, means it really is removing heat from the earth’s system.**

**One of the paper’s authors, MIT postdoc Zhengmao Lu explained**

**“The challenge previously was that evaporative materials often do not deal with solar absorption well.”**

**“when they’re under the sun, they get heated, so they are unable to get to high cooling power at the ambient temperature.”**

**The novel insight that the team have shown here is simply to bring together the three principles of evaporation, radiation and insulation into a single design architecture to overcome these previous deficiencies. The system was tested on a rooftop at MIT, using a small version about four inches across, and it demonstrated that even in suboptimal weather conditions it could achieve just over nine degrees Celsius, or about nineteen degrees Fahrenheit of cooling.**

**The design is so slimline that it could, theoretically, be incorporated into the lid of a food container, keeping food cold and fresh for much longer periods of time without the need for electrical power. That really could be absolutely transformational in remote off-grid areas, or in parts of the developing world where many folks simply can’t afford electrically powered cooling technologies.**

**But larger, roof mounted, panels could also be used to send chilled water through pipes to the condenser of an existing air conditioning system. Condensers in those systems remove heat from highly compressed refrigerant gas, allowing it to convert back into a liquid and carry on through the AC pipework. So, by design, condensers get very hot. If chilled water could be channelled around the condenser, then heat could be dissipated much more quickly, and the overall efficiency of the AC system would be greatly improved, which in turn would mean a significant reduction in energy requirement to run the equipment.**

**The only maintenance required by the MIT design is the addition of water from time to time to ensure that evaporation is happening. But the MIT team reckon the system’s water consumption is so low that this need only be done about once every four days in the hottest, driest areas, and only about once a month in wetter areas.**

**Now, there is an inevitable caveat of course, because life is never quite as simple as we’d like it to be, is it?**

**While the majority of materials in the system are readily available and relatively inexpensive, producing the aerogel is currently not a cheap process. It turns out that the size of the pores in the aerogel is a very specific and absolutely critical parameter in the overall efficiency of the system. The pores are produced by mixing the polyethylene with solvents and allowing it to set like a block of jelly, or jell-O if you’re of an American persuasion, until it reaches something called a critical drying point or CPD, where the solvent can be removed from the polyethylene without damaging its very delicate structure. That requires specialist equipment, which of course costs money.**

**The research team is looking at other less expensive techniques like freeze-drying, and they’re experimenting with alternative materials that might provide the same insulating function at lower cost, such as membranes separated by an air gap, but right now it sounds like the aerogel is a limiting factor that is going to increase the timeline for transforming this technology into a commercial reality. But if they can get that wrinkle ironed out then this one does look like a very promising development, especially for food storage and safety in those parts of the world with limited access to the resources we all enjoy in western societies. And if it can improve the efficiency of the billions of additional air conditioners I mentioned right at the start of the video, then it could make a significant contribution to climate change mitigation.**

**And while we’re on the subject of climate mitigation strategies, I just wanted to mention this brand-new publication called the Carbon Almanac. It’s not something I’ve personally been involved with and I’m not getting any money to plug the book, but I felt it was worth bringing it to your attention if you haven’t already seen it, because it’s absolutely jam packed full of just about every conceivable option for reducing the effects of climate change in the coming decades. Every technology and data point in the book is supported by comprehensive references that can be looked up on the accompanying website, so you can check out the scientific robustness of each technology idea for yourself. It’s well worth a read.**

**That’s it for this week though. Thanks to all our Patreon supporters out there who allow me to keep these videos free of ads and sponsorship messages, and if you’d like to join them in getting exclusive extra monthly content from me and having your say on future video topics, then you can visit**

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**As always, thanks very much for watching, have a great week, and remember to Just Have a Think.
See you next week**